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**Corporate Management Accounting for Sustainable
Development: a Multimethod Approach**

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Dissertation content

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Corporate Management Accounting for the Sustainable Development Goals: a Multi-Level Framework

B. Paper 1

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E. Paper 4

Wenzig, J., Nuzum, A.-K., and Schaltegger, S. (2022). Path dependence of accountants: Why are they not involved in corporate sustainability? *Business Strategy and the Environment*, 1–22.

F. Paper 5

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Annex

- I. Author contributions to dissertation papers and publication status
- II. Presentations related to this dissertation
- III. Declaration

A. Dissertation Framework

Corporate Management Accounting for the Sustainable Development Goals: a Multi-Level Framework

Corporate Management Accounting for the Sustainable Development Goals: a Multi-Level Framework

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Abstract

Companies are invited to contribute to the United Nations' 17 Sustainable Development Goals (SDGs) and sustainability management accounting (SMA) has an important role to play in achieving them. However, if companies are to address the SDGs and linkages beyond organizational boundaries, SMA needs a broader scope than is conventionally assumed. Therefore, I advance a multi-level framework that addresses context, action-formation, and transformative contributions (CAT) in the following directions: first, an innovative systematic method that allows screening company-related SDGs and assessing corporate contributions to selected SDGs is introduced; second, management control systems are integrated to support managers in guiding employee behavior to make contributions to the SDGs; and, third, self-reinforcing mechanisms of the path-dependence theory are incorporated to serve as a guide to identifying barriers to individuals and groups becoming involved in SMA. This advanced CAT framework contributes to corporate practice and research by providing a multi-level framework that offers concrete management guidance for SMA to address the SDGs. It also facilitates analysis of both enabling and inhibiting factors at the organizational level. The advanced CAT framework has several implications for SMA: it promotes backcasting from the SDGs for benchmarking purposes, integrates different social, environmental, and economic issues, facilitates future-oriented action and transformation planning, addresses different layers such as the company as well as individuals and groups within it and enables to identify barriers hindering individuals and groups from becoming involved in SMA.

Keywords

Sustainable development goals, corporate sustainability, sustainability management accounting, management control systems, management accountants

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1. Introduction

In 1992, the United Nations agreed on sustainable development as a guiding principle for the nations of the world (UNCED 1992). It defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (UNWCED 1987, p. 8). To set clear sustainability goals, in 2001 the UN established the 8 Millennium Development Goals (MDGs), which were to be achieved by 2015 (UN 2015a). The MDGs focused on improving social issues in developing countries, including reducing extreme poverty (MDG 1), achieving universal primary education (MDG 2), and improving maternal health (MDG 5; Fehling et al. 2013). The successor to the MDGs, the 17 Sustainable Development Goals (SDGs) and their 169 targets, envisions a broader scope of action for both developed and developing countries (UN 2015b). The SDGs address a wide range of sustainability impacts, such as good health and well-being (SDG 3), decent work and economic growth (SDG 8), sustainable cities and communities (SDG 11), and climate action (SDG 13).

Companies have a significant role to play in attaining the SDGs (Avrampou et al. 2019; van Zanten and van Tulder 2018). While the SDGs primarily address states, companies are also called upon to contribute to the achievement of the SDGs. Former UN Secretary-General Ban Ki-Moon explicitly called for companies to support the SDGs, stating that “business is an essential partner in achieving the Sustainable Development Goals. Companies can contribute through their core activities, and we ask companies everywhere to assess their impact, set ambitious goals, and communicate transparently about the results” (GRI et al. 2015, p. 4). Many of the issues addressed in the SDGs, such as ensuring human rights (e.g., Ruggie 2014), halting climate change (e.g., Burritt et al. 2011), slowing biodiversity loss (e.g., Campbell et al. 2017), or closing the global nitrogen cycle (e.g., Whiteman et al. 2013) are closely related to the impacts of companies.

Both corporate practice and academic research suggest that sustainability management accounting (SMA) could play an important role in promoting corporate contributions to sustainable development and the SDGs (e.g., CGMA 2018; Bebbington and Larrinaga 2014). SMA refers to the process of collecting, analyzing, and communicating sustainability-related information to support internal decision-making in pursuit of corporate sustainability (Burritt and Schaltegger, 2010). It focuses on the most material issues for decision-making (Farooq et al., 2021) and uses both monetary (e.g., sales, salaries) and non-monetary or physical data (e.g., carbon emissions), as both are recognized as drivers of value creation (Maas et al., 2016). In general, SMA is used to align internal processes to improve sustainability performance (Burritt et al. 2002).

To contribute to sustainable development, companies need SMA systems that take account of macro- and meso-level linkages (Schaltegger et al. 2022). From a corporate perspective, the macro-level includes, for example, the SDGs (UN 2015b), planetary boundaries (Steffen et al. 2015), and human rights (McPhail and Ferguson 2016). At the meso-level companies are influenced by and exert influence on networks (e.g., the Science Based Targets Network),

guidelines (e.g., the World Resources Institute's Greenhouse Gas Protocol), or accounting organizations (e.g., the Sustainability Accounting Standards Board). In a publication from this dissertation, Schaltegger et al. (2022) developed a framework to conceptualize the interlinkages of SMA with the macro- and meso-levels (Schaltegger et al. 2022). The framework distinguishes between situational context, action-formation, and transformative contributions (CAT). The situational context describes the influence of contextual processes and institutions (e.g., of networks, regulations, lifestyles, or the natural environment) outside the companies' boundaries on the organization, whereas transformative contributions describe how companies influence these processes and institutions. Action-formation represents the SMA practices companies adopt and the social, environmental, and economic activities they undertake.

However, several gaps in the CAT framework remain unexplored. First, at the macro-level, the framework remains vague on how companies can consider the situational context and their transformative contributions to the SDGs, which represent a key macro-level concept for SMA, as they have been adopted by all UN member states as a guiding principle for sustainable development (UN 2015b). Furthermore, other macro-level concepts such as the planetary boundaries are explicitly (SDG 6, 13, 14, 15) or implicitly (SDG 2, 7, 11, 12) included in the SDGs (Rockström 2021). Second, at the organizational micro-level where SMA is located, it does not specify in detail how companies can organize action-formation. Practical guidance for management to apply management accounting has been called for (Malmi and Granlund 2009) but is currently underspecified in the framework. Third, also at the micro-level, the role of individuals and groups in promoting action-formation is not addressed in the CAT framework. This is of relevance as the multi-level literature explicitly calls for consideration of individuals and groups and their interdependencies when conceptualizing macro-micro interactions (Hedström and Swedberg 1998). This framework paper aims to advance the CAT framework by addressing these gaps and answering the following overarching research question: How can companies account for their situational context and transformative contributions with regard to the SDGs and promote action-formation?

The advanced CAT framework makes the following contributions. First, it provides a comprehensive multi-level framework for SMA practice and research to address the SDGs. At the macro-level, it adopts a systematic method that allows for a thorough analysis of company-related targets and an assessment of corporate contributions to the SDGs. At the meso-level, the role of industry standards, guidelines, stakeholders, and competitors for SMA regarding the SDGs is discussed. At the micro-level, management control systems (MCS) are adopted and specified to promote action-formation concerning the SDGs. Second, the advanced CAT framework provides concrete management guidance on how to organize and structure SMA. While the original framework addressed situational context, action, and transformation, introduced multiple levels, and identified key questions for corporate practice and research, this framework paper concretizes the CAT framework by a) incorporating a systematic method for management to account for the situational context and transformative contributions concerning the SDGs, b) adopting MCS to support managers in guiding employee behavior, and c) using the self-reinforcing mechanisms of the path dependence theory to identify barriers

to involving individuals and groups. Third, adopting MCS and self-reinforcing mechanisms to promote action-formation at the micro-level, allows consideration of both enabling and inhibiting factors for effective multi-level SMA. Furthermore, both the company as well as the individuals and groups within it can be addressed.

This framework paper is structured as follows. In Section 2, I review the literature on SMA and its linkages with the macro- and meso-levels. It details the CAT framework and addresses gaps that remain unexplored. In Section 3, I present the publications of this dissertation and their methodologies. In Section 4, I advance the framework in line with the gaps identified and present an advanced CAT framework. In Section 5, I discuss the implications of the advanced CAT framework as well as its limitations and recommend avenues for future research.

2. Literature review

In this section I review the SMA literature and its links to the macro- and meso-levels with a focus on promoting sustainable development. Furthermore, I present the original CAT framework in detail and explore important gaps.

2.1 Sustainability Management Accounting and its Links to Macro- and Meso-Levels

SMA supports companies in managing their sustainability impacts (Adams and Larrinaga-González 2007) by organizing the collection, analysis, and communication of all information related to corporate sustainability management, including social, environmental, and economic data (Maas et al. 2016). SMA uses a heterogeneous set of methods and measurements for monitoring, data collection, information generation, reporting, and decision support (Burritt et al., 2002; CIMA 2005). Although the accounting literature began to address sustainable development some twenty years ago (Gray 2002), there has been frustration with the perceived lack of progress in how companies address sustainable development (Bebbington and Larrinaga 2014). Some scholars note that the concept of sustainable development is difficult to grasp in an organizational context and lacks credible accounts in practice (Gray and Milne 2004). Gray (2010, p. 47) observes that the “baggage associated with conventional accounting is no longer apposite when seeking to account for sustainability” and that “accounts of sustainability” in organizations have little, if anything, to do with sustainability. However, companies have an important role to play in promoting sustainable development, and SMA could support their internal organization (Burritt and Schaltegger 2010).

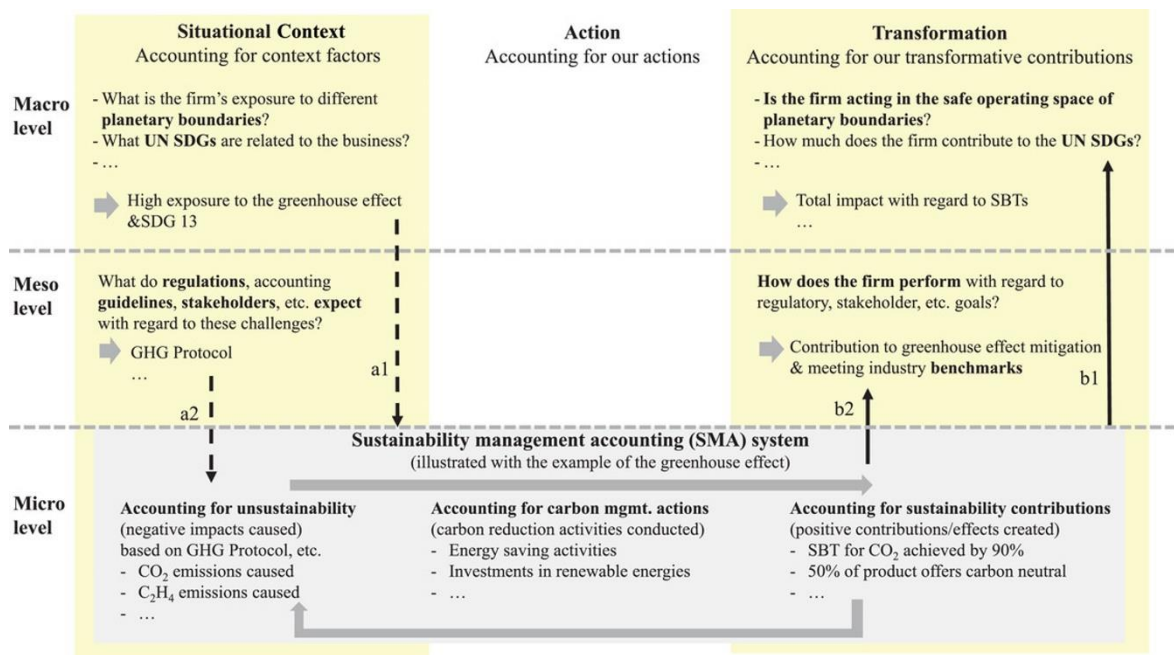
A key issue with accounting systems is their internal focus. Maas et al. (2016, p. 241) point out that “management accounting data is in general used for internal alignment and to improve performance. The measures and indicators are predominantly internally motivated.” SMA has a similar focus and has been studied specifically to improve various internal issues such as water use (Christ and Burritt 2017), waste (Fakoya and van der Poll 2013), material flows (Kokubu and Kitada 2015), carbon emissions (Stechemesser and Guenther 2012), and health and safety (Cooper et al. 2011). While the internal focus is appropriate for financial management accounting, SMA requires a broader scope that also considers linkages between the internal micro-level and the meso- and macro-level to address the wider notion of sustainable development (Schaltegger et al. 2022).

An analysis of the SMA literature shows that it largely neglects external links to the meso- and macro-level (Schaltegger et al. 2022). While there is some ambiguity as to whether this reflects actual corporate practice or the researcher's perspective, Silva's (2021) analysis of FTSE 100 reports shows that large companies only symbolically address the SDGs without substantively changing their routines and practices. Moreover, a lack of scientific methods to systematically analyze the SDGs and companies' contributions to them is identified (Weidema et al. 2018). The links that are addressed in the literature have focused on contextual factors that influence accounting systems (e.g., Doh et al. 2017), rather than on the contributions that companies can make to promote transformative contributions. However, particularly the transformative contributions by companies are crucial for attaining the SDGs. This finding can be interpreted as a more reactive perspective on SMA (Larrinaga-González and Bebbington 2001). Schaltegger et al. (2022) find that very little accounting research has focused on measuring impacts on the broader environment, and even less on achieving social goals. For example, the Science Based Targets initiative establishes direct links between corporate greenhouse gas emissions and global warming targets. However, the link between different SMA approaches and contributions to global warming mitigation has not been analyzed in depth (for an introduction, see Faria and Labutong, 2019).

2.2 Accounting for Context, Action-formation, and Transformative Contributions (CAT)

In order to conceptualize corporate links to the meso- and macro-levels, Schaltegger et al. (2022) draw on Hedström and Svedberg's (1998) refinement of Coleman's (1986) multi-level framework, a sociological model for explaining collective social action. According to Hedström and Swedberg (1998), changes and variations at the macro-level influence the behavior of individual actors, who in turn generate a new macro state at a later time. Social interactions are shaped by situational mechanisms (contextual influences) at the macro-level, action-formation mechanisms at the micro-level, and transformational mechanisms at the macro-level. An important notion of the multi-level framework is that mechanisms in the social sciences aim to explain, instead of showing causal relationships of effects (Hedström and Wennberg 2017). While causal (statistical) relationships can play an important role in describing macro-level outcomes, establishing a causal relationship is rarely sufficient to provide a good explanation. Instead, mechanisms in the sense of the multi-level framework can provide good explanations of how macro- or meso-level outcomes are brought about but are sometimes difficult to identify and replicate in practice (Hedström and Swedberg 1998).

FIGURE 1: THE ORIGINAL CAT FRAMEWORK FOR SMA FROM SCHALTEGGER ET AL. (2022)



The CAT framework was developed to assist research and practice in accounting for multilevel linkages and addresses the situational context, action, and transformation (Schaltegger et al. 2022; see Figure 1). In addition to the macro- and the micro-levels described by Hedström and Swedberg (1998), Schaltegger et al (2022) add a meso-level that encompasses, for instance, guidelines, regulations, and stakeholders. In this framework, companies account for the situational context by gathering data and insights about external contextual factors that influence them from the macro-level, such as SDGs and planetary boundaries (arrow a1 in Figure 1) as well as from the meso-level, including regulations, guidelines, stakeholders, standards, supply chains (arrow a2). In reaction to these influences from the macro- and meso-levels, companies then engage in action at the micro-level, which focuses on corporate activities with a direct social, environmental, and economic impact. To ensure that action-formation takes place, negative impacts (unsustainability), management actions, and positive contributions must be accounted for. To promote transformation and ensure effective sustainability contributions beyond the organization, companies need to closely align SMA with key macro-level sustainability frameworks, such as the SDGs or planetary boundaries (arrow b1) as well as meso-level regulations, stakeholder goals, and industry standards (arrow b2).

2.3 Gaps in the original CAT Framework

The original CAT framework has crucial gaps that remain unexplored with respect to accounting for the SDGs at the macro- and meso-levels and specifying comprehensive management controls as well as effectively engaging individuals and groups for action-formation at the micro-level. These gaps are detailed below.

Accounting for the SDGs

The original CAT framework emphasizes the importance of linking SMA to macro-level concepts such as the SDGs but does not specify how companies can account for the situational context regarding the SDGs, nor how they can select relevant targets. The SDGs represent a powerful concept at the macro-level that has a significant impact on companies and to which they aspire to contribute positively (e.g., KPMG 2017; ACCA 2017; PwC 2015). However, as the SDGs were designed for countries and are mostly at the policy level (Vermeulen 2018), it can be difficult for companies to select targets that are relevant to their business (Herrera-Almanza and Corona 2020). A study by PriceWaterhouseCoopers (PwC) finds that when it comes to engaging with the SDGs, companies tend to remain either vague or “cherry-pick the SDGs they want to focus on and ignore others that don’t meet their corporate priorities or comfort zones” (PwC 2015, p. 12). Subsequent evidence also shows that companies are still addressing the SDGs in a rather superficial way, suggestive of “SDG-washing” (Heras-Saizarbitoria et al. 2021, p. 317, Silva 2021). The CAT framework establishes a link to the SDGs but only asks very broadly, “What UN SDGs are related to the business?” without providing a way to systematically assess this link (Schaltegger et al. 2022, p. 493). Thus, further specification on how to assess the situational context and how to select company-related SDGs would provide additional management guidance.

Furthermore, the original CAT framework does not specify how companies can account for their transformative contributions to the SDGs. The CAT framework establishes a link between companies and their contributions to the SDGs, but only asks in a very general way how much the firm contributes to the UN SDGs without indicating how to assess this linkage (Schaltegger et al. 2022, p. 493). While the SDGs are complemented by a Global Indicator Framework (GIF-SDGs), which measures the respective 169 targets with 231 indicators, these are mostly at the country or policy level (UN 2022). A systematic method for measuring corporate contributions to the SDGs is lacking (Weidema et al. 2018). Even for the indicators that are suitable for measuring business contributions, most targets are not formulated in a way that allows companies to derive a quantified target and assess the extent to which they contribute to these targets (Eberle et al. 2022; van Zanten and van Tulder 2018). For example, Target 1.3 aims to “implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable” (UN 2015b). The corresponding GIF-SDG requires an analysis of the “proportion of population covered by social protection floors/systems” (UN 2022, p. 1). For this target and the GIF-SDG, several questions arise in assessing the contribution of companies to this target, including: What constitutes adequate social protection systems? Are companies only responsible for their employees or also for those along the value chain? How can the extent of the contribution be measured if not “everyone” benefits from social protection systems? Hence, a systematic method is necessary to account for the transformative contributions of companies to the SDGs and would significantly improve the CAT framework.

Comprehensive management controls for action-formation

At the micro-level action-formation is critical to promote transformative contributions at the macro-level (Schaltegger et al. 2022) but it is underspecified in the original CAT framework. The CAT framework only very broadly indicates that companies need an SMA system that accounts for unsustainability, management actions, and sustainability contributions (Schaltegger et al. 2022). In the example of the CAT framework for SMA at the micro-level (see Figure 1), accounting focuses mainly on measurement systems (e.g., CO₂ emissions, 50% carbon neutral products) and action planning (e.g., energy-saving activities).

The MCS literature has developed comprehensive management controls to manage companies (e.g., Malmi and Brown 2008; Simons 1995) and their impact on sustainability (e.g., Crutzen et al. 2017). While the linkage between SMA and MCS has not been thoroughly researched (Maas et al. 2016), in the systematic literature review by Schaltegger et al. (2022) MCS are considered part of management accounting. MCS offer a useful approach to specify action-formation and support companies in achieving their sustainability goals and strategies (Berry et al., 2009; Crutzen and Herzig, 2013; Guenther et al., 2016). They are conceptualized as a system when the controls are considered interdependent or as a package when a complete set of control practices are in place, regardless of their interdependence (Grabner and Moers 2013). This paper adopts the conceptualization of MCS as a package by Malmi and Brown (2008) who show that management controls (such as measurement systems or action planning) cannot be studied in isolation from each other. They provide a comprehensive typology of MCS as a package in five control areas—planning, cybernetics, reward and compensation, administrative, and cultural—that managers use to direct employee behavior. Management controls include both formal and informal controls to ensure the alignment of employee and managerial behavior and decision-making with organizational goals (Maas et al. 2016). Hence, MCS as a package can be used to specify action-formation at the micro-level and enhance the CAT framework.

The role of individuals and groups

The original CAT framework addresses the linkages between the micro- and the macro- and meso-levels but disregards the role of individuals and groups. This is a critical shortcoming because, as described in the previous section, employee behavior is instrumental in steering companies toward their goals and in implementing sustainability strategies (Guenther et al. 2016; Maas et al. 2016). Important insights for further developing the CAT framework in this regard can be drawn from the multi-level literature (Hedström and Swedberg 1998, Hernes 1998).

The general thrust of the multi-level literature is to analyze how “macro states at one point influence the behavior of individual actors” and “how the individual assimilates the impact” (Hedström and Swedberg 1998, p. 21). The actor in the situational context and action-formation mechanisms is a single individual, while in transformational mechanisms the analysis is extended to several actors who jointly influence new macro states. Only when applied to the organizational sphere, and depending on the specific problem at hand, can micro-level analysis focus on companies (Hedström and Wennberg 2017). In analyzing the

social interactions among individuals and in groups that lead to action-formation, Hedström and Wennberg (2017, p. 99) emphasize that contributions to “macro processes are typically not simple aggregations of micro processes but rather are the result of social interdependencies and complex feedback loops.” Analysis of individuals and groups should therefore consider interdependencies and feedback loops. Hedström and Swedberg (1998) also argue for the use of social mechanisms rather than statistical relationships to analyze and explain social phenomena. A fine-grained analysis of the action-formation mechanisms and positive feedback loops can assist managers to assess the barriers to individuals and groups becoming involved in SMA. Thus, addressing the role of individuals and groups in promoting action-formation and analyzing feedback loops that hinder action-formation at the micro-level would be a fruitful advancement in the CAT framework.

One group of actors that is key for promoting SMA are management accountants, who are typically responsible for management accounting and control systems (Oesterreich and Teuteberg 2019) and have great potential to promote corporate sustainability (e.g., Egan and Tweedie 2018; Williams 2015). According to Schaltegger and Zvezdov (2015), management accountants could support SMA by acting as methodological experts, authorities and gatekeepers, as well as knowledge experts. Their role as methodological experts includes their accounting skills in measuring, recording, monitoring, verifying, and handling data (Lovell and MacKenzie 2011; Pierce and O’Dea 2003) and reducing the cost of information collection (Burritt et al. 2011). In a gatekeeper function, they use their authority to ensure the flow of information to and from top management (Schaltegger and Zvezdov 2015; Adams, 2002). In their role as knowledge and information experts, management accountants contribute to corporate sustainability by assessing the type of information needed to successfully manage an organization (Jack and Kholeif 2008).

However, empirical research shows that, despite numerous reasons for their involvement, management accountants are largely absent from SMA (Egan and Tweedie 2018; Mistry et al. 2014; Spence et al. 2012). When they are involved, they mainly act as gatekeepers for top management and impede the flow of sustainability information (Schaltegger and Zvezdov 2015). Analyzing barriers to management accountants’ non-involvement and ways to overcome these barriers is critical for successful SMA and transformative contributions to the SDGs. The analysis of barriers and corresponding feedback loops as well as suggestions for overcoming them would support managers in facilitating effective action-formation.

3 Methodology

As part of this dissertation, together with other authors I wrote several papers that explored how companies could consider the situational context and transformative contributions toward the SDGs and promote action-formation. Each publication of this dissertation uses a different method: a systematic literature review, a conceptual development, case studies, and qualitative interviews. Table 1 provides an overview, including their key contributions to (further) develop the CAT framework, as well as the theories and frameworks they were based on. In this section, I extract the key results and findings of each paper and detail their methodologies.

TABLE 1: OVERVIEW OF THE PAPERS THAT ARE USED TO (FURTHER) DEVELOP THE CAT FRAMEWORK

Publication Title	Authors	Analysis / Contribution	Theory / Framework
“Corporate sustainability management accounting and multi-level links for sustainability— A systematic review”	Schaltegger, S., Christ, K. L., Wenzig, J., Burritt, R. L. (2022)	Analysis of SMA literature on multi-level linkages and proposal of the CAT framework	Coleman’s multi-level framework (1986) as refined by Hedström and Swedberg (1998)
“Assessing the contribution of products to the United Nations’ Sustainable Development Goals: a methodological proposal”	Eberle, U., Wenzig, J., Mumm, N. (2022)	Proposal of a systematic method to assess company- and product-related targets and contributions to the SDGs	Sustainable development report by Sachs et al. (2022) and biodiversity impact assessment method by Lindner et al. (2021)
“Managing Impacts on Biodiversity—A Comprehensive Analysis of Management Control Systems in Three Pioneer Food Companies”	Hübel, C., Wenzig, J. (2023)	Analysis of the biodiversity management control systems of three pioneering food companies and proposal of an ideal biodiversity management control package	Management control systems as a package by Malmi and Brown (2008)
“Path dependence of accountants: Why are they not involved in corporate sustainability?”	Wenzig, J., Nuzum, A.-K., Schaltegger, S. (2022)	Analysis of self-reinforcing mechanisms that lead to path dependence and prevent management accountants from engaging in corporate sustainability	Organizational path dependence theory based on Sydow et al. (2009)

The article by Schaltegger et al. (2022) systematically reviews the SMA literature on macro- and meso-level linkages. We followed the guidelines for systematic literature reviews of Tranfield et al. (2003) and used five leading databases (EBSCO Host-Business Source Premier, JSTOR, ScienceDirect, Scopus, and Web of Science). In order to find articles that address multi-level linkages to SMA, a set of terms related to SMA (e.g., carbon accounting, sustainability accounting, sustainability management control) were combined with terms related to the desired entities (e.g., company, corporation, business). From the 5,456 retrieved articles, we excluded duplicates, non-English and non-scientific quality journal publications (Australian Business Deans Committee quality criteria level C and above), and then reviewed references to multi-level linkages. A Krippendorff’s alpha with a cutoff threshold value of 0.8 (Krippendorff, 2019; Lombard et al., 2002) based on an SPSS macro by Hayes and Krippendorff (2007) was used as a proxy to analyze intercoder agreement on the criteria. The final sample for the review consisted of 62 publications. In this review, we identified a lack of linkages in the SMA literature to macro- and meso-levels. We developed the original CAT

framework to broaden the scope of SMA research, which forms the basis for the remaining papers in this dissertation.

The article by Eberle et al. (2022) is conceptual and proposes a systematic method to assess the contribution of products (and companies) to the SDGs. We develop questions to systematically screen the SDGs for product and company relationships, identify suitable indicators based on broadly accepted indicator frameworks, develop a social (organizational) life cycle impact assessment method based on an approach formulated in the Sustainable Development Report by Sachs et al. (2022), and use a biodiversity impact assessment method by Lindner et al. (2021) to assess their impact on the SDGs.

Hübel and Wenzig's (2023) article consists of exploratory case studies (Yin 2017) of three pioneering German food companies to analyze their biodiversity management controls. We collected data for the case studies in the form of 73 internal and publicly available documents and 17 semi-structured interviews. We analyzed them according to the five management controls specified by Malmi and Brown (2008). Qualitative data analysis was conducted using MAXQDA with a codebook that included the definition of codes, their usage, and corresponding examples (DeCuir-Gunby et al., 2011). Our data analysis was also validated by the companies' sustainability managers. Based on our findings, we presented key characteristics of the pioneers and an ideal biodiversity management control package.

In the article by Wenzig et al. (2022) we conducted semi-structured interviews with 33 management accountants from German companies and analyzed self-reinforcing mechanisms that prevent them from contributing to corporate sustainability. We analyzed the data using MAXQDA, following a coding scheme based on the identified mechanisms documented in a codebook. To ensure intercoder reliability, we regularly discussed coding results and double-checked all codes by another researcher. Based on the findings, we discuss the implications for path-breaking.

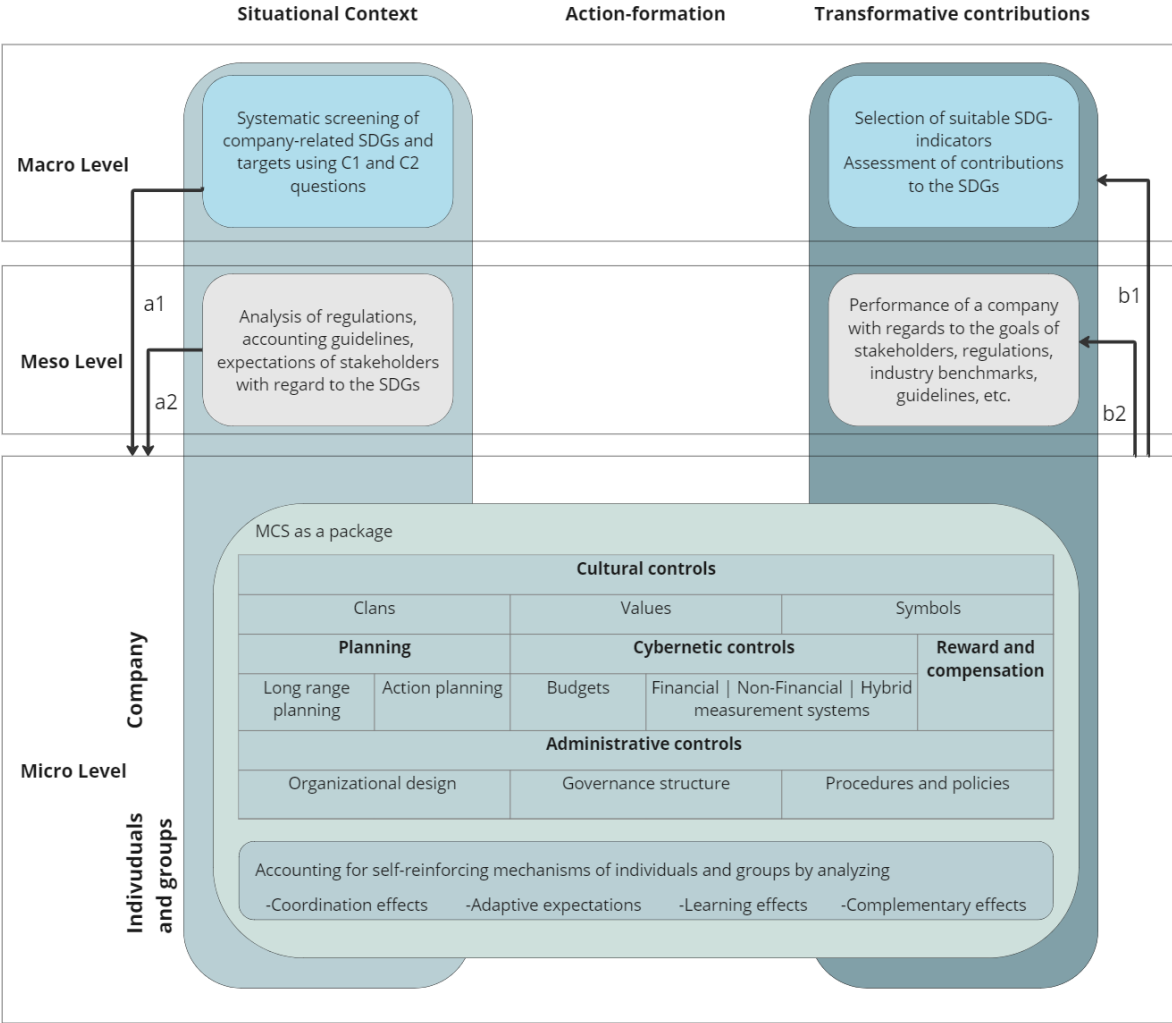
4 Advancements in the CAT Framework

This paper advances the CAT framework based on the publications that comprise this dissertation addressing the three gaps of the framework explored in Section 2.3. Table 2 provides an overview of the three main advancements of the CAT framework regarding a) context and transformative contributions related to the SDGs, b) effective action-formation using MCS, and c) self-reinforcing mechanisms of individuals and groups.

TABLE 2: ADVANCEMENTS IN THE CAT FRAMEWORK

	a) Context and transformative contributions related to the SDGs	b) Effective action-formation using MCS	c) Accounting for self-reinforcing mechanisms of individuals and groups
Limitations in the original CAT framework	How companies can account for the SDGs is not further specified	How companies can engage in effective action-formation is not elaborated in detail	Barriers to individuals or groups are not considered
Related publication	“Assessing the contribution of products to the United Nations’ Sustainable Development Goals: a methodological proposal”	“Managing Impacts on Biodiversity – A Comprehensive Analysis of Management Control Systems in Three Pioneer Food Companies”	“Path dependence of accountants: Why are they not involved in corporate sustainability?”
Advancement	A systematic method on how to account for context and transformative contributions related to the SDGs is added to the macro-level	MCS are added to the micro-level to specify how companies can comprehensively account for sustainability	Self-reinforcing mechanisms of individuals and groups are incorporated at the micro-level to assist managers in assessing positive feedback loops that hinder action-formation
Used theory/ framework/ method	Sustainable development report by Sachs et al. (2022) and impact assessment by Lindner et al. (2021)	MCS by Malmi and Brown (2008)	Path dependence theory by Sydow et al. (2009)
Mechanisms	Situational mechanisms Transformational mechanisms	Action-formation mechanisms	Action-formation mechanisms
Implication for management	Company-related targets of the SDGs can be systematically selected and their contribution quantitatively or semi-quantitatively assessed	Sustainability issues can be managed more comprehensively using MCS related to culture, planning, cybernetics, rewards and compensation, and administration	Self-reinforcing mechanisms that hinder individuals or groups (e.g., management accountants) from effectively engaging in SMA based on path dependence theory can be identified and overcome

FIGURE 2: THE ADVANCED CAT FRAMEWORK



The advanced CAT framework (Figure 2) is presented in the following sections. Section 4.1 elaborates on how companies can account for the SDGs by addressing both the situational context and transformative contributions, Section 4.2 explores how MCS can be used to organize action-formation at the micro-level, and Section 4.3 presents how management can account for self-reinforcing mechanisms of individuals and groups. The following sections address linkages between the macro- and micro-levels (arrow a1 and b1), between the meso- and the micro-levels (arrow a2 and b2) as well as action-formation at the micro-level.

4.1 Context and Transformative Contributions Related to the SDGs

In this section, I explore how the CAT framework can be advanced to address the SDGs more systematically. To account for the situational context and transformative contributions related to the SDGs at the macro-level, I adopt the method developed by Eberle et al. (2022) in the framework. The method accounts for the situational context of the SDGs by developing systematic questions to identify company-related targets and addresses transformative contributions to the SDGs by proposing a methodology to quantitatively or semi-quantitatively assess the contribution of companies to the targets. In the logic of the CAT framework, first,

systematic questions are introduced (arrow a1); second, it is illustrated how SMA produces relevant meso-level information regarding the SDGs (arrow a2); third, the methodology to quantitatively or semi-quantitatively assess the contribution to the 169 targets is presented (arrow b1); fourth, the transformative contributions at the meso-level are illustrated (arrow b2).

To account for the situational context of the SDGs at the macro-level, Eberle et al.'s (2022) method proposes two questions that allow companies to analyze the relationship of the 169 targets to their business and products (arrow a1). Originally, we proposed a method for social life cycle assessment at the product level. However, we specified that this method also allows for a social organizational life cycle assessment, which is more appropriate for this framework. Therefore, the original method is slightly modified in the advanced CAT framework to be suitable for an organizational assessment, but the basic logic and methodology remain the same. Two systematic questions and related cases allow an analysis of the relationship between the company and the targets in a replicable way (Eberle et al. 2022). Case 1 (C1): Does the company have a direct impact on the achievement of the target, and if so, on which components? The C1 question determines whether a positive or negative contribution to the achievement of the target, or a part of it, can be made directly through the potential impacts caused by the company itself. Case 2 (C2): Do companies along the company's supply chain have a direct impact on the achievement of the target, and if so, on which components? The C2 question assesses whether companies along the supply chain can contribute positively or negatively to the target. While these questions leave some room for interpretation, they do indicate that a) it is necessary to analyze all 169 targets, b) it is necessary to include impacts from both the company itself and companies in the supply chain, and c) it is sometimes possible that only part of a particular target is company-related, while other parts may be out of scope. These questions allow management to select company-related SDGs and more systematically consider contextual factors related to the SDGs. In an analysis of the food sector, Eberle et al. (2022) identified a reference to companies and their products for only 61 out of 169 targets (36%). This indicates that most SDGs are at the policy and not the company level (Eberle et al. 2022), which is consistent with previous research (e.g., Vermeulen 2018). Although the authors have developed a blueprint for companies and their products, companies are encouraged to screen all targets themselves, taking into account their own operations and supply chains, and assess their potential contribution to the targets.

SMA can also produce meso-level data on societal expectations, regulatory requirements, guidelines, as well as standards regarding the SDGs (arrow a2). For example, some industry associations, such as the Copper Alliance, publish information on the relevance of specific SDGs to their industry (Copper Alliance 2023). Similarly, the Sustainability Accounting Standards Board mapped its industry standards to the SDGs, allowing companies to assess expectations at the meso-level (SASB 2020). Moreover, several guidelines support companies in addressing the SDGs (e.g., GRI et al. 2015). Furthermore, an analysis of how competitors address the SDGs can yield additional meso-level insights. All this information can also be used to screen company-related targets. To validate and refine the assessment of company-related targets, companies can discuss them with experts and stakeholders. Discussions with stakeholders can assist companies in avoiding cherry-picking and related "SDG-washing"

(Heras-Saizarbitoria et al. 2021) and prevent negative campaigning by NGOs (Lambin et al. 2020; Khor 2011).

To account for transformative contributions to the SDGs, Eberle et al.'s (2022) method proposes a quantitative or semi-quantitative assessment of contributions to company-related targets addressing social and economic issues (arrow b1). Assessing the contributions of companies or their products to environmental targets was considered challenging and not part of the research conducted (see limitations in Section 5.2).

The first step of the method is to identify suitable indicators from generally accepted frameworks. The most prominent framework is the GIF-SDG, which is the regularly updated official set of UN indicators (2022). However, the GIF-SDG indicators are mostly at the policy level and need to be adapted for corporate use. For instance, the GIF-SDG indicator 1.1.1, which measures the "proportion of the population living below the international poverty line" is adapted to the "proportion of the workers and employees along the supply chain living below the international poverty line." If no suitable indicator can be found in the GIF-SDGs, the method suggests screening indicators from the European Commission's process to specify the Environmental Footprint (EC-JRC 2017). However, the Environmental Footprint is mostly used to assess the impacts of products, and some indicators are difficult to apply to companies. To assess the impacts of companies, indicators from reliable sources listed in the SDG compass (www.sdgcompass.org) could be used. The SDG compass is an initiative of the Global Reporting Initiative (GRI), the UN Global Compact, and the World Business Council for Sustainable Development, which collects business indicators from various frameworks. It includes indicators from, among others, the GRI's reporting guidelines, the UN Global Compact's and Oxfam's Poverty Footprint, and the Women's World Banking Gender Performance Indicators and organizes them according to the 169 goals. However, as the SDGs rarely provide a quantitative or quantifiable reference to assess whether a particular goal has been achieved, selecting indicators is not sufficient to assess corporate contributions. Therefore, a systematic approach to derive a quantified reference value is additionally needed.

The second step is to adopt an approach to derive a quantified reference value from the targets. The method uses the annual Sustainable Development Report by the Sustainable Development Solutions Network (SDSN) and the Bertelsmann Stiftung (Sachs et al. 2022, p. 70) and slightly modifies it for the assessment of companies. The approach enumerates five steps that can be taken sequentially to derive a quantified reference value from the targets: 1) derive the quantitative threshold directly from the target; 2) include all countries, peoples, and individuals based on the guiding principle of the SDGs, "Leave no one behind" so that no one is left behind (UNDP 2018); 3) use science-based targets; 4) use the average of the five best-performing companies or countries; 5) if none of the above steps can be taken, address the issue specified in the company-related target using GRI's (2016) Sustainability Risk Management. This ensures that objectives, actions, and responsibilities are adequately defined to effectively manage a particular issue. Adopting approaches of meso-level institutions like the SDSN and GRI further emphasizes the multi-level linkages in the framework. In screening the food sector, Eberle et al. (2022) find that 29% of the company-related targets included in the SDGs (18 out of 61) could not be measured quantitatively and

had to be addressed semi-quantitatively in sustainability risk management. Once a reference value is derived, an impact assessment method is needed to assess whether a company is contributing fully or partially to the targets.

The third step is to apply Lindner et al.'s (2021) impact assessment method to quantitatively assess the contribution of companies to reaching the targets. The method contains contribution functions that quantify the contribution y of a parameter x to the achievement of the target for a given indicator. For example, the proportion of employees in the supply chain with access to social protection support, as defined by the International Labor Organization (parameter x), allows assessment of a company's contribution to "implementing nationally appropriate social protection systems and measures for all" (contribution y , Target 1.3) (see Eberle et al. 2022). The contribution interval ranges from +1, indicating that the company contributes fully to the achievement of the target, to -1, indicating that the company has a negative impact on the achievement of the target. In most quantitative assessments, 0 represents the country average. For sustainability risk management, if no steps were taken, the contribution was set to 0, with each step adding 0.33 to the contribution. This range further substantiates the notion of accounting for positive and negative sustainability impacts and contributions, as proposed in the original CAT framework (Schaltegger et al. 2022) and emphasized in recent literature (Dijkstra-Silva et al. 2022). Following Lindner et al. (2021), the relationship between the parameter and its contribution is defined by Gaussian and linear functions, which determine the shape of the functions and the corresponding curves. The shape of the Gaussian functions is determined by the six constants α , σ , β , γ , δ , and ϵ , which are selected based on expert judgment, while the shape of the other curve is simply linear (for a more detailed description and examples of indicators and contribution functions, see Eberle et al. 2022). This method must be applied to all company-related targets. If an aggregate SDG performance score is desired, companies could simply aggregate the results of targets belonging to the same SDG. However, aggregating SDG scores is not recommended, because each SDG is unique, and a positive contribution to one SDG cannot offset a negative contribution to another SDG. At the micro-level, the results can be used by managers to reflect on the impact of the company's activities and develop strategies to promote their positive contributions beyond the organizational level (arrow b1).

Reporting the results of the assessment allows networks, markets, and societal stakeholders as well as shareholders at the meso-level to evaluate the company's performance concerning their goals (arrow b2). Schaltegger et al. (2022, p. 495) propose the use of a new type of report, a Corporate Sustainability Transformation Statement, which would uniformly disclose company-related SDGs, indicators, and the results of the contribution functions. Eberle et al. (2022) also suggest developing a company- or product-related indicator framework for the SDGs. This could be developed with global stakeholders similar to the GIF-SDGs. Companies could also serve as best-practice examples in networks and markets, and would thus contribute to transformational change at the meso-level.

4.2 Effective Action-Formation Using Management Control Systems

In this section, I explore how MCS can specify action-formation mechanisms in the CAT framework. Previous studies have identified MCS as useful for an organization’s comprehensive and effective management of social, environmental, and economic issues (e.g., Gond et al. 2012). MCS are used by managers to formally and informally ensure that their employees’ behaviors and decisions are consistent with the organization’s goals and strategies (Berry et al. 2009; Chenhall 2003; Simons 1995). They were found to be particularly useful for strategy formulation and implementation (Crutzen et al. 2017). MCS as a package conceptualized by Malmi and Brown (2008) consist of planning, cybernetics, reward and compensation, administrative, and cultural controls (Table 3). Planning controls include long-term goals as well as more immediate actions. Cybernetic controls include budgets and measurement systems, which can be either financial, non-financial, or hybrid. Rewards and compensation are used to motivate employees and management. Cultural controls include clans (formal or informal groups), value-based controls (norms, values), and symbols (design, dress code). Administrative controls comprise the governance and organizational structure as well as policies and procedures (Malmi and Brown 2008).

TABLE 3: MANAGEMENT CONTROL SYSTEMS AS A PACKAGE (ADAPTED FROM MALMI AND BROWN (2008))

Cultural controls					
Clans		Values		Symbols	
Planning		Cybernetic controls			Reward and compensation
Long range planning	Action planning	Budgets	Financial Non-financial Hybrid measurement systems		
Administrative controls					
Organizational design		Governance structure		Procedures and policies	

The literature on MCS encourages the use of a variety of management controls (Malmi and Brown 2008; Grabner and Moers 2013). Therefore, the conceptualization of MCS as a package is adopted in the CAT framework to promote action-formation related to the SDGs. Hübel and Wenzig (2023) find the complementarity of formal and informal management controls to be a particularly important characteristic of sustainability pioneers. This is in line with previous research, which argues that focusing on either formal or informal controls is not sufficient to build strong corporate sustainability commitment (Svensson and Funck (2019). Therefore, the indicators and functions (cybernetic controls) developed in Section 4.1 should be complemented with further management controls to align employee behavior to contribute to the SDGs and promote action-formation. For instance, the planned contributions to the targets could be added to existing corporate goals and long-term plans and supplemented with meaningful actions (planning controls). To ensure sufficient internal funding to achieve the desired targets, budgets could be implemented specifically for the achievement of certain

SDGs or the responsible departments (cybernetic controls). Salaries and benefits could be implemented at the individual or team level to motivate employees to achieve set targets (rewards and compensation). Official corporate values could embrace the SDGs, symbols such as the SDG logo could be placed in the entrance hall of the company, and tiepins in the colors of the SDGs could be distributed to employees to promote a corporate culture that contributes to the SDGs. Informal or formal groups could be created or supported, and knowledge and perceived relevance of the SDGs could be asked as part of the employee selection process. Internal training could also be provided to support internal learning processes (cultural controls). To implement effective administrative controls, members of the management team could take personal responsibility for achieving the company's SDG-inspired goals, and organizational structure and hierarchies could be designed to ensure their achievement. In addition, a steering committee could regularly review performance concerning the SDGs, and an official policy in support of the SDGs could be published on the website (administrative controls).

4.3 Accounting for the Self-Reinforcing Mechanisms of Individuals and Groups

This section is an exploration of how individuals and groups can be better accounted for in the advanced CAT framework, supporting managers in identifying mechanisms that hinder action-formation. The multi-level literature underlines the importance of analyzing social interdependencies and feedback loops related to action-formation at the micro-level when considering individuals and groups (Hedström and Swedberg 1998).

The self-reinforcing mechanisms of organizational path dependence theory (Sydow et al. 2009, 2020) have been embedded in the framework as they allow for a systematic and scientifically sound analysis of intra-organizational dependencies and feedback loops. Path dependence theory assesses self-reinforcing mechanisms that hinder organizational change and lead to strategic persistence and operational rigidity (Sydow et al. 2009; Wenzel, 2015). The theory and related mechanisms address both individual processes (such as learning) and organizational dependencies (on other actors). While the theory addresses the entire organization, it incorporates mechanisms that focus on the behavior of individuals and their relations and interdependencies with others and is therefore used as a theoretical lens to investigate the role of individuals and groups (Wenzig et al. 2022). Despite some theoretical disagreements (Garud et al. 2010; Sydow et al. 2009, 2020; Vergne and Durand 2010), conceptualizations of path dependence tend to follow three stages: 1) path emergence, 2) self-reinforcing mechanisms, and 3) lock-in. In path emergence, organizational actors are embedded in organizational routines and practices, but their decisions are largely unconstrained. However, small contingent events or actions may inadvertently lead to a "critical juncture" (Mahoney 2000, p. 513), which promotes organizational rigidity (Dobusch and Kapeller 2013). Subsequently, self-reinforcing mechanisms (Arthur 1994; Vergne and Durand 2010) or "increasing returns" (Arthur, 1989, p. 122; Pierson, 2000) form a cycle of positive feedback loops that narrow the scope for action (Koch 2011). In the third phase, the lock-in phase, the dominant patterns become fixed. As conditions change at the macro- or meso-level, organizations may fail because they are dominated by inappropriate and inefficient patterns and mechanisms.

At the heart of path dependence theory are self-reinforcing mechanisms that cause positive feedback loops. Sydow et al. (2009) distinguish four main effects: coordination, complementary, learning, and adaptive expectation effects. Coordination effects occur when actors within the organization agree on the same set of rules and continuous repetition reinforces the dominance of this rule. Complementary effects result from synergies among different actors or departments, which become more attractive and thus dominant each time they are combined. Learning effects describe the increased efficiency of processes or routines each time they are iterated. When these processes or routines are associated with success and are often repeated, it becomes increasingly difficult for actors to deviate from them. Adaptive expectation effects come into play when individuals within the organization act in response to the expectations of others. If a particular decision or pattern is perceived to be favored by certain groups or actors, other actors are likely to prefer the same, and a dominant solution emerges.

The self-reinforcing mechanisms of path dependence theory can be used as tools and a theoretical lens for managers to identify feedback loops that hinder action-formation. Individuals and groups can become trapped in self-reinforcing mechanisms and positive feedback loops (Dobusch and Schüßler 2013; Vergne and Durand 2010) that prevent the organization from developing its full potential to contribute to macro- and meso-level change related to the SDGs. When such mechanisms are identified, managers can use this knowledge to engage in path-breaking or path-creating processes (Dobusch and Kapeller 2013; Garud et al. 2010) by implementing countervailing management controls, reflecting on them with affected individuals, or developing more advanced strategies to counteract them.

While self-reinforcing mechanisms can be analyzed for all relevant individuals and groups, special emphasis should be placed on management accountants as they are considered crucial for effective SMA (e.g., Egan and Tweedie 2018; Schaltegger and Zvezdov 2015). According to Wenzig et al. (2022), self-reinforcing mechanisms explain why management accountants (mostly) refrain from contributing to corporate sustainability (and the SDGs). Coordination effects were observed as the focus on financial issues was dominant for almost all management accountants in our study. Closely related to the coordination effects observed were adaptive expectation effects. Most management accountants adjusted their work behavior and the information they provided to meet the perceived expectations and needs of top management, and most explicitly stated that this focus was in line with top management's expectations. Learning effects played a role only in some cases. While some management accountants described existing routines as inflexible and inefficient, others perceived them as adaptable and appropriate. None of the management accountants mentioned of their own accord that sustainability accounting was an area of interest for future learning (Wenzig et al. 2022).

Managers can take some steps to support the involvement of management accountants, and thus promote action-formation concerning the SDGs. To demonstrate the importance of the SDGs, the core of the business strategy could be aligned with the SDGs using MCS. This would send a strong signal to management accountants, prevent false adaptive expectations, and challenge the coordination effects associated with a sole focus on financial results. A

strong position taken by management for contributions to the SDGs could also increase management accountants' willingness to learn about SMA. In addition, managers could problematize the underlying coordination effect and related assumptions related to adaptive expectations in workshops with management accountants.

5. Discussion and Conclusion

SMA is considered promising as a means to promote corporate contributions to sustainable development as specified in the SDGs (e.g., Bebbington et al. 2017). However, SMA requires a broader scope than is conventionally assumed if it is to address the situational context and transformative contributions beyond organizational boundaries (Schaltegger et al. 2022). The original CAT framework broadened the scope of SMA and addressed macro- and meso-level linkages (Schaltegger et al. 2022). However, it left important gaps unexplored in terms of how to precisely account for macro-micro interactions concerning the SDGs and promote action-formation. This framework paper addresses the research question of how companies can account for the situational context and transformative contributions with regard to the SDGs and promote action-formation. It advances the original CAT framework by a) introducing a systematic method to identify company-related SDGs and assess corporate contributions, b) positioning MCS at the micro-level to support managers in guiding employee behavior toward contributing to the SDGs, and c) identifying self-reinforcing mechanisms of individuals and groups at the micro-level to prevent feedback loops that hinder action-formation. The advanced CAT framework (Figure 2) provides an impulse to corporate practice and academic research to facilitate and study effective corporate contributions to the SDGs and sustainability transformations beyond their organizational boundaries. This section discusses the methodological implications, limitations, as well as avenues for future research on the advanced CAT framework.

5.1 Methodological Implications

In this section, the most important methodological implications for SMA of the advanced CAT framework are discussed. Several methodological implications of the original CAT framework were proposed by Schaltegger et al. (2022), which are extended and concretized by the advancements made in this paper. These and further implications of the advanced CAT framework are presented in Table 4.

TABLE 4: METHODOLOGICAL IMPLICATIONS OF THE ADVANCED CAT FRAMEWORK

	Methodological Implications	Contribution of the advanced CAT framework
<i>Implications based on Schaltegger et al. 2022</i>	Backcasting to develop benchmarks from desired future conditions and goals for sustainable development are envisioned and measures for achieving these benchmarks are defined.	An innovative systematic method for determining SDG-inspired goals and contributions is adopted. Contribution functions center around the national average to create meaningful benchmarks. Comprehensive MCS support action-formation to derive meaningful measures to attain goals and contributions.
	Management guidance is provided in addition to transparency.	The systematic method provides detailed guidance on how to conduct an assessment and how goals are to be set. MCS propose a concrete typology on how to implement SMA at the micro level. Path dependence theory guides management to identify barriers to action-formation.
	Integration of different social, environmental, and economic issues is facilitated.	SDGs are the new focus and include all sustainability impacts internationally agreed upon by UN member states. Each company-related SDG is equally important, and all company-related targets are systematically identified.
	Facilitation of future-oriented action and transformation planning.	The method uses the SDGs to derive goals for sustainable development to be achieved by 2030. All action-formation at the micro-level is oriented toward these goals and targets.
<i>Additional Implications of the advanced CAT framework</i>	Different layers of the micro-level such as the company as well as individuals and groups within it are addressed to foster action-formation.	In addition to the macro- and the meso-level, the advanced framework addresses both the company as well as individuals and groups at the micro-level. A comprehensive MCS package containing formal and informal controls considers the role of individuals and groups in fostering action-formation.
	Barriers hindering individuals and groups from action-formation are identified.	The framework allows to identify coordination, complementary, learning, and adaptive expectation effects that lead to organizational path dependence and hinder action-formation for individuals and groups.

A key implication of the original CAT framework was to use backcasting and create a database to help achieve sustainable development, for instance by setting climate goals following the Paris Agreement (Schaltegger et al. 2022, Holmberg and Robert 2000). In the advanced CAT framework, backcasting is further facilitated by introducing a systematic method to address the situational context and transformative contributions to the SDG and adopting MCS to derive meaningful measures to attain the goals and contributions. Another implication of the original CAT framework was to provide management guidance in addition to facilitating transparency (Schaltegger et al. 2022). The advanced framework offers even more concrete guidance by introducing a method to account for the situational context and transformative contributions

related to the SDGs and introducing MCS at the micro level. Self-reinforcing mechanisms of the path-dependence theory serve as a guide to identifying barriers to change. Furthermore, the implication of addressing different social, environmental, and economic issues was stressed (Schaltegger et al. 2022). By setting the SDGs as the focus of the advanced CAT framework, all sustainability impacts agreed upon by the UN member states are addressed. As the method does not allow the contributions to one SDG to offset a negative contribution to another SDG, an overarching sustainability perspective is facilitated. To foster the use of future-oriented actions and transformation planning identified by Schaltegger et al. (2022), all action-formation at the micro-level is future-oriented toward the SDGs to be reached by 2030.

By incorporating MCS and self-reinforcing mechanisms, the advanced CAT framework additionally addresses different layers of the micro-level such as the company as well as individuals and groups within it. This is crucial as formal and informal management controls have been identified as important for steering a company (e.g. Berry et al. 2009) and self-reinforcing mechanisms can support detecting feedback loops of individuals and groups that inhibit action-formation (Hedström and Wennberg 2017). In addition to backcasting from a desirable future expressed in the SDGs, the advanced CAT framework allows the identification of barriers to change by assessing self-reinforcing mechanisms leading to path dependence. Thus, in addition to creating a positive vision, the framework incorporates negative factors that hinder individuals and groups from contributing to transformative change.

5.2 Limitations and Future Research

There are several limitations to this framework paper that can be addressed by future research. While Eberle et al.'s (2022) method for assessing the situational context and transformative contributions related to the SDGs is novel and concretizes the CAT framework, several limitations can be addressed in future research. First, the method adopted in the advanced CAT framework has not been empirically tested so far. This applies to all parts including the questions to screen company-related SDGs, the indicators, as well as the functions to assess corporate contributions to the SDGs. Empirically investigating whether these questions, indicators, and functions support companies in assessing their situational context and transformative contributions to the SDGs would be a worthwhile avenue for future research. In addition, research could investigate whether the method can prevent cherry-picking or "SDG-washing" (Heras-Saizarbitoria et al. 2021, p. 317).

Second, the method in the advanced CAT framework cannot measure all social and economic targets of the SDGs quantitatively but requires a semi-quantitative approach in sustainability risk management. In an exemplary application to the food industry, 29% of the company-related targets (18 out of 61) could not be measured quantitatively (Eberle et al. 2022). The semi-quantitative approach is based on the GRI standard (GRI 2016) but only allows for an analysis of whether a company has assigned goals and targets, responsibilities, and concrete actions. Whether a company contributes to the achievement of a specific target cannot be analyzed in these semi-quantitative assessments, and the results are hardly comparable to the quantitative contribution functions used in the advanced CAT framework (Eberle et al. 2022). However, quantitative measurement is not an end in itself, and the conventional wisdom

encapsulated in the adage “what gets measured gets managed” has been refuted both empirically (Catasús et al. 2007, p. 506) and logically (Emiliani 2000, p. 613). What matters more than measurement is mobilization, both in the sense of mobilizing corporate resources and of providing direction (Catasús et al. 2007). As long as the issues are mobilized, this supports our approach to addressing issues mentioned in the targets in sustainability risk management. However, as quantitative indicators were found to support the relationship between mobilizing and acting, future research should attempt to develop quantitative indicators for the respective targets (Catasús et al. 2007).

Third, in the systematic method and the advanced CAT framework, contributions to environmental issues of the SDGs cannot yet be quantitatively assessed. While Eberle et al. (2022) identify indicators for environmental issues, we considered assessing the contribution of companies or their products to environmental targets too challenging and did not include it in our research. Important progress has been made by the Science Based Targets initiative, which provides a methodology to assess whether companies are in line with the level of decarbonization required to keep global temperature rise below 1.5°C compared to preindustrial temperatures (Faria and Labutong 2019). However, assessing companies' contributions to staying within other planetary boundaries, such as biogeochemical flows of phosphorus and nitrogen, biodiversity loss, land-use change, or freshwater remains much more difficult than assessing impacts on climate change (Rockström et al. 2009; Steffens et al. 2015). Compared to climate change, these boundaries are often more regional and there is no precise global target so it remains difficult to break down the contributions of individual companies (e.g., Whiteman et al. 2013). Future research should develop methodologies to quantitatively assess the contributions of companies to the environmental targets of the SDGs. Important progress can be expected from the Science Based Targets Network (<https://sciencebasedtargetsnetwork.org>) in addressing these issues when it publishes its science-based targets for nature in 2023. Future research should verify and further develop these quantitative methodologies.

Fourth and finally, there are open questions regarding the micro-level in the advanced CAT model. Empirical research is needed on how companies can use MCS to promote contributions to the SDGs. Moreover, companies need to pay attention to many different issues simultaneously. Future research should explore how different social, environmental, and economic issues (e.g., creating attractive product portfolios, addressing biodiversity loss, and promoting employee retention) can be addressed simultaneously using MCS. Furthermore, the relationship between MCS and self-reinforcing mechanisms concerning individuals or groups warrants further research. For example, MCS consider informal or formal “clans” as part of cultural controls. The role of these clans and possible self-reinforcing mechanisms could be explored in terms of fostering action-formation. Furthermore, as research into the self-reinforcing mechanisms of management accountants was based solely on interviews with them, future research should triangulate the findings with an analysis of their organizational context by interviewing other stakeholders in the companies. The magnitude and interrelationships of these mechanisms also need to be investigated in quantitative and longitudinal studies.

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B. Paper 1

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Corporate sustainability management accounting and multi-level links for sustainability – A systematic review

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Abstract

The societal vision of sustainable development changes both the context of businesses and expectations that management should contribute to solving sustainability problems beyond organizational boundaries. Companies are influenced by macro-level developments such as new environmental regulations and by meso-level context such as social industry standards and guidelines. At the same time, companies are expected to contribute to sustainability transformations of markets at the meso-level and to solving grand sustainability problems at the macro-level such as the greenhouse effect. These developments increase and change sustainability information needs of managers and management accounting. This paper provides a systematic literature review of how sustainability management accounting (SMA) addresses links with the organization's contexts and contributions to sustainability transformations beyond organizational boundaries. The analysis questions the conventional assumption of an internal scope for SMA. It recognises this as a problematic constricting assumption in the literature and, instead, proposes a multi-level Context, Action-formation and Transformative contributions (CAT) framework for further development of SMA.

INTRODUCTION

Involvement of the private corporate sector is vital if sustainable development is to be achieved (Atkinson, 2000). Managers need to consider sustainability in their decisions, and this requires support from accounting to raise awareness of desired and undesired environmental, social and economic impacts (Schaltegger & Burritt, 2018). Corporate sustainability management accounting (SMA) organizes the collection, analysis and communication of environmental, social and economic information for internal use by the organization's managers. Nevertheless,

scepticism about corporate sustainability management, accounting and reporting has been prominent in various publications influencing the research agenda, as some authors see sustainability concerns and solutions resting more at national and global levels than with businesses (Gray, 2010). Moreover, questions arise over the extent to which SMA considers sustainability at societal and planetary boundary levels (Gray, 2010; Linnenluecke & Smith, 2019; Rockström et al., 2009; Whiteman et al., 2013).

To make progress with informed corporate sustainability management, SMA needs to support organizations in analysing and managing links with macro- and meso-level

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sustainability challenges. These include, for example, clarification about how business is integrated in its environment, how it operates within the scope of planetary boundaries, and how it sources supplies without negative sustainability impacts in supply chains.

Emergence of a number of global environmental, social and economic problems, ranging through climate change, water crises, gender equality, global poverty, the COVID-19 pandemic and policies such as the EU Green Deal, has led to greater concern about the lack of sustainability (Eckert & Kovalevska, 2021). It has brought pressure encouraging development of a more comprehensive, integrated approach to corporate sustainability management, supported by accounting and reporting (e.g., Linnenluecke et al., 2015; Whiteman et al., 2013). Nonetheless, a contemporary review and analysis of contexts and outcomes and the potential role of accounting for management to contribute to sustainable development beyond the organization's boundaries is missing. In order to further develop a research agenda which supports the contribution of business to sustainable development, this review investigates how existing SMA research explicitly considers the connection with sustainability at different levels, leading to the following research question: *How does SMA literature address links with meso- and macro-level contexts and outcomes beyond organizational boundaries?*

Underpinned by a multi-level framework, this study makes the following contributions. First, it uncovers the extent to which SMA research has explicitly addressed links between the organization, macro-level (e.g., planetary ecological boundaries) and meso-level (e.g., sustainability transformation of supply chains). The review reveals a growing number of publications addressing macro- and meso-micro links. These highlight various aspects of the business environment in general, indicating that regulations, networks and ecological necessities, do or can influence the context for SMA (e.g., Qian et al., 2015; Wang et al., 2019). Second, the review indicates few publications examine *how* SMA could be further developed to better inform management about macro- and meso- level contextual factors. Third, the review findings are problematised by challenging the underlying assumption that the *scope of SMA* needs to be internal to the organization. Revealing the core idea and purpose of sustainability management and accounting in general, this article proposes that SMA needs to enlarge its scope by considering influences on and impacts of the organization beyond its boundaries. In a business setting facing increasing sustainability problems, SMA can help managers to create contributions to sustainable development of markets, society and the natural environment. It can do this if it provides information to make explicit corporate influences of and impacts on meso- and macro-levels

beyond organizational boundaries. Finally, to improve its purpose of supporting management in contributing to sustainable development, reorganization of SMA is proposed through a newly created CAT framework, linking Context, Action-formation and Transformative contributions.

The paper proceeds as follows: the next section distinguishes macro- and meso-level links with SMA and introduces a multi-level framework for analysing these links. The following two sections detail the systematic literature review method adopted and examine the findings from the review within the multi-level framework. The findings are then discussed and problematised in relation to the scope assumption of SMA adopted in the existing SMA multi-level literature, leading to the proposal of a new CAT framework to reorganize SMA. Finally, a short conclusion is presented.

ANALYTICAL FRAMEWORK FOR LINKING SMA WITH MULTIPLE LEVELS

SMA interacting with multiple analytical levels of sustainable development

Sustainable development is a vision of and for society (UN, 2015). As corporations are embedded in the social and natural environment, they are influenced by and have influence beyond organizational boundaries (Benn et al., 2014). Corporations are key actors able to increase or mitigate social and environmental impacts of mankind, having an impact on this vision (Schaltegger et al., 2017). Previous corporate SMA literature has analysed ways to address sustainability from a corporate perspective. These include reviews of methods (Christ & Burritt, 2015; Dienes et al., 2016), management areas (e.g., Moreno-Camacho et al., 2019; Vitolla et al., 2019), sustainability orientation (Mathews, 1997) and themes (Marrone et al., 2020). To extend these reviews and analyze the existing organizational SMA (micro) research to meso- and macro-levels of analysis, the paper adopts Coleman's multi-level framework (1986), as refined by Hedström and Swedberg (1998).

Four reasons lie behind the choice of this conceptual framework. First, the multi-level perspective (MLP) framework (Geels, 2002, 2011) has been widely applied in the transitions literature and provides valuable oversight of system level connections and dynamics. The multi-level approach of Hedström and Swedberg (1998) has informed entrepreneurship research, with its focus on social mechanisms, to explain both enabling influences on the micro- and meso-level impacts on other levels. The framework, therefore, complements the systems view of the MLP perspective by offering a novel analytical lens to analyze the SMA literature with regard to its enabling potential

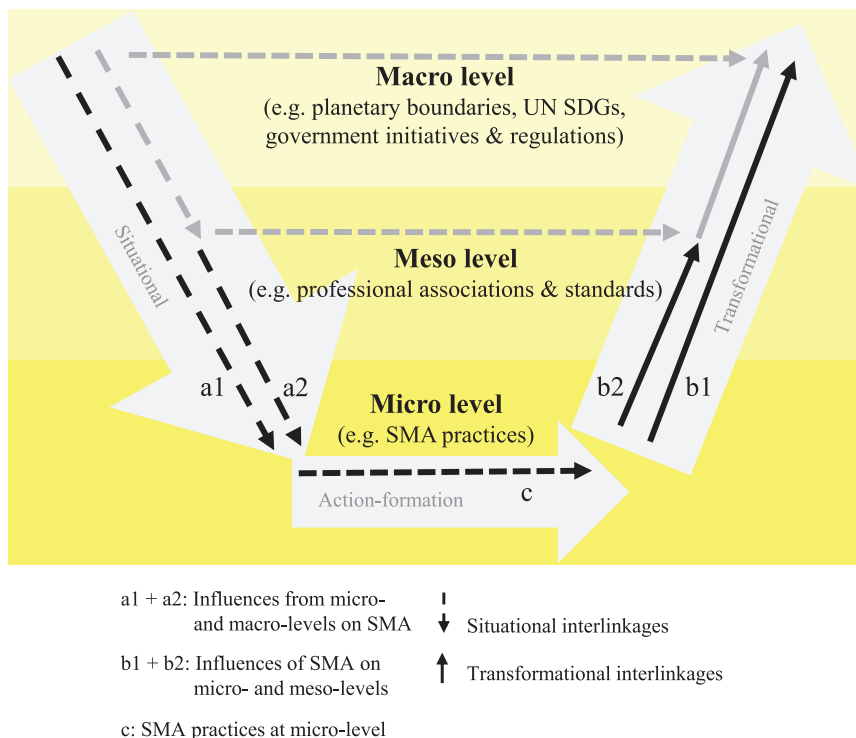


FIGURE 1 Framework for analysis of SMA links at multiple levels [Colour figure can be viewed at wileyonlinelibrary.com]

and to discuss how SMA at the micro-level is influenced by and can contribute to impacts at other levels. Second, the framework allows contributions from different research streams (i.e., accounting, management and sustainability) to be synthesised. Third, the framework requires analysis of the links between context and outcomes (Hedström & Wennberg, 2017). This complements recent dynamic analysis of SMA processes associated with the introduction and use of SMA within organizations (e.g., Burrett et al., 2019). Finally, the framework requires activities at multiple levels to be linked, which helps to provide a comprehensive understanding of SMA and its role in corporate sustainability and sustainable development at larger scales. According to Hedström and Swedberg (1998), interactions between the different levels of business and society can be analysed in terms of contextual influences, activities that occur at the micro-level, and transformational change fostered by organizations (see Figure 1). The dark arrows in Figure 1 display links connecting macro- and meso-levels with the organizational micro-level where SMA is located.

Situational mechanisms (arrow a1 and a2 in Figure 1) describe the contextual and institutional-based processes affecting beliefs, motivations and actions of managers, linking macro- and meso-level conditions to the micro-level of the company.

Transformational mechanisms (arrow b1 and b2) explain individual and collective processes of organizations influencing networks and associations at the meso-level, as well as regulations, consumption patterns, life-styles and ecological phenomena at the macro-level. Arrow 'c' (action-

formation) in Figure 1 represents SMA practices that are adopted at the micro-level. Micro-level SMA activities often result from situational pressures acting on the organization leading to meso and macro transformational change.

Situational links influencing SMA

Both the macro- and the meso-levels provide a situational context in which organizational actors operate and where changes take place slowly over time (e.g., Hernes, 1998). *Macro-micro links* are characterised by situational mechanisms influencing SMA through context (arrow a1 in Figure 1). Macro-level concerns about unsustainability can, for example, be related to the United Nations Sustainable Development Goals (SDGs) (UN, 2015), planetary boundaries (Rockström et al., 2009), specific global environmental problems such as the greenhouse effect, or social and environmental government initiatives at the national or supra-national levels. *Meso-micro links* (arrow a2 in Figure 1) are characterised by situational social mechanisms that capture the influence of networks on corporate adoption of SMA. Various societal actors, such as international organizations (Greenhouse Gas Protocol developed by the World Resources Institute, the World Business Council for Sustainable Development and the Global Reporting Initiative), sustainability-oriented business networks (Carbon Disclosure Project), and professional accounting organizations (e.g., Sustainability Accounting Standards

Board) propose approaches to monitor, measure, assess and report on corporate sustainability issues at the corporate level. This shapes the accounting and reporting context at the meso-level, having a substantial influence on the sustainability issues considered in corporate SMA (Narthey, 2018).

At the *micro-level* (arrow c 'action-formation' in Figure 1), entities apply, develop or refrain from using SMA. They mobilise resources and involve partners in the adoption and adaptation of information systems for sustainability (Melville, 2010; Seidel et al., 2013). The micro-level is also a key place where innovations emerge (Geels, 2002; Kemp et al., 2001; Smith & Raven, 2012). Organizations react to situational influences beyond organizational boundaries (Geels, 2010), including niche interactions with incumbents (Geels, 2019). As SMA requires new approaches and innovations different from conventional accounting, the micro-level is crucial for SMA research, experimentation and practice (e.g., Burritt et al., 2019), development of capabilities (Albertini, 2019) and competencies (Ascuí & Lovell, 2012). New SMA approaches are developed through dedicated arrangements of actors, pioneering companies, external research projects and citizen's initiatives. Where companies see sustainability as a means to obtain benefit, the situational context is important for SMA development, but not always essential if managers have a well-developed social conscience.

Analyzing situational links between the macro-, meso- and micro-levels helps with understanding why certain SMA approaches emerge and how companies react to the broader business context. The potential contribution of SMA to creating solutions to planetary environmental and social challenges requires investigation of the transformational outcomes at the meso- and macro-levels (Loorbach et al., 2010) that result from SMA activity and adoption.

Transformational links of SMA influence

Sustainability transformations involve multi-party participation at different levels, akin to a transdisciplinary approach (e.g., Lang et al., 2012) to setting strategic long-term goals (e.g., Loorbach et al., 2010), experimenting with different situations and tools, and linking the long-term aims of the different parties with pragmatic short-term actions to achieve these (Rotmans et al., 2001). If SMA is to be effective in supporting improved management decisions then processes which create impacts at the societal meso-level of markets and networks (transformational link b2) as well as at the macro-level (transformational link b1), should be initiated in the corporation at the micro-level.

Transformational mechanisms linking the micro- and meso-levels of analysis address the influence of micro-level SMA development and use on networks, industry associa-

tions and markets at the meso-level. These links capture the influence of SMA adoption on establishing industry initiatives for SMA, sustainability-oriented industry associations, professional accounting organizations issuing reports on SMA, and sustainability awards (e.g., Hansen et al., 2010). Transformational links between micro-level development of innovative methods of SMA, with disseminating organizations at the meso-level, potentially play an important role in altering unsustainable practices and creating new, more sustainable professional and industry-based standards. These, in turn, can subsequently exert situational influence on the whole industry and economy towards sustainability.

Transformational mechanisms *linking micro- and macro-levels* of analysis address the involvement of SMA effects on wider global societal and planetary ecological areas and governments, with sustainable development as the ultimate goal. This link addresses, for instance, the influence of pioneer companies on regional and government programs and regulations as well as the contribution of SMA information to macro-level sustainability accounts.

For SMA to contribute to creating sustainable development requires situational and transformational links, between the corporation and the meso- and macro-levels, be addressed. To structure analysis of how SMA literature has addressed these links, a multi-level framework is adopted.

RESEARCH METHOD

Based on Tranfield et al. (2003), a systematic literature review was conducted to identify relevant prior research (Breslin et al., 2019). The method has been applied in sustainability, management (e.g., Moreno-Camacho et al., 2019; Vitolla et al., 2019) and accounting (e.g., Hansen & Schaltegger, 2016; Lavia López & Hiebl, 2015) research. The literature is organized using the multi-level framework originally proposed by Coleman (1986) and refined by Hedström and Swedberg (1998). The analysis of existing literature problematises key assumptions SMA research has adopted from conventional management accounting. It proposes a new Context, Action, Transformation (CAT) framework for SMA research and practice and suggests a new assumption on scope be adopted in future SMA research.

Table 1 lists the agreed search strings, combining text from Groups 1 and 2, applied to the titles, abstracts and keywords of research articles focused on environmental, social and sustainability accounting. Five commonly used databases (EBSCO Host-Business Source Premier (BSP); JSTOR; ScienceDirect; Scopus and Web of Science) were selected as different databases can lead to different themes

TABLE 1 Search strings for the systematic review

Group 1: Terms referring to SMA	
Carbon accounting	Sustainable cost management
Water accounting	Environmental cost management
Material flow accounting	Social cost management
Material flow cost accounting (MFCA)	Sustainability benchmarking
Biodiversity accounting	Environmental benchmarking
Social accounting	Social benchmarking
Environmental accounting	Sustainability budgeting
Environmental management accounting	Environmental budgeting
Sustainability accounting	Social budgeting
Sustainability management accounting	Sustainability key performance indicators
Ecological accounting	Environmental key performance indicators
GHG accounting	Social key performance indicators
Greenhouse gas accounting	Sustainability performance management
Energy accounting	Environmental performance management
Environmental management control	Social performance management
Social management control	Sustainable product design indicators
Sustainability management control	Environmental product design indicators
Sustainability control	Social product design indicators
Eco control	Sustainability investment appraisal
Sustainability balanced scorecard	Environmental investment appraisal
Environmental balanced scorecard	Social investment appraisal
Social balanced scorecard	Accounting for stakeholder
Sustainable decision-making	Accounting for human right
Environmental decision-making	Accounting for modern slavery
Social decision-making	
AND	
Group 2: Terms referring to entity	
Company	Firm
Companies	Organisation
Corporate	Organization
Corporation	Enterprise
Business	

Note: Each term in Group 1 is matched in turn with each term in Group 2 to capture combinations of terms in sustainability management accounting.

(Meho & Yang, 2007). Table 2 shows the search yielded 5456 articles to the end of 2019. The final number of articles for analysis, after data cleaning (as described) and adjustments, was 62 high quality peer-reviewed journal articles.

The goal was to include reviewed articles that address multi-level linkages with SMA. In the analysis of title and abstract, articles which only mention SMA issues at the margin, such as those dealing with broader corporate social responsibility issues, external communication, reporting and disclosure of sustainability aspects, were excluded. Furthermore, with the focus on for-profit companies, articles were excluded that examine an entire economy, local or regional areas, governments, municipalities, non-profits and public sectors. Likewise,

articles dealing with sustainability accounting from an engineering perspective focusing on technical analysis or on different forms of sustainability accounting for ecosystems, forests or other natural habitats, were excluded to ensure a clear focus for the study. Intercoder agreement on the exclusion criteria was assessed using the Krippendorff α (Krippendorff, 2013; Lombard et al., 2002) based on a SPSS macro by Hayes and Krippendorff (2007). All four authors reviewed 30 randomly chosen articles and rated whether they should be included in the sample based on the exclusion criteria given above. The results were discussed to achieve agreement and then new sets of randomly chosen articles were rated until agreement by all authors was reached at the threshold of Krippendorff

TABLE 2 Derivation of publications included in the review

Database From origin to end 2019	EBSCO – BSP	JSTOR	Science Direct	Scopus	Web of Science	Total number
<i>First scan – citations</i>	1687	37	543	2207	982	5456
Data cleaning. Removal of duplicates and incorrect entries.	–476	–6	–397	–2	–763	–1644
Data cleaning. Adjustment to exclude non-scientific journal publications	–399	–16	–35	–544	–53	–1047
Data cleaning. Adjustment to exclude non-English articles	–111	–1	–0	–57	–44	–213
<i>Articles after data cleaning</i>	701	14	111	1604	122	2552
Exclusion of journals based on Australian Business Deans Committee quality criteria (English language level C peer-reviewed journal articles and above), cut off for minimum number of publications, and removal of non-accounting publications	–340	–8	–81	–951	–91	–1471
<i>Articles after quality adjustment</i>	361	6	30	653	31	1081
Removal of articles based on title and abstract	–320	–6	–23	–392	–22	–763
<i>Articles subjected to full text review</i>	41	0	7	261	9	318
Exclusion based on full text review	–38	0	–6	–207	–8	–259
<i>Articles included after full text review</i>	3	0	1	54	1	59
Expert recommendations						3
<i>Total</i>						62

Note: Columns show the number of publications.

α of 0.8 (Guthrie & Mathews, 1985). By applying the exclusion criteria to the titles and abstracts, a total of 763 articles was removed from the sample.

Despite a rigorous review of titles and abstracts, the full text analysis revealed that many articles did not have the desired focus on SMA. Therefore, the exclusion criteria mentioned above were also applied when reading the articles in their entirety. In the full text review, two authors searched for links to the meso level and two authors for links to the macro level while also assuring that all articles explicitly dealt with SMA. To double-check these results, the teams then reversed their focus. It was found that many articles mention a link to the macro or meso level. However, most papers address these links as a side concern, or use them to set the scene in relation to the specific accounting issue examined. Therefore, differentiation was made between articles that solely mention a link and those that deal with a link in depth. Only the latter are included in the final sample, to which three articles were added as a result of expert recommendation. In the full text review, 259 articles were excluded that did not fit the exclusion criteria or had no meso or macro link. Only papers that explicitly considered situational or transformational links to and from micro- to meso- and macro-levels of analysis and deal with SMA are included in the final sample and are listed by number in the Appendix.

Finally, to conceptualise the analysis of the identified literature dealing with SMA links, a framework (see 'Discussion' below where the framework is proposed) was abduc-

tively developed in a continuous iteration between the data (the reviewed articles) and the theory that informed the analysis (multi-level perspective distinguishing social mechanisms).

FINDINGS AND ANALYSIS OF THE EXISTING LITERATURE

In total, 62 research papers were identified as thoroughly and explicitly addressing links between corporate SMA and meso- and macro-levels. Overall, more of these papers deal with situational (53 articles) than with transformational links (23 articles) and more discuss SMA links with the meso-level (55 articles) than the macro-level (36 articles) (Table 3).

Figure 2 displays each of the articles analysed mapped against the multi-level framework.

In relation to the multi-level framework in Figure 1 the set of articles addressing multiple links is analysed first for situational links and second for transformational links before a key underlying assumption behind all SMA literature is problematised.

Situational links influencing SMA practices

The systematic literature review serves first to identify situational influences linking macro- and meso-level

TABLE 3 Number of in-depth links addressed in the existing literature (some articles address several links)

Situational links (53 articles; 85%)		Transformational links (23 articles; 37%)	
Meso-micro situational	Macro-micro situational	Micro-meso transformational	Micro-macro transformational
(40 articles)	(25 articles)	(15 articles)	(11 articles)

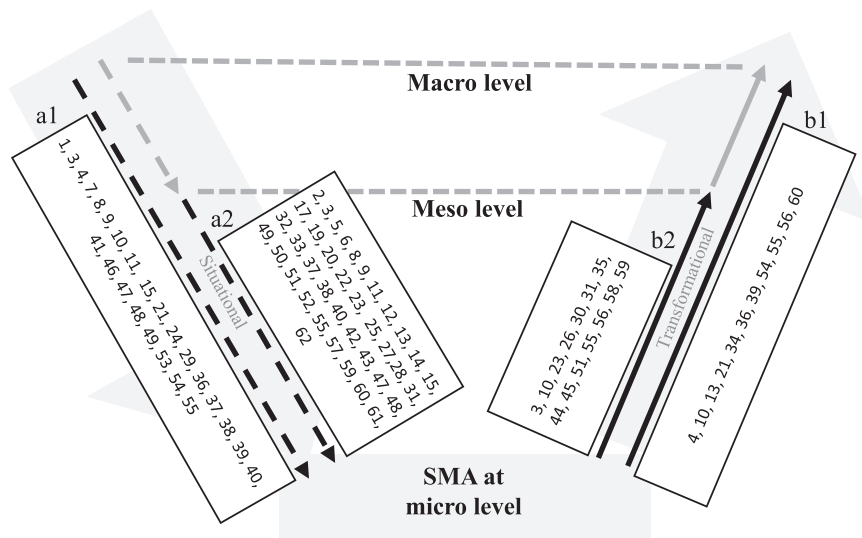


FIGURE 2 Literature mapped against the multi-level framework

contexts to SMA at the organizational level. Situational links (arrows a1 and a2 in Figure 1) describe how external issues influence whether, what and how organizations take-up and develop SMA. Table 4 provides an overview of different topics that have been specifically addressed in the accounting literature and explanations as to how they link either macro- or meso-levels with SMA at the micro-level.

Among the situational links to SMA, in the publications analyzed (Table 3), meso-level influences (40 articles) are considered more than macro-level impacts (25 articles). This reflects the importance of stakeholder relationships with industry associations, professional accounting organizations and sustainable business networks for introducing and developing SMA in organizations (e.g., Ascui & Lovell, 2012; Rodrigue et al., 2013). For example, Burritt et al. (2019), while mentioning macro topics briefly in the introduction, emphasise meso-level influences when explaining why and how a company started to engage with SMA. With few exceptions (e.g., Hörisch et al., 2015; Qian et al., 2018) the literature, while developing tools, processes and accounting systems for use by management, assumes that the application of SMA will (somehow) contribute to sustainable development (e.g., Atkinson, 2000; Hansen et al., 2010; Jalaludin et al., 2011), leaving the issue of scope to later research.

Publications at the *macro-level* informing situational mechanisms, which are discussed in the existing literature with regard to influencing SMA adoption and development in organizations, cover a *wide range of single influencing*

factors, including regulations (e.g., carbon management accounting, to comply with the EU emissions trading scheme (ETS) (e.g., Ascui & Lovell, 2012), ETS related standards on how companies should monitor, collect and report carbon emissions (Stechemesser & Günther, 2012), international agreements such as the Kyoto protocol and related national and supra-national regulations shaping the introduction and design of SMA with regard to carbon accounting (Bui & Fowler, 2019), direct stakeholders of a company (e.g., Mokhtar et al., 2016), accounting standards (e.g., Zou et al., 2019), international organizations (e.g., Burritt and Christ, 2017) and business associations, media and NGO pressure (e.g., Wang et al., 2019).

Topics include the influence of global, large scale and national institutions on SMA. Most prominent are references to global ecological problems (Hartmann et al., 2013; Lee, 2012), planetary boundaries (e.g., Schaltegger, 2018), unmet societal needs (e.g., Bui & Fowler, 2019) as well as, more recently, the SDGs (Nartey, 2018). A large number of SMA publications (259) are framed adding just a few sentences on global environmental and social problems. Only 53 publications (e.g., Nartey, 2018; Scavone, 2006) analyze situational mechanisms in some depth. These papers examine whether and how scientific information about sustainability problems, national regulations (e.g., Bui & Fowler, 2019, on the link between European and New Zealand climate change policies and standards for corporate carbon accounting), supra-national agreements (like the EU ETS), SDGs, and others at the societal

TABLE 4 Situational links between macro- and meso-levels with SMA at the organisational micro-level

Macro → micro	Explanations and related concepts	Prominent authors and examples
Global ecological problems and unmet societal needs	Exceeding planetary boundaries and unfulfilled societal, non-market needs on a global, large scale regional or national scale such as contained in the SDGs, including poverty, hunger, quality education and gender inequality and concepts on planetary boundaries can influence the emergence and design of SMA approaches.	Planetary-boundary-oriented related EMA (Schaltegger, 2018). Human rights reports on the global situation encourage companies to create HR reports and HR management accounting (e.g., McPhail & Ferguson, 2016).
Global and government institutions and regulations supporting SMA	Regulations, political- and institutional-driven opportunities, including provision of educational programmes, and encouragement of SMA and reporting driving SMA.	Regulations requiring certain SMA approaches like carbon management accounting (Bui & Fowler, 2019; Hartmann et al., 2013) or preserving limited resources (Aladwan, 2018).
Meso → micro	Explanations and related concepts	Prominent authors and examples
Accounting institutions (rules, standards, etc.) facilitating conservation of the natural environment	Deals with institutions (e.g., accounting standards) enticing or forcing companies to take decisions to account for impacts on the natural environment and causing social problems.	EMA as a reaction to institutional pressures (Wang et al., 2019). Sustainability reporting guideline by the Global Reporting Initiative lists social and environmental issues and indicators, which are expected to be accounted for and continuously improved with the support of management accounting (Gibassier & Alcouffe, 2018).
Public concern provoking the introduction of certain SMA approaches	Deals with public, stakeholder and media pressure encouraging to account for environmental and social impacts.	Increasing public concern about climate change leads to proactive corporate environmental strategies to prevent pollution via development of management capabilities through new management control systems (Albertini, 2019).
Business and accounting networks disseminating and supporting SMA knowledge and applications	Deals with professional accounting organizations, industry associations and sustainability networks encouraging to account for environmental and social impacts.	The UN Division of Sustainable Development, the IFAC and ISO 14051 on MFCA promote development of resource efficiency (Zou et al., 2019). Business initiatives fostering the development of the GHG Protocol (Lee, 2012).

macro-level, influence the take-up and design of SMA. An increasing number of human rights related reporting requirements and regulations (e.g., the UK Modern Slavery Act and the US Dodd-Frank Act) has been addressed, creating the necessity for SMA to deal with social problems at the macro-level. While human rights reports on the global situation encourage companies to consider human rights aspects with SMA (e.g., Christ et al., 2019; McPhail & Ferguson, 2016) research is still challenged to develop more concrete social management accounting and encompassing SMA methods at the corporate level.

Situational mechanisms addressed in the existing literature linking the meso- and micro-level SMA adoption and development in organizations include the role of accounting standards facilitating conservation of the natural environment (e.g., Aladwan, 2018), professional accounting organizations promoting SMA (e.g., issuing guidelines,

expert reports, opinion pieces) and business networks disseminating and supporting SMA knowledge (e.g., material flow cost accounting, Günther et al., 2015). For example, the Carbon Disclosure Project (CDP) has a framework and requests data on greenhouse gas emissions from companies, as published in CDP databases and reports (CDP, 2011). As the data is requested in a standardised format CDP influences corporate SMA at the micro-level and the way they collect, aggregate and report greenhouse gas information. CDP has a similar approach for water data influencing water management accounting at the micro-level (CDP, 2020; Christ & Burritt, 2017). Qian and Schaltegger (2017) provided empirical evidence that CDP disclosure requirements have led to improved corporate carbon management performance, and the influence of the GHG Protocol for accounting and reporting of greenhouse gases by corporations (GHG Protocol, 2004) on the adoption of

carbon accounting has been investigated empirically by various authors (e.g., Brander 2017, Bui & Fowler, 2019).

With regard to meso-micro-level mechanisms in different countries, Aladwan (2018) found that Jordanian chemical and mining companies started to work alongside governments to solve the side effects of environmental problems through adopting necessary accounting standards and legislation; Scavone (2006) considered internal reporting methods of Argentinian companies responding to the National Government Cleaner Production Policy.

A growing body of accounting literature has addressed or started to analyze what and how situational mechanisms influence the introduction and adoption of SMA. Being embedded in a societal, regulatory and natural environment, entities can and do react to situational mechanisms. However, neither managers nor companies react in a purely mechanical way to external influences. External pressure or incentives can be transformed in very different ways within the organization. To understand internal corporate processes better, the way in which situational influences are taken up and how SMA adoption and development takes place requires investigation of how SMA is applied at the corporate micro-level. While much SMA literature deals with specific SMA tools (e.g., MFCA, Nakajima et al., 2013; sustainability balanced scorecard, Hansen & Schaltegger, 2016) much less research analyzes processes of SMA development influenced by situational mechanisms or creating transformational processes. To develop recommendations for public policy and professional organizations regarding how to create effective support and framework conditions to foster corporate SMA, however, requires a better understanding of how SMA is adopted, used and understood at the micro-level. This type of SMA research is also relevant with regard to whether and how SMA development processes address transformational links to the meso- and macro-levels.

Transformational links of SMA fostering sustainable development

If companies and their SMA approaches are to foster sustainable development, then the transformational mechanisms linking the organizational micro-level of SMA with macro- and meso-level impacts must be effective. Only a small number of publications have addressed transformational links between SMA and meso- (15) and macro- (11) levels (Table 3). The development of innovative SMA methods, however, can only create recognisable sustainability contributions in industries and markets if disseminating organizations at the meso-level help change existing unsustainable practices and create new, more sustainable professional and industry standards. Whether

companies can become drivers of sustainability transformations of markets and society and of standard setting, and whether SMA can be a helpful approach in this context, needs to be assessed with regard to the effects of SMA on macro-level sustainability goals such as planetary boundaries (Schaltegger, 2018) and the SDGs (Bebbington & Unerman, 2018). Table 5 provides a summary of topics about transformational links, which have been explicitly addressed in the existing SMA literature.

Transformational mechanisms connecting the micro-level of SMA involvement of organizations with the meso-level entails presenting SMA innovations with the aim of promoting SMA to create sustainability improvements for many actors (e.g., for involving stakeholders, see Hansen et al., 2010), of forming and supporting SMA networks (e.g., Rodrigue et al., 2013), of considering value-creating stakeholder partnerships in SMA (Mitchell et al., 2015), and of applying SMA with the goal of transforming markets and supply chains towards sustainable development (e.g., Koh et al., 2013; Moreno-Camacho et al., 2019; Schaltegger & Burritt, 2014; Spence & Rinaldi, 2014). The arguments examining use of SMA to help transform supply chains often reflects a relational view based on the importance of the supply chain to the social and environmental impacts of the business (e.g., Lee, 2012; Koh et al., 2013; Nakano & Hirao, 2011).

A prominent example of the influence of micro-meso transformational mechanisms is the development and introduction of the International Federation of Accountants (IFAC) guideline and the ISO 14051 standard on material flow cost accounting fostered by an increasing number of companies adopting material flow cost accounting (MFCA) (Jasch, 2008). MFCA was developed at the micro-level in transdisciplinary projects between universities, companies and consulting organizations (Herzig et al., 2012; Jasch, 2008), eventually promoted by a UN Division for Sustainable Development (DSD) project (UN DSD, 2001) in a workbook on environmental management accounting (EMA) and feeding into an IFAC guideline on EMA, particularly MFCA (IFAC, 2005). Later, driven largely by Japanese academics in collaboration with companies, the ISO 14051 MFCA standard (meso-level) was developed (Nakajima et al. 2015). In Japan, the ISO standard 14051 was at a later stage even taken up at the macro-level by the government and federal ministries (Kokubu & Kitada, 2015).

Micro-macro transformational mechanisms are notably underdeveloped in extant research. Mechanisms which are addressed in the existing accounting literature include fostering the transformation of micro institutions towards low carbon impact and sustainable development (Asci & Lovell, 2012; Schaltegger & Csutora, 2012), supporting the creation of new regulations supporting the uptake of

TABLE 5 Transformational links between SMA at the organizational micro-level and macro- and meso-level contexts

Micro → meso	Explanations and related concepts	Prominent authors and examples
Presenting SMA innovations and transforming markets and supply chains towards sustainable development	Correcting market failures and changing market sensitivity through new accounting approaches, including what is understood by 'best accounting practice'. Companies with superior SMA methods can destroy existing conventional accounting patterns, and replace them with new ones. Examples include Puma, a company that applied a new accounting approach to assess environmental impacts in supply chains. This led to media reactions, and motivated consultancies to develop and disseminate similar methods to other companies.	Role of accounting in transforming supply chains (Burritt & Schaltegger, 2014; Spence & Rinaldi, 2014). Assessing the role of supply chains on broader stakeholder groups (Taplin et al. 2006). Applying and disseminating new accounting approaches by consultancies (Bradley et al., 2013).
Forming and supporting SMA networks and professional guidelines and norms	Creation of new SMA networks or SMA in existing networks, including professional accounting associations and support networks with new norms and guidelines. Examples include the uptake of Material Flow Cost Accounting by IFAC with a guideline. Another example is the development of the Greenhouse Gas Protocol by the WRI, WBCSD and GRI based on experiences in pilot projects at the corporate micro-level.	Roles for collaboration and boundary organizations in developing SMA for carbon (Ascui & Lovell, 2012), including the GHG Protocol (Lee, 2012). Importance of corporate community involvement in SMA (Hansen et al., 2010). Development of IFAC guideline on MFCA, initiated by academics and companies involved in pilot projects (Roy et al., 2013).
Value-creation stakeholder partnerships as a rationale for stakeholder inclusion in SMA	Value-creation stakeholder partnerships as a mechanism for the implementation of value-creation stakeholder accounting to develop and to communicate the knowledge required for decision-making. To better inform decision making accounting should create knowledge rather than just information. Knowledge considers application of information in the context of stakeholder partnerships.	Value-creation stakeholder accounting with stakeholder risk-sharing and partnerships as a rationale for stakeholder inclusion in SMA (Mitchell et al., 2015).
Micro → macro	Explanations and related concepts	Prominent authors and examples
Fostering the transformation of government institutions towards sustainable development	Company-lead promotion and diffusion of SMA on a large scale with governmental and societal implications. Also discussed as socio-economic transformations changing socio-economic conditions. Case studies aiming to encourage macro-level support for regulatory promotion of SMA.	Influences of companies sharing their SMA experiences to foster government policies (Schaltegger & Csutora, 2012). Clean Development Mechanism-related EMA contributing to the Philippines Development Plan (Burritt et al., 2009).
Creating new regulations supporting the uptake of SMA	Companies promoting and influencing governments to change existing accounting policies, norms and regulations.	Initiating the introduction of regulations on Material Flow Cost Accounting in Japan (Kokubu & Kitada, 2015).
SMA supporting to meet supra-national sustainability goals	Companies applying SMA to contribute to meeting the SDGs.	Research on linking accounting with SDGs (Schaltegger, 2018).
SMA contributing to solving large-scale sustainability problems	Companies and corporate foundations promoting and disseminating SMA to support solving global problems (such as related to planetary boundaries).	Importance of micro-level full cost accounting for macro-level sustainability improvement (Atkinson, 2000). Research encourages consideration of how SMA influences corporate externalities, particularly planetary boundaries (Gibassier & Alcouffe, 2018).

SMA (Burritt et al., 2009), the (potential) role of SMA to support companies in contributing towards the SDGs, and contributing to solving large-scale sustainability problems (Atkinson, 2000) such as developing an economy operating within planetary boundaries (e.g., Gibassier & Alcouffe, 2018).

An example of aiming to establish a micro-macro link by developing a transformational mechanism based on SMA information is the actions and advocacy of member companies of the Science Based Targets Initiative (Faria & Labutong, 2019). Each member company calculates the necessary greenhouse gas reductions to improve

corporate performance sufficiently to create an effective contribution to limiting global warming to below a 2°C increase and pursuing efforts to limit warming to 1.5°C.

Articles emphasizing the need to establish transformational links are mainly normative, argumentative and conceptual (e.g., Bebbington et al., 2020; Renaud, 2013). Few authors emphasise the need to establish a connection between SMA and planetary boundaries or the SDGs (e.g., Gibassier & Alcouffe, 2018), or provide a framework for how such an SMA approach could be structured (e.g., Schaltegger, 2018).

The literature review shows considerably more publications dealing with situational (85% of the sample) than with transformational links. This finding reveals a reactive approach of the existing sustainability accounting research. First, by focusing on how standards and guidelines at the meso-level can best be applied for internal purposes of the organization these research publications take a predominantly adoptive and internal view. Second, the small number of articles analyzing transformational links unveils that contributions to solving grand sustainability challenges are either assumed to happen automatically while focusing on internal processes, and therefore do not need to be investigated, or that they are ignored. Globally increasing sustainability problems and stakeholder pressure, however, challenge management ever more to measure and communicate whether corporate sustainability contributions are sufficient and effective. The findings reveal that SMA publications addressing situational and transformational links with the organizational micro-level have largely adopted the underlying assumptions of conventional management accounting. In particular, although the identified publications explicitly address links, the addressees and the scope of SMA are both considered to be internal. While SMA, as distinct from financial and other accounting systems, should serve different types of managers as internal addressees, in a world of increasing sustainability problems this can only be achieved if SMA considers linkages to meso- and macro-levels beyond organizational boundaries.

The next section discusses the results and problematises the assumption that the scope of SMA is internal.

DISCUSSION, PROBLEMATISATION AND FUTURE RESEARCH

Results of the systematic review of contextual and transformational aspects of SMA literature indicate a low take-up of research that considers linkages between SMA at the organizational micro-level with meso- and macro-levels (62 of 321 identified SMA publications).

This section reflects upon a main assumption in the literature about the scope of SMA. It argues for extending the scope of SMA beyond the internal, to go beyond organizational boundaries, discusses implications of such a change and proposes a new CAT (context, action, transformation) framework to organize SMA in line with the proposed extended scope.

SMA research opportunities addressing situational links

The emphasis on situational links in the existing literature can be seen as an *indication of a reactive perspective*, the introduction and adaptation of SMA under pressure from external influences. While reactive uptake of SMA could represent business practice (see Christ, 2014; Hartmann et al., 2013; Pondeville et al., 2013), it could also reflect what researchers expect from businesses. The results also indicate that research has adopted the assumption that SMA's scope is internal to the organization. Overall, the SMA research addressing situational links discusses consequences for SMA to support internal company process improvements. With this internal focus, the existing SMA literature has not explicitly analyzed how SMA could be developed to link situational influences with contributions of the company towards solving sustainable development problems beyond the organization's boundaries.

For example, in relation to the analysis of *macro-micro links*, current research does not investigate the role of government actions and the impact of government failure (Ekins et al., 2003) on SMA development. Government failure can range from maintaining the unsustainable status quo of political and societal contexts, to institutional voids (e.g., Doh et al., 2017). It includes bureaucracy failure, the politics of power and the focus on elections instead of solving sustainability problems. For SMA, government failure leads to accounting regulations which ensure that management is under-informed about sustainability crises (Mauders & Burritt, 1991). Although some authors mention government failure as a source of sustainability problems in their SMA-related articles (e.g., Milne & Grubnic, 2011; Nartey, 2018), the topic has not been analyzed in depth in relation to situational influences on SMA. Of recent interest is that government regulations, such as policies and regulations introducing a Circular Economy (e.g., EC, 2020a, 2020b), could be analyzed in relation to how moves towards a Circular Economy could help foster SMA.

Only a few publications have started to address links between SMA, the UN SDGs (e.g., Bebbington & Unerman, 2018) and other international agreements (e.g., Kyoto and Paris GHG protocol), although the macro-level can, and

increasingly does, require certain topics to be considered in SMA (e.g., the US Dodd-Frank Act or UK Modern Slavery Act with regard to human rights issues in supply chains; e.g., Silva & Schaltegger, 2019).

Also, not addressed in depth with regard to the uptake and design of SMA is the influence of macro-level accounts on the global state and deterioration of the natural environment (e.g., the WWF living planet report; WWF, 2018) as well as reports on key global social problems of humankind (e.g., Walk Free Foundation, 2018) shaping the understanding of managers, employees and stakeholders about whether and how their company operations and products relate to large-scale sustainability problems. Likewise, the influence of EU policy aiming to foster a circular economy has not been investigated in depth in the SMA literature although it shapes the macro business environment of companies operating in the EU in relation to material flows, waste streams, reuse and recycling (EC, 2020a, 2020b), and explicitly requires monitoring, tracking and tracing of material flows at the corporate micro-level.

In relation to *meso-micro links* market failure could also be investigated with regard to meso-micro link consequences for SMA. While international and national accounting institutions mostly neglect market failure and developing markets for renewable energy, new regulations such as emissions trading and carbon compensation, are creating additional needs and incentives for companies to consider SMA. Existing research mentions market developments such as a growing demand for carbon neutral products (Milne & Grubnic, 2011), but does not analyse how these situational influences could inform SMA to account for transformational sustainability contributions of products.

With the exception of Ascui and Lovell (2012), also not addressed is the influence of voluntary accounting standard setters on SMA. These include the International Accounting Standards Board (IASB), Financial Accounting Standards Board (FASB), Sustainability Accounting Standards Board (SASB) and accountancy professional bodies such as the International Federation of Accountants (IFAC), the Chartered Institute of Management Accountants (CIMA) and the Association of Chartered Certified Accountants (ACCA). In addition, research on links between the UN reports directly addressing SMA (UN DSD, 2001, 2002) as well as GRI and IR voluntary standards for external reporting and SMA have yet to be closely examined.

Another underexamined *situational mechanism*, linking meso- with micro-levels of SMA, is expectations and influences of societal stakeholders (Silva et al., 2019) and *social movements* as 'purposive and collective attempts of a number of people to change societal institutions and structures' (Sine & Lee, 2009, p. 123). Apart from recent social move-

ments, such as the 'Fridays for Future' movement, various environmental and social networks have addressed partial aspects of SMA, like the Earth Day movement (www.earthday.org), the International Women's Day and call to action (www.internationalwomensday.com), and the Ecological Footprint Network (www.footprintnetwork.org; Dao et al., 2018). As there is no in-depth discussion of such movements with regard to their influence on SMA future research could investigate how they constrain, enable and shape measures and themes used in corporate SMA practices.

SMA research opportunities addressing transformational links

While the small amount of SMA multi-level research focuses on contextual regulations and guidelines, it is apparent that few studies require SMA to account for transformational sustainability contributions of companies.

At the *micro-macro level*, few publications address links between SMA and the impact on specific environmental outcomes beyond the organizational boundaries (e.g., Hörisch et al., 2015; Qian et al., 2018), and none of the identified SMA publications deal with *how effective the application of SMA methods is in meeting social goals*. For example, while the Science Based Target Initiative aims to establish direct links between corporate greenhouse gas emissions and global warming goals, with one exception (Faria & Labutong, 2019), the link between different SMA approaches and contributions to combatting global warming has not been analysed. Instead, the scope of SMA research is restricted to specific internal issues, such as energy and material flows (Dunuwila et al., 2018), health and safety (Jasch & Lavicka, 2006), water (Christ & Burritt, 2017), biodiversity (Siddiqui, 2013), waste (Fakoya & van der Poll, 2013) and their measurement to support different types of managers. While reducing material flows, saving water and avoiding waste are all seen in the analysed literature to make important contributions to reducing the environmental burden of corporations and their products, there is no guarantee that these activities necessarily or inevitably lead to sufficient improvement at the societal or ecosystem level.

At the *micro-meso level*, with regard to transformation, the small number of publications touching upon mechanisms linking SMA and the meso-level of analysis includes the connection of SMA with supply chains (e.g., Moreno-Camacho et al., 2019; Schaltegger & Burritt, 2014; Spence & Rinaldi, 2014). Arguments reflect a relational view based on importance of the supply chain to the social and environmental impacts of the business (e.g., Nakano & Hirao, 2011; Lee, 2012; Koh et al., 2013). Measuring sustainability

impacts of the supply chain is a key area in which SMA could create transformational impacts (e.g., Beske-Janssen et al., 2015; Moreno-Camacho et al., 2019), yet, research is still needed to develop effective SMA approaches for doing so.

SMA and *stakeholder engagement* (Burritt & Schaltegger, 2010) has commenced through publications on accounting for stakeholders and shared-value creation (e.g., Harrison & van der Laan Smith, 2015; Mitchell et al., 2015, Hörisch et al., 2020). These articles could provide a basis for exploring the importance of SMA for stakeholders in transformational processes. The research would need to find SMA approaches that aim at creating sustainability improvements for many stakeholders. Apart from the challenge to create value for both companies and society, developing SMA would also have to discuss how creating improvements of two or more sustainability aspects could be achieved (e.g., combined biodiversity and poverty improvements pursued by different stakeholders).

SMA and *micro-macro links* are hardly touched upon in the existing sample of publications, again presenting opportunities for future research, for example, SMA and gender equality and global poverty. As most of the research literature has focused on specific internal issues in the organization (e.g., material flows) other important impacts of the company or its products with regard to the grand picture of sustainable development as expressed in the UN SDGs or the planetary boundary concept may be missed.

Finally, only three articles address both, the meso- and macro- situational and transformational levels of analysis. Nevertheless, detailed analysis of these articles reveals that the levels are addressed separately and that the interaction between transformative influences of SMA on the meso-level with possible subsequent influences on the macro-level has not been investigated.

Problematizing the internal scope assumption of SMA

Management accounting by definition has internal organizational addressees. Furthermore, it has been based on the assumption that the purpose of management is to increase profits by optimizing organizational processes (e.g., innovation, production, logistics) and therefore has an *internal scope* (Horngren, 2004). Likewise, the review of SMA literature reveals an internal scope with an *implicit separation of the recognition of external context from the development of internal SMA methods*. It may appear paradoxical that publications mentioning links to meso- and macro-levels beyond the organizational boundaries imply that the scope of SMA should be on issues internal to the organization. Such an internal focus

of SMA, however, can be explained by the adoption of the internal scope assumption of conventional management accounting. As a result, only a few of the publications addressing multi-level issues (e.g., Gibassier & Alcouffe, 2018; Schaltegger, 2018) have explicitly considered that SMA should extend the accounting scope beyond organizational boundaries. With the shortage of research which looks beyond the assumed internal scope of SMA the issue needs to be problematised (Alvesson & Sandberg, 2011). Results from the SMA literature contrast with strategic, sustainability-oriented management literature. This literature emphasises that companies are embedded in a business environment and should consider stakeholders, regulations and guidelines in their decisions, including internal management decisions (e.g., Antolín-López et al., 2016; Baumgartner & Rauter, 2017; Hörisch et al., 2014).

The existing SMA literature has so far invisibly adopted the assumption of an internal scope by focusing on optimizing company production processes, material and energy flows and investments. This implies the SMA focus is on helping to develop the organization towards its own sustainable development. However, as sustainable development is a normative societal vision, to help towards achieving this vision, SMA needs an enlarged scope that considers influences from and on the outside as well as impacts of the organization within its boundary (Schaltegger & Burritt, 2017; Schaltegger, 2018). Such an extension of the scope of SMA is also in line with the transformation necessities identified in the sustainability transition literature (Loorbach & Wijsman, 2013; Williams & Robinson, 2020).

As long as SMA continues to adopt the conventional management accounting assumption of an internal scope it reinforces the view that internal optimisations will suffice to meet external expectations about contributions towards sustainability. SMA based on the internal scope assumption of management accounting results in managers being ill-informed about sustainability relevant issues, with the effect that SMA does not support broader transformational change. If SMA is to contribute to the societal vision of sustainable development it should be designed with the purpose of supporting managers in creating external contributions of organizations to sustainable development of markets, society and the natural environment. The question of whether planned and achieved sustainability improvements are sufficient to achieve effective contributions to sustainable development at the global macro-level, therefore, needs to be brought into the focus of SMA.

The next section proposes a new assumption and goal for SMA that addresses the identified multi-level links between SMA and sustainable development for which the literature review has been a catalyst.

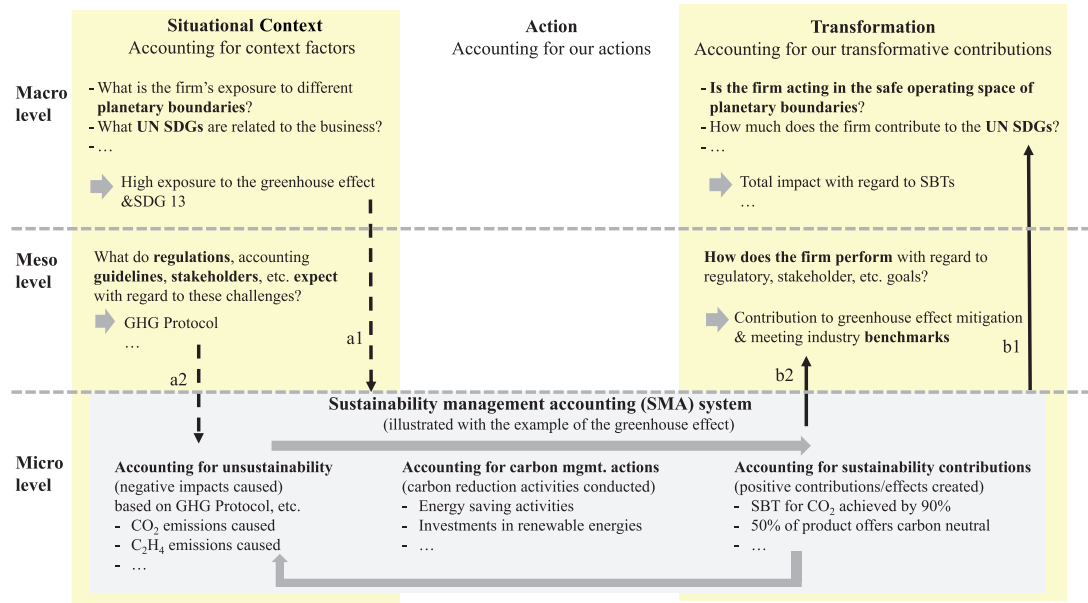


FIGURE 3 CAT framework for SMA [Colour figure can be viewed at wileyonlinelibrary.com]

CAT framework to organize SMA

The embeddedness of organizations in meso- and macro-level contexts as well as the inevitable influence of organizations on these levels requires management to be better informed with SMA about how situational topics and mechanisms can intrigue sustainability management of the business, and how the effectiveness of the organization's contributions to sustainability transformations can be measured and communicated.

To conceptualise the analysis, a framework was abductively developed in a continuous iteration between the data (the reviewed articles) and the theory that informed the analysis from a multilevel perspective. Based on analysis of the existing literature, and by referring to the social mechanisms framework that distinguishes situational (context), action-formation and transformational mechanisms, a CAT (context, action, transformation) framework to reorganize SMA is proposed as follows (see Figure 3):

a. *Context*: Performance is achievement in relation to certain expectations or goals. Managing performance therefore requires being informed about external requirements and expectations. To contribute to sustainable development first requires an understanding of scientific and societal requirements from the macro-level of analysis (e.g., planetary boundaries) as well as stakeholder expectations expressed in regulations, guidelines and standards at the meso-level (left side of Figure 3). As sustainability is a complex, multifaceted vision with many different goals a structured account

of what is expected is needed. Knowledge about stakeholder expectations is a prerequisite to perform according to expectations as well as to create legitimacy (Deegan, 2002). SMA is therefore challenged to provide answers to the *key context question*, *what is the organization's exposure to macro-level requirements and expectations such as planetary boundaries or the UN SDGs (link a1 in Figure 3)?* If, for example, a company is particularly exposed to climate change, the subsequent key question for SMA is whether it sufficiently takes the respective context factors into account. SMA can create related meso-level information (link a2) about societal expectations, regulatory requirements, guidelines and standards (e.g., GHG Protocol) as well as heat wave or water scarcity (forecasts) faced by the company. At the micro-level of the organization, the proposed purpose of SMA accounting for context factors is to take account of potential unsustainability of the company with regard to these contextual expectations. SMA could, for example, account according to the GHG Protocol standard for the current negative impacts of the business (e.g., CO₂ and C₂H₄ emissions caused).

b. *Action*: SMA for the company's actions is what current research literature has mostly focused on. *The key question to be answered by SMA for management actions includes what social and environmental activities are conducted with what immediate economic (e.g., costs of investment in energy saving devices), social (e.g., safety improvement at working place) and environmental implications (e.g., energy savings achieved and carbon emissions reduced)?* Research and practice offer

multiple SMA methods, such as material flow cost accounting, safety and environmental investment appraisals. While internal actions in the organization have been the main focus of most SMA methods so far, the existing approaches have considered context with regard to the expectations of the own actions only partially. Implementation of material flow cost accounting in line with the ISO 14051 standard (Kokubu & Kitada, 2015), or developing carbon accounting with regard to regulatory requirements of the EU Emissions Trading Scheme, have been investigated (Asci & Lovell, 2012). Explicit links to whether planetary boundary conditions or UN SDGs are considered (e.g., in MFCA) and what consequences need to be drawn for benchmarking, goal setting, etc. has only more recently been addressed as a requirement and needs further development of SMA with regard to creating contributions to sustainability transformations beyond organizational boundaries.

- c. *Transformation*: The assumption that internal improvements in an organization will invariably lead to sustainability, has been questioned in the existing literature (Gray, 2010), but it has not informed research into how SMA could be further developed to ensure effective sustainability contributions beyond the organization. Whether and to what extent the company contributes to societal and scientifically developed environmental goals is, however, crucial information managers need to develop a sustainable business (Hörisch et al., 2014). SMA is therefore challenged to create information to answer the *key transformational question*, *how does the company contribute to sustainable development beyond its organizational boundaries; that is, a sustainable development of supply chains, markets, society and the natural environment?* Sustainable entrepreneurship literature suggests that organizations can contribute to sustainable development (Shepherd and Patzelt, 2011) and further sustainability research has frequently called managers to think about such effects of their activities on the macro- and meso- levels (Johnson & Schaltegger, 2020). SMA needs to be linked as explicitly as possible to key sustainability concepts such as planetary boundaries and the SDGs which relate to social, economic and ecological conditions beyond the confines of the organization. To assess whether the business contributes sufficiently to sustainable development therefore requires measurement and disclosure of the negative and positive sustainability impacts and contributions of the organization to networks (guideline development, standards development), markets (sustainability change of markets and consumption patterns), society (change of life styles) and the natural environment.

The CAT framework has various intended methodological implications for SMA, including: the necessity for backcasting from macro-level sustainability problems for benchmarking purposes in SMA; a focus on management guidance, integrating different sustainability issues to ensure comprehensive contributions to sustainable development; and moving from ex post-tracking to future-oriented action and transformation:

Backcasting to develop benchmarks. Backcasting rather than forecasting has been proposed in the sustainability science literature (Holmberg & Robèrt, 2000) to create a database and goals with regard to achieving sustainable development. Backcasting aims to calculate the necessary reductions at a global scale to stay in the limits of a 2-degree Celsius increase to global climate, and it can be broken down for industries and individual companies (e.g., Schaltegger et al., 2017). This shows the amount of greenhouse gas emissions an individual company must reduce to be in line with an economy operating within planetary boundaries. Such alignment of sustainability accounting and benchmarking with macro-level planetary boundary targets serves to establish micro-macro-level transformational mechanisms, which may help managers to set and achieve the goal to transform the own company to be in line with planetary boundaries. With regard to planetary boundaries, the Science Based Target Initiative (<https://sciencebasedtargets.org/>) provides a novel approach providing macro-level benchmarks establishing a link between SMA and the 1.5-degree Celsius goals of the Paris agreement to combat climate and to create meaningful informational value for manager.

Management guidance in addition to transparency. Creating transparency has been highlighted in the existing literature as a key goal for social, environmental and sustainability accounting (e.g., Gray 1992). Much of the literature has also addressed reporting as an important aspect of sustainability accounting (e.g., Adams, 2008; Antonini & Larrinaga, 2017; de Villiers & Sharma, 2020). However, while transparency certainly has its value to inform management and stakeholders, to create awareness about problems, challenges and changes (whether improvements or deteriorations), transparency alone does not lead to management actions and sustainability transformations. As the Volkswagen 'diesel gate' case has shown, excellent reporting practices (e.g., Isenmann et al., 2007) are neither sufficient to motivate nor to guide managers to create excellent environmental and social performance with regard to the grand sustainability challenges relating to planetary boundaries and the SDGs. In spite of that, empirical research shows that, on average, improved disclosure quality leads to improved environmental performance of large companies (Qian & Schaltegger, 2017). Sustainability accounting that supports management to

make better decisions with regard to sustainability needs to provide guidance with regard to macro-level sustainability challenges. This research suggests to investigate whether a new type of report – a ‘*Corporate Sustainability Transformation Statement*’ could provide more guidance to managers to bridge the gap from SMA at the organizational micro-level to meso- and macro-levels. Recent global warming literature has touched on such an approach at the facilities level for companies operating in Australia (Australian Government, 2020), but such an approach has not been proposed for the corporate level, so far. Such a sustainability transformation statement could foster SMA projections with regard to meso- and macro-level action and transformational aims, and would also involve audit and assurance for such a new statement.

Integrating different sustainability issues to develop comprehensive contributions to sustainable development. Integrating social, environmental and economic perspectives remains somewhat abstract and insufficiently tangible for most managers in corporate practice. Furthermore, material flow management and accounting still does not provide information about whether the improvements achieved create trade-offs between different global sustainability goals. For example, the reduction of greenhouse gases by means of planting trees (Bastin et al., 2019) may contribute to combatting climate change and may be achieved in a socially and economically beneficial way. However, the means chosen to achieve this climate-related goal could potentially impact another planetary boundary: biodiversity (Veldman et al., 2019). From an overarching sustainability perspective, integration thus has a new meaning beyond the ‘environmental-social-economic’. Sustainability accounting research and practice is challenged to develop approaches to measure and assess crossing and side-effects between different SDGs as well as between different planetary boundaries.

Moving from ex post-tracking to future-oriented action and transformation. Social and environmental accounting and reporting largely focus on the provision of past data to external parties, but communication in this way does not lead to action per se. While SMA, as with all management accounting, has so far focused on accounting using past and contemporary data to assist managers with decision making, taking actions leading to transformations towards sustainability would necessarily be concerned with data about the future.

This analysis of the existing SMA literature also has implications for research beyond the accounting discipline. Analyses on how well SMA supports managers and organizations to create effective sustainability contributions also becomes important for *research on sustainable entrepreneurship* (which assumes that social and green entrepreneurs can contribute to sustainability

transformations of markets and sustainable development of society; e.g., Hockerts & Wüstenhagen, 2010). Only if entrepreneurs contribute effectively to meso- and macro-level transformations the promises of sustainable entrepreneurship hold true.

For *innovation management*, questions of fostering SMA dissemination in organizations to translate context changes into organizational processes and structures and to understand how situational mechanisms and related management actions help transforming organizations may be of particular interest. Silva et al. (2019) suggest to involve stakeholders in the assessment of sustainability performance to overcome the situation that most practitioners find the sustainability assessment and measurement approaches proposed in the research literature of little practical value and therefore do not apply them in practice. This raises the question how SMA could be further developed as an approach that involves stakeholders in assessing context factors and in contributing to sustainability transformations.

Policy and governance research could examine the effectiveness of different macro- and meso-level contexts and situational mechanisms on SMA introduction and adoption. For the last decade, various publications in the general corporate sustainability and corporate social responsibility domain have addressed the political role of companies and how companies can try to motivate business associations, influence regulations (Marques, 2017). The purpose of corporate political activities is to influence or create the future situational context through legislation for other companies to adopt a certain sustainability approach or issue as well. The accounting literature, however, has not dealt in depth with how SMA could contribute to the political role of companies in fostering sustainability transformations of professional accounting and business associations, markets or regulations.

CONCLUSION

SMA research has large development potential, both with regard to methods as well as dissemination. Analysis of the existing research literature on SMA suggests that innovation potential could be unleashed by reframing the role of *SMA based on an extended scope that* explicitly addresses context and transformational contributions, and links them with the organization’s activities as proposed with the CAT framework.

Most social, environmental and sustainability accounting publications are focused only on the organizational level. While this focus is understandable, it has been criticised for many years as being too narrow (Marland et al., 2015; Milne, 1996; Stechemesser & Günther, 2012). In

corporate practice, reference points to assess an organization's sustainability performance are either past emission levels, own reduction goals, the industry average or best practices (Bradley et al., 2013). Such information, however, does not tell us anything about whether the respective reductions are sufficient to achieve SDGs or be in line with an economy operating in the safe space of planetary boundaries. Corporate sustainability includes contributing to sustainability transformations not just of the organization but also of markets at the meso-level and sustainability transformations of society at the macro-level (Patterson et al., 2017). Until now, practically no methods have been proposed as to how to broaden the management accounting scope including linkages to the meso- and macro-level in an effective way, which would be meaningful for company managers with regard to their job duties at the organizational level and create effective contributions to sustainability transitions beyond organizational boundaries. Accounting research is therefore challenged to develop innovations that enable SMA to translate situational influences on the organization and its management accounting to transformational contributions that support sustainable development.

The intended implications of the CAT framework for SMA include the necessity for backcasting from macro-level sustainability problems for benchmarking purposes in the organization with SMA to explicitly consider the organization's embedding in society and the natural environment. In addition, the implications include the need to integrate different sustainability issues to ensure comprehensive contributions to sustainable development, and moving from ex post-tracking to future-oriented action with the framework's focus on management guidance towards creating effective contributions to sustainability transformations.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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C. Paper 2

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Assessing the contribution of products to the United Nations' Sustainable Development Goals: a methodological proposal

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Abstract

Purpose The 17 Sustainable Development Goals (SDGs) and their 169 targets pose the most important framework for sustainable development worldwide. However, the contributions of products and companies to the SDGs using social and environmental life cycle assessment (S-LCA; E-LCA) have not been thoroughly addressed in the scientific literature. The purpose of this research is therefore to identify product-related targets, derive suitable indicators and develop a social life cycle impact assessment (S-LCIA) method.

Methods To systematically select product-related targets, two questions are developed. The questions ask whether a product (a) has a direct impact on the achievement of the target or (b) if the companies along the life cycle that produce or offer the product have a direct influence on the achievement of the respective target. Suitable indicators are derived and adapted from generally accepted frameworks such as the Global Indicator Framework (GIF-SDG). To develop an S-LCIA method, the targets are translated into conditions beneficial or damaging to the achievement of the target to estimate the socio-economic impact of the product using a scale from +1 to −1. In cases where the targets remain vague, a systematic five-step approach to derive a quantifiable target involving five steps is applied.

Results and discussion The main contribution of this paper is to propose a coherent method to measure the contribution of products to the targets. All 17 SDGs and 61 of the 169 targets (36%) were evaluated as product-related. For 57% of the product-related targets, indicators from the GIF-SDGs could at least partly be used after slight adaptations, while for the remaining 43% of the product-related targets, indicators were taken from other frameworks or sources or had to be added. In total, 45 indicators have been identified to be suitable for assessing the potential contribution of products to the 61 targets. To illustrate the systematic five-step approach to quantitatively assess the contribution of products to the targets, five types of contribution functions are presented in detail.

Conclusions The presented method allows companies to analyse their impact and that of their products on the targets both within their own company and in the supply chain. As especially the latter is increasingly demanded by supply chain laws in different countries such as France, the Netherlands or the UK, the method fills an important research gap. However, future research to examine the proposed approach, the derived indicators and the impact assessment method is strongly encouraged.

Keywords 2030 agenda of the United Nations · Life cycle sustainability assessment · Social impact assessment · Social performance measurement · Sustainability accounting · Supply chain management · Corporate sustainability · Corporate social responsibility

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1 Introduction

The United Nations (UN) has adopted sustainable development as the global guiding principle for the world in 1992 in Rio de Janeiro (UNCED 1992). Sustainable development has been defined as “development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (UNWCED 1987). Since then, most nations have adopted sustainable development as

a guiding principle of their policies. However, implementation was and still is difficult (Drexhage and Murphy 2010). In September 2015, the United Nations (UN) adopted the Sustainable Development Goals (SDGs): 17 goals with 169 targets to be achieved by 2030 (United Nations 2015a), which followed the Millennium Development Goals (United Nations 2015b). With the Agenda 2030 and its 17 SDGs, a paradigm shift was realised: from goals for developing countries to sustainable development goals for all nations worldwide. This is considered a milestone as all 193 UN member states have agreed for the first time in history on a set of goals for sustainable development which serve as a basis for their policies.

Even though the SDGs have not been directly formulated for companies and their products, they can contribute to achieving these goals. Ban Ki-Moon, former General Secretary of the United Nations, explicitly invited companies to support the achievement of the SDGs: “Business is a vital partner in achieving the Sustainable Development Goals. Companies can contribute through their core activities, and we ask companies everywhere to assess their impact, set ambitious goals, and communicate transparently about the results” (GRI et al. 2015, p. 4). Indeed, reports from professional service organisations indicate that businesses are taking a vital interest in how they can contribute to the SDGs (e.g. Association of Chartered Certified Accountants 2017; KPMG 2018; PwC 2015).

For companies, however, it is difficult to assess which of the 169 targets they can and should contribute to and which they have hardly any influence on. Additionally, methods to systematically measure the contribution of companies and their products are still scarce. A report from PwC found that businesses tend to either greenwash (also called SDG-washed) or “cherry-pick the SDGs they want to focus on and ignore others that don’t meet their corporate priorities or comfort zones” (PwC 2015, p. 12). To prevent cherry-picking and facilitate the adoption of SDGs, academia must develop methods to help companies to identify relevant SDGs and to find ways to measure their contribution or the contribution of their products and services (henceforth referred to only as products for ease of reading).

While the UN has supplemented a Global Indicator Framework for the Sustainable Development Goals (GIF-SDGs) that measures the respective targets using 231 indicators, these are mostly at the policy or state (macro) level (United Nations 2021). Vermeulen (2018) found that only about a quarter (25%) of the 169 targets were formulated in terms of endpoint impacts, e.g. on the natural environment or human health as well as planetary or social well-being. By contrast, most targets (54%) are formulated plans, projects or regulations for policy outputs or policymaking. A method for measuring the progress of individual countries in achieving the SDGs has been proposed by the Sustainable

Development Solutions Network and the Bertelsmann Stiftung and updated various times (Sachs et al. 2021). This method has also been adapted by the OECD (2019) and uses a four-step approach to measuring the SDGs and uses reference values from other international agreements (e.g. reduce PM_{2.5} pollution to less than 10 µg/m³, according to the WHO) as a second step. Additionally, Lisowski et al. (2020) proposed a structured procedure for selecting relevant environmental GIF-SDGs but not focussed further on the SDGs itself or on impact assessment. Hence, the role of businesses and other actors with regard to their contribution to the SDGs has been largely neglected in the literature (Herrera Almanza and Corona 2020; Spangenberg 2016).

A common method to measure the environmental, social and economic performance of a product is the life cycle sustainability assessment (LCSA) (UNEP/SETAC 2011; Chhipi-Shrestha et al. 2014). LCSA is “the evaluation of all environmental, social, and economic negative impacts and benefits in decision-making processes towards more sustainable products throughout their life cycle” (UNEP/SETAC 2011, p. 3). It consists of three components: environmental life cycle assessment (ELCA), life cycle costing (LCC) and social life cycle assessment (SLCA) (Klöppfer 2003; UNEP/SETAC 2011). While E-LCA and LCC are quite established in the scientific literature as well as in corporate practice (Finkbeiner et al. 2006; Finnveden et al. 2009), S-LCA is at an earlier stage of development (Benoît et al. 2010; Jørgensen et al. 2008; Kühnen and Hahn 2017). That S-LCA is still less developed, both in general and specifically regarding the SDGs, can be attributed to the relative novelty of both S-LCA and the SDGs, but also to the complexity of social systems and the difficulty of translating qualitative data into a quantitative assessment (Corona et al. 2017; Herrera Almanza and Corona 2020; Kühnen and Hahn 2017). This is also reflected in the fact that the S-LCA method has not yet been standardised by the International Organization for Standardization (ISO) as is the case with E-LCA (ISO 14044/44). S-LCA has only been described in guidelines by the United Nations Environmental Program (UNEP) and the Society of Environmental Toxicology and Chemistry (SETAC) which leaves plenty of space for interpretation and further research (Benoît et al. 2010; UNEP 2020, UNEP/SETAC 2009). However, recently the further developed S-LCA guidelines have been published (UNEP 2020), and research on S-LCA is ongoing. The following research will focus on developing a social life cycle impact assessment method (S-LCIA) method to assess the contribution of products to the targets. Indicators for E-LCA are, however, also proposed for comprehensiveness. LCC is beyond the scope of this paper but should be considered in future research.

An issue of S-LCA is the current lack of standardised indicators that relate to social performance (Kühnen and Hahn 2017; Traverso et al. 2012). Kühnen and Hahn (2017)

argue that the selection of indicators is currently mostly done based on common sense or based on previous studies as there are few existing frameworks or standardised sets of indicators that researchers and practitioners could rely on. A plausible method to select indicators can be to follow political decision processes. Wulf et al. (2018) therefore propose to use the targets to derive indicators for S-LCA. The UNEP Guidelines for S-LCA (2020) state that the SDGs underscore the importance of assessing social impacts of products and also give a list of the most prominent impact categories to assess the 17 SDGs. However, a detailed description of these and a method to assess the impact of products on the SDGs is still missing. Therefore, the paper will derive suitable indicators that allow measuring the respective target and is applicable to products.

Furthermore, there seems to be a high interest of companies to link LCSA to the SDGs, but robust and scientifically grounded approaches to assess a product's impact on the SDGs are scarce (Weidema et al. 2018). Herrera Almanza and Corona (2020) conducted a study in the textile sector and related various S-LCA indicators to several SDGs. Thereby, the authors give an indication of which goals and targets are mostly affected by the product's social supply chain but this method does not allow to measure the impacts of a certain product on the SDGs. The authors call for more S-LCA research that uses SDG-adjusted indicators that measure the scope of business activities to the current degree of global SDG accomplishment (Herrera Almanza and Corona 2020). Wulf et al. (2018) related various indicators provided by the Product Social Impact Life Cycle Assessment (PSILCA) database combined with indicators from E-LCA and LCC to the SDGs and found that several of the SDGs cannot be matched with existing indicators and that it remains difficult to relate the macro-level of the SDGs to the micro-level of product assessments. The latter finding is also supported by Vermeulen (2018), who proposed an integrated LCSA framework aligned to the SDGs. Hence, a comprehensive S-LCA method to consistently and effectively assess a product's social contribution to the SDGs is missing and further research is much needed.

Against this background, the aims of this paper are threefold:

- i. To develop an approach to identify targets which are related to products.
- ii. To derive suitable indicators from existing frameworks.
- iii. To develop an S-LCIA method based on the targets.

The paper is structured as follows: First, Sect. 2 contains the approach to derive the product-related targets, the corresponding indicators and the approach to developing an S-LCIA method. Second, the product-related targets and the

corresponding indicators are given in Sect. 3. Additionally, the S-LCIA is described for the identified indicators. Third, the findings of the research in relation to the existing literature, its contribution and shortcomings are discussed. Last, the article is concluded by discussing its use in corporate practice and suggesting avenues for further research (Sect. 4).

2 Methods

The approach used consists of four steps and is described in the following Sects.: (2.1) the selection of product-related targets, (2.2) the identification of suitable indicators, (2.3) the development of an S-LCIA approach and (2.4) a first validation of the approach with stakeholders.

2.1 Selecting product-related targets

As stated in Sect. 1, the 17 SDGs were not primarily formulated for companies and for assessing the sustainability of products. Therefore, the product-related targets have to be identified first. This is done at the level of the 169 targets, which concretise the 17 SDGs (United Nations 2015a).

To systematically identify product-related targets in a replicable way, it was identified to which target or specific target components a product can make a potential contribution to achieve the respective target or target components. For that purpose, two questions were defined:

1. Case 1 (C1): Does the product have a direct impact on the achievement of the respective target along its life cycle and on which components of the target? This question aims to determine whether a contribution to the achievement of the target (positive or negative) or a part of it can be made directly through the potential impacts caused by the product itself. Impacts caused by the product itself can occur through emissions, e.g. emissions to air, water or soil, or the use of resources, e.g. primary energy resources, water, land, minerals or metals.
2. Case 2 (C2): Do the companies along the life cycle that produce or offer the product have a direct influence on the achievement of the respective target through their activities and on which components of the target? This question aims to identify whether a contribution to the achievement of the target (positive or negative) or a part of the target can be made by business activities of each single company involved along the value chain of the concerned product. This considers that the social performance of products is determined mainly by the organisational behaviour and the operations of the businesses involved. Business activities are all those in which the company itself acts directly. Examples include the level of wages paid, the

implementation of corruption avoidance practices or the coverage of social security support. On the other hand, potential indirect effects through business activities are not considered, for example when workers invest in their children's education with their wages.

These cases are analysed for each of the 169 targets to find a possible product relation. To illustrate this process, some examples are described in Box 1.

BOX 1: Selecting product-related targets

Target 2b aims to “Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round” (UN 2015b). Neither the material flow (C1) nor the activities of companies involved in the production of products or provision of services (C2) can be directly linked to the aims of target 2b or parts of it. Therefore, it is not considered relevant to assess the contribution of products to this target.

By contrast, target 8.5 aims to “By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value” (UN 2015b). In the view of the involved experts and stakeholders (see chapter 2.4), the activities of the companies involved in the production of the product (C2) can be linked to the aim of providing “decent work for all” as well as achieving “equal pay for work of equal value”. However, the achievement of “full [...] employment [...] for all” is seen as a responsibility of governments but not as a responsibility of products, services or the providing company behind it. Obviously, companies are a key actor involved in providing jobs. However, one single company cannot achieve full employment on a society level, and the number of jobs that a company has to provide to contribute to full employment is hardly logically derivable. Instead, it is the responsibility of politics to ensure that the framework conditions are designed in such a way that companies can provide sufficient jobs for all. In contrast, a company is fully responsible for providing decent jobs. In the opinion of the involved experts and stakeholders, companies can therefore contribute to “decent work for all” as well as achieving “equal pay for work of equal value” but not “full [...] employment [...] for all”.

In the study, the targets are examined exhaustively for foods as food systems play a central role in the implementation of the SDGs. However, further branches, e.g. cosmetic and hygiene products, mobility and information technologies have also been discussed within a stakeholder workshop (see Sect. 2.4), but the elaborations here refer to food only. This focus resulted for example in some quite food-specific indicators like the coverage of sustainable agriculture, biodiversity, food losses and investments in conservation and sustainable use of biodiversity and ecosystems in the sustainability risk management.

2.2 Identifying suitable indicators

After identifying the product-related targets and the parts of targets to which products can contribute, suitable indicators are derived. An indicator is defined as suitable if it allows measuring the respective target and is applicable to products.

To be compatible, the indicators are primarily drawn from generally accepted frameworks. As the SDGs are the reference point of this approach, the indicators of the GIF-SDG were analysed first (United Nations 2021). The GIF-SDG proposes indicators for measuring the targets, but these mostly aim to measure the contributions at the policy or state level. As this method aims to measure the contributions at the product level and not the policy or state level, the indicators identified as suitable had to be adapted in many cases. Indicators were adapted if the scope was outside the level of companies and products with the aim to narrow their scope. For instance, indicator 1.1.1 of the GIF-SDG measures the “proportion of the population living below the international poverty line”. As it is deemed suitable to measure the target 1.1 “By 2030, eradicate extreme poverty for all people everywhere [...]”, it is selected as an indicator within this method. However, since a company can only contribute to improving the situation of workers involved in the production of the product as well as of other employees such as procurement, research and development (R&D) or sales but not all people everywhere, the indicator has been adapted to measure this contribution. It now measures “workers/employees earning below UN poverty line of \$1.90 per day”.

The GIF-SDG indicators were supplemented by the indicators proposed within the framework of the European Commission's Environmental Footprint (EF) process (EC-JRC 2017; EC 2018). This was necessary as especially the indicators addressing ecological and health-related issues focus on the policy or state level and many could not be used to measure the contribution of products. The indicators of the EF process on the other hand focus on products and services and address ecological and health-related issues. Therefore, the indicators of the EF process are more suitable for this analysis. This framework was chosen because it is – as the GIF-SDG – a supranational indicator framework agreed upon in a stakeholder dialogue of several years and validated in pilot studies. Furthermore, the indicators are particularly designed for the impact assessment of products and thus, do not need adaptation. As EF indicators have been used, when it was not possible to adapt the GIF-SDG to products, the content of the target has been used for the matching of EF indicators to targets. For instance, for SDG 3.9 “[...] substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination”, it was looked for EF indicators measuring health impacts with respect to hazardous chemicals used along a product's life cycle. This was identified to be the case for the two EF indicators “Comparative Toxic Unit for Human Health (Human toxicity): cancer and non-cancer”. Furthermore, it was looked for EF indicators measuring potential negative impacts on health due to air, water and soil pollution and contamination. These effects can be modelled by the EF indicators “Photochemical ozone creation

potential”, “Disease incidences (Particulate matter)” and “Comparative Toxic Unit for ecosystems (Ecotoxicity)”. The same procedure was followed for the other targets. If no suitable indicator could be found in generally accepted frameworks, indicators were taken from other sources or were developed specially to measure the contribution the respective target.

Thereafter, indicators have been differentiated in inventory indicators, defined as “indicators assessed at the inventory level by aggregating inventory flows” (Arvidsson 2021, p. 1), and impact indicators, defined as “quantifiable representation of an impact category” (ISO 14040:2006, p. 13). Next, indicators have been assigned to E-LCA and S-LCA impact categories. E-LCA impact categories such as land use, biodiversity, eutrophication, human toxicity, photochemical ozone formation, particulate matter, ecotoxicity, water scarcity, resource depletion, climate change, ionising radiation and acidification have been taken from the framework of the European Commission’s EF process (EC-JRC 2017; EC 2018). In S-LCA, there is an agreement on six impact categories, human rights, working conditions, health and safety, cultural heritage, governance and socio-economic repercussions, and 31 sub-categories (UNEP 2020).

2.3 Social life cycle impact assessment

The social life cycle impact assessment (S-LCIA) aims at calculating and evaluating social impacts throughout the life cycle of the product (UNEP 2020). This includes all steps of the value chain and can be related to all countries and regions, depending on the scope of the analysis. As this method presented here aims to assess the impact of products on the targets, it aims to assess performance and not risks. As defined by the S-LCA guidelines, risks address a potentially adverse impact on stakeholders based on probabilities. Performance, on the other hand, refers to concrete outcomes of businesses on relevant stakeholders (UNEP 2020). As the S-LCA guidelines note that S-LCIA “mainly focuses on evaluating potential social impacts – not social impacts per se” (UNEP 2020, p. 80), the method proposed here aims to enable its users to assess the potential impact based on specific performance of the products on the achievement of the targets. It uses primary specific data collected directly from the supplying companies.

To assess the contribution to the targets, the methodological approach developed by Lindner (2016) for the impact assessment of biodiversity is adapted to S-LCIA. This has already been started by Kühnen et al. (2019) for the assessment of positive sustainability impacts of products and has been developed further in this study. The approach permits both quantitative and qualitative knowledge to be transformed into a numerical representation (Lindner 2016; Lindner et al. 2021). The method proposed

by Lindner (2016) is used in biodiversity impact assessment (Lindner et al. 2019a, b, 2021) and uses fuzzy modeling, an approach that is used in a wide range of scientific fields, e.g. risk assessment (Singh et al. 2013).

2.4 Reference point approach

For the impact assessment, the performance reference point approach (Chhipi-Shrestha et al. 2014; UNEP 2020) with the targets as references is used. This is coherent with the six main types of performance reference points for reference scales used in the UNEP Guidelines (2020), where the qualitative and quantitative reference can be based on specific norms, practices and best practices. At the same time, reference is made to a comparison with the sector average, which is also anchored in the UNEP Guidelines (2020).

Since the targets do not always specify a quantitative or quantifiable reference value, a systematic approach is chosen to derive a quantifiable reference value. The systematic approach consists of five steps to derive a reference value from the targets for the impact assessment. The first four steps are taken from the sustainable development report of the Sustainable Development Solutions Network (SDSN) and the Bertelsmann Stiftung (Sachs et al. 2021, p. 70). The report is the first worldwide study to assess where each country stands with regard to achieving the SDGs and has been published annually since 2015. The methodology described in the report of Sachs et al. (2021) has been developed and refined in several rounds of expert consultations and has been also used in prior scientific literature on SDG assessment (Sciarra et al. 2021). Therefore, the chosen approach was deemed a convincing yardstick for deriving target-based reference values for the S-LCIA. As some aspects mentioned in the targets remain very difficult to quantify, a fifth step with a semi-quantitative assessment was added.

The following steps were used to derive reference values from the targets:

1. The priority is always to use absolute quantitative thresholds given to the target itself. This is the case, for example, with target 1.1 (By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.90 a day).
2. In the second priority, the guiding principle of the SDGs “Leave no one behind” is used: This states that all countries, peoples, individuals, etc. must be included in sustainable development and that no one must be left behind (United Nations 2018). This means, for example for target 1.3 (Implement nationally appropriate social protection systems and measures for all..) that all employees along the value chain should benefit from

certain benefits (e.g. social security) and none should be excluded.

3. The third priority is to use science-based targets to quantify the reference value to assess the impact on the target. This is, for example, used for target 2.5 (By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species...) to derive a reference value for the number of used breeds and varieties in agriculture.
4. In the fourth priority, the average of the top five performers is chosen which can be either companies or countries. This is, for example, used for target 9.5 (Enhance scientific research... and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending) to derive a reference value for the share of income spent on research and development.
5. As a last resort, if the definition of a reference value is not possible in the ways described above, the topic in question is included in an indicator on “Sustainability risk management”. The indicator contains how companies take up a specific topic in management and whether (a) goals, (b) measures and (c) responsibilities are defined. This semi-quantitative approach is taken from the Indicator 103–2 “Management Approach” of the Global Reporting Initiative (GRI 2016). This is, for example, used for target 14.1 (By 2025, prevent and significantly reduce marine pollution of all kinds...) to protect marine ecosystems since a quantitative assessment was not (yet) possible. Even though this step does not use quantitative data, it still assesses the actual performance of the company and not generic risk, e.g. based on a database.

2.5 Defining S-LCIA functions

The definition of the S-LCIA functions is based on the approach proposed by Lindner et al. (2021) for biodiversity impact assessment. According to this approach, first, measurable input parameters for the defined indicators and reference points are identified and, second, a contribution function is defined. The contribution function allows to quantify the contribution y of a parameter x to achieving the target for the defined indicators. To define each contribution function consistently, the following steps were taken. First, the contribution interval was set to be between +1 and –1, following the approach by Kühnen et al. (2019). +1 means that the product fully contributes to the achievement of the target and –1 means that the product has a negative impact on the achievement of the target. For the sustainability risk management (C2.3), the highest possible impact (+1) is achieved when all management measures (goals, measures and responsibilities) are

covered. Each individual measure adds 0.33 to the contribution. The lowest impact (0) is assumed when no management measures are covered.

Next, the relationship between the parameter and its contribution is defined following the approach proposed by Lindner et al. (2021). The type of curve, describing the relationship, is based on expert knowledge and is furthermore discussed within an expert workshop (see Sect. 2.3). There are Gaussian and linear functions which determine the shape of the curve. The Gaussian functions have six constants¹ α , σ , β , γ , δ and ε which determine the shape of the curve. Once the curve type is defined, it is discussed with experts how the relationship is shaped. This is mapped accordingly via the six constants. The other type is a simple linear curve. To identify which type fits the contribution of a given parameter, three questions have to be discussed with experts, in order to be able to define the S-LCIA-functions (Lindner et al. 2021):

- First, the start and the end of the function are defined. This is done by discussing the relationship between the parameter x and the reference point. The related questions are as follows: Does more of the parameter lead to a higher contribution to achieving the target? Or is a lower proportion of the parameter a higher contribution to achievement of the target? Where should “–1” or “+1” be set?
- Second, the overall shape of the curve is defined. This is achieved by discussing whether (a) the contribution to achieving the target is always higher (or lower) when more (or less) of the parameter is present, or (b) if it peaks and then drops again, or (c) if it reaches a plateau at some point, or (d) if there is a bend in the curve.
- Third, the curve is further refined by discussing for instance where exactly the plateau starts, how steep the slope/rise of the curve is to best refer to the targets’ reference point or at what point a positive contribution to the target could be expected.

For example for C2.1, first, the start and the end of the function were defined. The target 1.1 aims to “eradicate extreme poverty for all people everywhere” and defines that no one should earn less than the current UN poverty line of \$1.90. Thus, it was first discussed with experts whether the target is achieved if more or fewer workers/employees earn below the UN poverty line and where “–1” should be set. The answer was that the fewer workers/employees

¹ Constants of the Gaussian function: α fixes the width of the plateau without affecting the width of the entire bell; σ determines the width of the bell, but not the plateau; β and γ shift the entire curve in either the x or y direction; δ and ε shift the top of the of the bell either in the x - or in the y -direction (Lindner et al. 2021; p. 3).

earn below the UN poverty line, the higher the contribution to the target. This means that the curve must run from the lower left to the upper right. It was defined together with the experts that the target is not achieved at all if no worker/employee earns above the UN poverty line. Thus, “−1” was set at 0% of workers/employees earning above the UN poverty line. Accordingly, the target is met when there are no workers/employees earning below the current UN poverty line and “+1” was set there. Second, the shape of the curve was discussed with experts. The result of the discussion for indicator C2.1 was that every single worker/employee who earns above the UN poverty line contributes to reaching the target and that the curve is therefore linear. Third, to refine the curve, it was discussed at what point a positive contribution to the target could be expected. The result of this discussion was that a positive contribution to the achievement of the target can be expected when more of analysed workers/employees earn above the poverty line than the national average. Accordingly, $y = 0$ (neither positive nor negative contribution) was set for the national average. Hence, a value above national average is always positive and a value below is always negative.

2.6 Validation through stakeholder and expert involvement

Furthermore, a stakeholder workshop with representatives from NGOs, companies, science, funding bodies and administration was held to discuss product-related targets, indicators and first ideas for the contribution functions. For the selection of stakeholders, a stakeholder analysis according to DIN 69901–5:2009: “Stakeholder analysis” was carried out. DIN provides for an “[...] analysis of the project stakeholders with regard to their influence on the project and their attitudes (positive or negative) [...]” (DIN 69901–5:2009). For this purpose, the following questions were asked for the selection of external stakeholders: (i) Which stakeholders are relevant for the project? (ii) What are the stakeholders’ expectations of the project? (iii) Who has an interest in the project goal being achieved? Who has an interest in it not being achieved? (iv) Who can influence the project positively or negatively? This analysis (see supplementary material) resulted in a shortlist of 40 stakeholders, of which 2 were from the funding bodies, 2 from the case study partners, 8 from other companies, including 2 LCA software providers, 6 from NGOs, 4 from administration and 9 scientists. Thirteen of the invited stakeholders participated in the workshop where, after an introduction to the topic, six discussion stations were used to discuss the selection of the product-related targets (1), on the proposal to define core and comprehensive indicators (2), on indicators for food

(3), for cosmetics and hygiene products (4), for information technology (5) and for mobility (6) were discussed. There was also the opportunity to make general comments on the method. Participants were free to choose which of the six discussion stations they wanted to give input to. The input was collected and after an hour of discussion at the stations, and the results were discussed with all participants station by station. Common insights were extracted, and open questions were recorded. In addition, the participants also discussed the approach of defining contribution functions. The results of the workshop were used in the final selection of the product-related targets, and in the selection of the indicators which was done by experts.

Moreover, results were used in the ongoing discussion on the definition of the functions. The final discussion of the selection of the targets and indicators was held with a group of experts. Furthermore, the definition of the contribution functions was discussed according to the questions described in Sect. 2.5. This resulted in the defined S-LCIA functions, and their description as given in the supplementary material. In addition, a further expert was subsequently consulted with regard to the contribution functions in order to further validate them.

3 Results

In the following sections, the results of the described approach are presented. First, the identified product-related targets are analysed; second, the identified impact categories and indicators are shown; and third, some contribution functions are described in detail.

3.1 Product-related targets

The analysis of the product-related targets based on two defined cases, (C1) whether the products along their life cycle have a direct impact on the achievement of the target and (C2) whether the companies along the life cycle that produce or offer the product have a direct influence on the achievement of the target through their activities (see Sect. 2.1), shows that a reference to products could be identified for 61 of the 169 targets, corresponding to 36% of the targets. This has been analysed especially with regard to food products. Targets belonging to all 17 SDGs were identified. 65.5% of the targets correspond to case C2, 19% to both cases and 15.5% to case C1. The highest fraction of targets with a product relation was found for SDG 6 “Clean Water and Sanitation”, where 6 out of 8 targets (75%) were identified, followed by SDG 15 “Life on Land” with 8 out of 12 (67%) targets. All identified relations to the targets, the used indicators and their assignment to E- and

Table 1 C1-Impact indicators, impact categories, origin of indicator and SDG relation

#	Indicator	Impact category	Origin of indicator	SDG
C1.1	Soil quality index	Land use	EF 3.0	2.4
C1.2	Terrestrial biodiversity	Biodiversity	Lindner et al. (2019a)	2.4, 15.9
C1.3	Accumulated exceedance	Eutrophication	EF 3.0	2.4
C1.4	Comparative toxic unit for human health: a: Cancer b: Non-cancer	Humantoxicity	EF 3.0	3.9, 11.6
C1.5	Photochemical ozone creation potential	Photochemical ozone formation	EF 3.0	3.9, 11.6
C1.6	Disease incidences	Particulate matter	EF 3.0	3.9, 11.6
C1.7	Comparative toxic unit for ecosystems	Ecotoxicity	EF 3.0	3.9, 6.3, 12.4
C1.8	P-equivalents	Eutrophication	EF 3.0	6.3
C1.9	Scarcity-adjusted water use	Water scarcity	EF 3.0	6.4
C1.10	Abiotic resource depletion: a: Minerals and metals b: Fossils	Resource depletion	EF 3.0	8.4, 9.4
C1.11	Global warming potential	Climate change	EF 3.0	9.4, 13.2
C1.12	Ionising radiation potential	Ionising radiation	EF 3.0	12.4
C1.13	N-equivalents	Eutrophication	EF 3.0	14.1
C1.14	Marine biodiversity	Biodiversity	To be developed	14.2
C1.15	Marine acidification potential	Acidification	Bach et al. (2016)	14.3

S-LCA impact categories can be found in the supplementary material.

3.2 Suitable product-related indicators to measure the targets

After identifying the product-related targets and the parts of targets to which products can contribute, suitable indicators are derived from the GIF-SDGs, the EF framework, other sources or are added if no suitable indicator was available. The indicators are split into C1 impact indicators (Table 1), C1 inventory indicators (Table 2) and C2 impact indicators (Table 3). The respective impact categories, origin of indicators and targets are given. As the inventory indicators have no impact categories, there are no impact categories mentioned in Table 2.

The identified indicators belong to twelve environmental and six social impact categories (Tables 1 and 3). Regarding the environmental impact categories, not all impact categories proposed by EF are used in this framework (EC-JRC 2017; EC 2018). For example, the targets do not address ozone depletion. Therefore, this impact category does not appear in this study. On the other hand, the targets address the protection of biodiversity on land, in freshwater and in the oceans very prominently. Here, EF recommends assessing the impact on terrestrial biodiversity, but no concrete method has been proposed so far. Aquatic biodiversity is not yet addressed in EF, nor is ocean acidification, the reduction of which is explicitly mentioned in target 14.3. Concerning

the social impact categories, all six categories proposed in the S-LCA guidelines (UNEP 2020) are reflected in the targets and all C2-indicators belong to social impact categories.

The first finding is that none of the indicators proposed in the GIF-SDG could be used directly to assess the potential contributions of products to the targets. The reason is that most targets and the corresponding GIF-SDG indicators address the policy level which is in line with the findings when identifying product-related targets. In particular, the targets focussing on ecological and health-related issues were addressed using indicators from the EF process as they focus especially on products. However, for 57% of the product-related targets, indicators from the GIF-SDGs could be used after they were slightly adapted to fit products. This is for example the case for the GIF-SDG indicator “1.1.1 Proportion of population below the international poverty line” which was adapted to “Workers earning below the UN poverty line”. Similarly, indicator 14.3.1 covers the “average marine acidity (pH) measured at agreed suite of representative sampling stations” which was adapted to measure the “marine acidification potential” of products with the E-LCIA method proposed by Bach et al. (2016).

For 43% of the product-related targets, GIF-SDG indicators could not be adapted or modified to fit products. This is for example the case for GIF-SDG 5.1.1 “Whether or not legal frameworks are in place to promote, enforce and monitor equality and non-discrimination based on sex” because legal frameworks do not apply to specific products. Therefore, the indicator C2.10 “Equal wages

for men and women” was developed which compares the wages of women and men. As the corresponding target 5.1 states to “end all forms of discrimination against all women and girls everywhere” and does not include further genders, the indicator has been confined to men and women. Additionally, discrimination and equal opportunities were added as a topic for the sustainability risk management described in indicator C2.3 (the last step of the reference point approach).

In total, 45 indicators have been identified to be suitable for assessing the potential contribution of products to the 61 targets. This means that several indicators are used for the assessment of more than one target. However, for some targets, more than one indicator is necessary to map the potential contributions, e.g. target 5.1. 15 indicators assess the contribution to more than one target, 11 indicators assess the contribution to two targets, three indicators to three targets and one assesses the contribution to 26 targets (C2.3). However, most indicators (30) specifically assess the contribution to one target. All identified product-related indicators can be found in Tables 1, 2 and 3.

3.3 S-LCIA functions

The S-LCIA aims to assess the contribution of a product to the respective targets. The contribution is based on indicators that were identified using the approach specified in the method section. The expert and stakeholder discussions on the definition of contribution functions resulted in three types of curves:

- Linear functions (15 out of 20): Here, each unit more (or less) was considered a positive contribution to the target. In some cases, the slope of the curve depends on the national or the sector average which results in a piecewise linear function.

- Bell-shaped functions (3 out of 20): These were considered suitable for targets that address gender inequality and are based on Gaussian functions. Here it was discussed that inequality can occur equally for both genders considered. Therefore, both need to be assessed in the function. It was discussed that the maximum inequality for both genders is equally negative. In addition, it is very difficult to achieve exact equality, so that the slope at the peak (absolute equality) must be lower than when more inequality occurs. Hence, a symmetric bell-shaped function, resembling a downwards quadratic function was determined to be most appropriate.
- Plateau functions (2 of 20): This function expresses that the contribution y to the target increases rapidly with the parameter x at lower values but tends to reach a threshold at which the slope becomes smaller, resulting in a plateau. These functions are also based on Gaussian functions.

Other possible curve types described in Lindner et al. (2021) were not considered suitable by the experts for the impact assessment of the identified 20 indicators discussed here. Since it would be beyond the scope of the paper to discuss the impact assessment for each of the 20 C2-indicators, in the following, an example is given for each of the five priorities defined in the systematic approach to setting the reference value for the impact assessment. In line with the aim of this paper, functions were only developed for C2 indicators.

As a first choice, the reference value for the impact assessment is derived directly from the target. This is the case for indicator C2.12 that is based on target 6.1 “By 2030, achieve universal and equitable access to safe and affordable drinking water for all”. The corresponding GIF-SDG aims to enhance the “proportion of population using safely managed drinking water services” and can be directly transferred to employees involved in the production and management of a certain product. The indicator captures the share of employees that have access to safely managed drinking water at work (input parameter). Result

Table 2 C1-Inventory indicators, origin of indicator and SDG relation

#	Indicator	Origin of indicator	SDG
C1.16	Income per hectare – small-scale producers	GIF-SDG (adapted)	2.3
C1.17	Yield per hectare – small-scale producers	GIF-SDG (adapted)	2.3
C1.18	Death rate due to road traffic injuries	GIF-SDG	3.6
C1.19	Water use	GIF-SDG (adapted)	6.4
C1.20	Energy use: a: Renewable b: Non-renewable	GIF-SDG (adapted)	7.2, 7.3
C1.21	Food losses	GIF-SDG (adapted)	12.3
C1.22	Waste generation (per fraction)	GIF-SDG (adapted)	12.4
C1.23	Use of recycled material	GIF-SDG (adapted)	12.5
C1.24	Marine debris (incl. (micro) plastic)	GIF-SDG (adapted)	14.1
C1.25	Share of by-catch in catches	GIF-SDG (adapted)	14.4

Table 3 C2-impact indicators, impact categories, origin of indicator, SDG relation and base of reference point

#	Indicator	Impact category	Origin of indicator	SDG	Reference point based on
C2.1	Workers/employees earning below the UN poverty line of \$ 1.90 per day	Working conditions	GIF-SDG (adapted)	1.1	Explicit SDG
C2.2	Coverage of social security support	Health and safety	GIF-SDG (adapted)	1.3	Leave no-one behind
C2.3	Coverage of product-related sustainability (risk) management a: Sustainable agriculture (SDG 2.4) b: Driver/passenger safety and reduction of accidents (SDG 3.6) c: Equal opportunities (SDG 5.1) d: Water use and scarcity (SDG 6.5, 6.6) e: Natural resources (SDG 12.2) f: Food losses (SDG 12.3) g: Chemicals (SDG 12.4) h: Waste (SDG 11.6, 12.5) i: Climate change (SDG 13.2) j: Marine biodiversity (SDG 14.2) k: Terrestrial and freshwater biodiversity (SDG 15.1–15.5, 15.8) l: Patents on natural resources (SDG 15.6) m: Corruption prevention (SDG 16.5) n: Human rights (SDG 16.a) o: Promotion of environmentally sound technologies in developing countries (SDG 17.7) p: Energy efficiency (SDG 7.3) q: Small-scale suppliers/industry borrowers in the supply chain (in particular from least developed countries) (SDG 9.3) r: Share of products/materials from developing countries (SDG 17.11) s: Investments in conservation and sustainable use of biodiversity/ecosystems (SDG 15.a, 15.b) t: Engagement in multi-stakeholder partnerships for sustainable development (SDG 17.16, 17.17)	Governance	Added	2.4, 3.6, 5.1, 6.5, 6.6, 7.3, 9.3, 11.6, 12.2, 12.3, 12.4, 12.5, 13.2, 14.2, 15.1, 15.6, 15.8, 15.9, 15.a, 15.b, 16.5, 16.a, 17.7, 17.11, 17.16, 17.17	Sustainability risk management
C2.4	Number of used breeds/varieties	Cultural heritage	Lindner et al. (2019b)	2.5	Science-based
C2.5	Health insurance	Health and safety	GIF-SDG (adapted)	3.8	Leave no-one behind
C2.6	Occupational injuries	Health and safety	GIF-SDG (adapted)	3.9, 8.8	Leave no-one behind
C2.7	Access to protective clothing	Health and safety	GIF-SDG (adapted)	3.9, 8.8	Leave no-one behind
C2.8	Training in sustainability issues a: ICT skills (e.g. technical and vocational) (SDG 4.4) b: Sustainability in general (SDG 4.7) c: Climate change (SDG 13.3) d: Corruption and bribery prevention (SDG 16.5)	Governance	GIF-SDG (adapted)	4.4, 4.7, 13.3, 16.5	Leave no-one behind
C2.9	Equal share of training for men and women	Human rights	GIF-SDG (adapted)	4.5	Leave no-one behind

Table 3 (continued)

#	Indicator	Impact category	Origin of indicator	SDG	Reference point based on
C2.10	Equal wages for men and women	Human rights	GIF-SDG (adapted)	5.1, 8.5	Leave no-one behind
C2.11	Equal managerial positions for men and women	Human rights	GIF-SDG (adapted)	5.5	Leave no-one behind
C2.12	Drinking water at work	Health and safety	GIF-SDG (adapted)	6.1	Explicit SDG
C2.13	Adequate sanitation at work	Health and safety	GIF-SDG (adapted)	6.2	Explicit SDG
C2.14	Wastewater treatment	Health and safety	GIF-SDG (adapted)	6.3	Top 5 (countries)
C2.15	Employees under 24 years	Socio-economic repercussions	GIF-SDG (adapted)	8.6	Leave no-one behind
C2.16	Fulfilment of ILO conventions: a: Child work and minimum age, forced labour b: Freedom of association, discrimination, collective bargaining for all employees, equal remuneration of workers	Working conditions	GIF-SDG (adapted)	8.7, 8.8	Leave no-one behind
C2.17	Investments in R&D	Governance	GIF-SDG (adapted)	9.5	Top 5 (companies)
C2.18	Relative poverty rate	Working conditions	GIF-SDG (adapted)	10.2	Leave no-one behind
C2.19	Income spread	Working conditions	GIF-SDG (adapted)	10.3	Science-based
C2.20	Product-related sustainability information	Governance	GIF-SDG (adapted)	12.6, 12.8, 14.4	Explicit SDG

of the expert discussion was that the contribution to the target (reference value) is fully achieved ($C2.12 = +1$) when all workers/employees have access to safe drinking water at work (Fig. 1), and that there is a negative impact when none of the workers/employees have access to clean and safe water ($C2.12 = -1$). The impacts are assessed positively if the proportion of workers/employees who have access to safely managed drinking water is higher than the national average of the country in which the company is located. The impacts are assessed negatively, if the proportion is below the national average. If the company’s proportion of workers/employees who have access to safely managed drinking water at work is equal to the national average (n), $C2.12 = 0$. This is done for all steps in the value chain. The impact assessment equation is expressed as a piecewise linear function (Fig. 1, Eq. (1) [S-LCIA for indicator C2.12]), as every additional worker/employee with access to drinking water at work is considered an improvement. Because of the piecewise definition dependent on the national average, the slope between $y = -1$ and $y = 0$ is prone to be different than the slope between $y = 0$ and $y = +1$.

$$C_{2.12} = \begin{cases} 1, & \text{for } n = 1 \\ x * \frac{1}{n} - 1, & \text{for } x < n \\ x * \frac{1}{(1-n)} - \frac{n}{(1-n)}, & \text{for } x \geq n \end{cases} \quad (1)$$

where x is the company specific value and n is the national country average.

This approach of deriving the impact assessment directly from the target is also used for indicators C2.1, C2.13 and C2.20. All of these indicators are defined as linear contribution functions.

Secondly, the reference value can be derived from the principle “leave no one behind”. For example, target 1.3 aims to “implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the

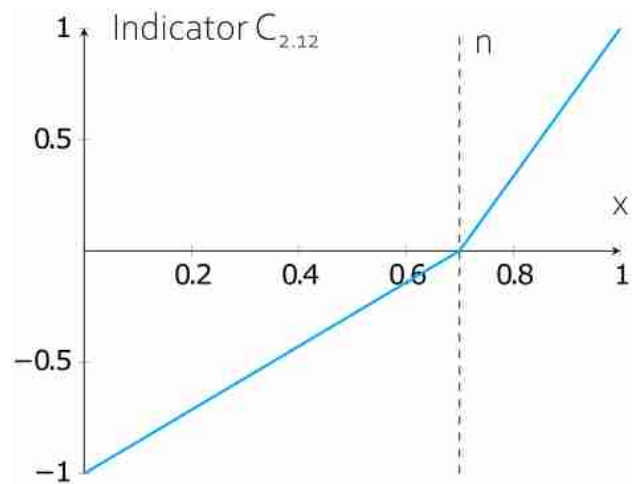


Fig. 1 S-LCIA contribution function for indicator C2.12. x is the proportion of workers/employees with access to safely managed drinking water at work. n is the national country average of employees with access to safely managed drinking water at work

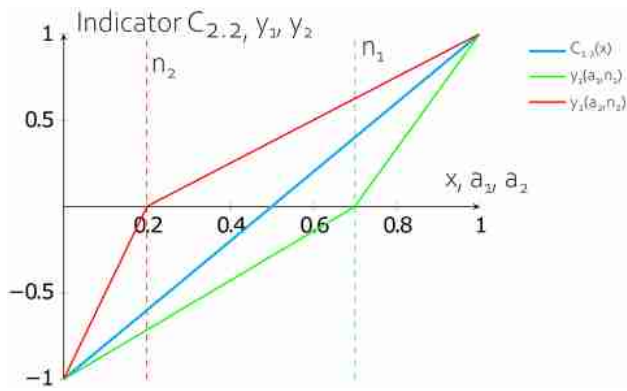


Fig. 2 S-LCIA contribution function for indicator C2.2. y_1 and y_2 represent different types of social security support as an example. n_1 and n_2 are the corresponding national country averages

vulnerable”. The requirement for the corresponding GIFSDG is to analyse the “proportion of population covered by social protection floors/systems [...]”. If the principle “leave no one behind” is applied to target 1.3, the reference value can be set to let all employees along the product life cycle benefit from all types of social security (C2.2 = +1; Fig. 2). A neutral impact on the target (C2.2 = 0) is assumed if the average coverage of the company’s employees with social security equals the average coverage of employees in the country concerned. If none of the employees is covered by any type of social security, a negative impact of C2.2 = -1 is assumed.

To define a social security system, the definition of the International Labour Organisation (2017, p. 168) was used, which includes the following types of social security: (a1) child and family benefits (e.g. benefits in form of periodic cash or housing, holidays, help); (a2) maternity protection (e.g. paid leave or leave with adequate social security benefits); (a3) unemployment support; (a4) employment injury benefits; (a5) sickness benefits; (a6) health protection; (a7) old-age benefits; (a8) disability benefits; (a9) survivors’ benefits (e.g. earnings-related periodic cash benefits and funeral grants to survivors of deceased workers). The contribution is first assessed for all nine types of social security independently (y_1 to y_9) and then summed up to an equally weighted average C2.2. Since the average coverage with social security varies within the different countries and also for the different types of social security systems, the x axis intercept can occur at different values of x . Figure 2 shows an example of this for y_1 and y_2 . The impact assessment equation is expressed as a linear function (Fig. 2, Eq. (2) [S-LCIA for indicator C2.2]), as every additional worker/employee with access to one or more of

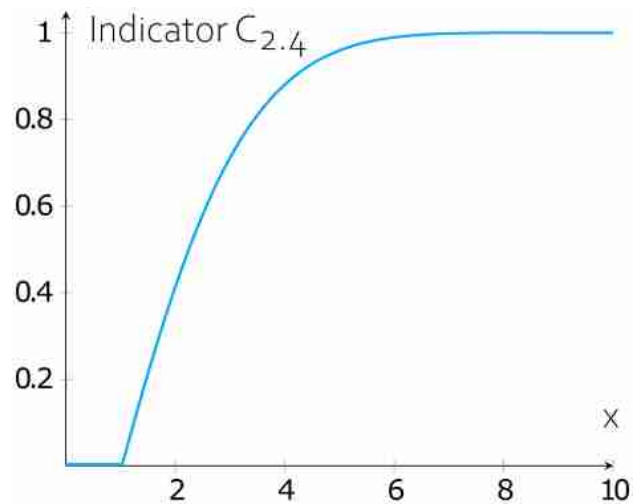


Fig. 3 S-LCIA contribution function for indicator C2.4. x is the number of the used breeds/varieties

the nine different types of social security is considered an improvement. Since the national averages regarding social protection systems are different for different countries and thus $y_i = 0$ is varying, this also results in different slopes of the functions as displayed in Fig. 2.

$$C_{2.2} = \frac{1}{9} \cdot \sum_{i=1}^9 y_i \text{ where } y_i = \begin{cases} 1, & \text{for } n_i = 1 \\ a_i * \frac{1}{n_i} - 1, & \text{for } a_i < n_i \\ a_i * \frac{1}{(1-n_i)} - \frac{n_i}{(1-n_i)}, & \text{for } a_i \geq n_i \end{cases} \quad (2)$$

where a_i is the share of employees benefiting from social security support, a_1 is the child and family benefits, a_2 is the maternity protection, a_3 is the unemployment support, a_4 is the employment injury benefits, a_5 is the sickness benefits, a_6 is the health protection, a_7 is the old-age benefits, a_8 is the disability benefits, a_9 is the survivors’ benefits and n_1 – n_9 is the national country average of related coverage a_1 – a_9 .

The approach of using the principle “leave no one behind” is also used for the indicators C2.5, C2.6, C2.7, C2.8, C2.9, C2.10, C2.11, C2.15, C2.16 and C2.18. However, due to the different issues addressed by the other indicators, the indicators C2.9, C2.10 and C2.11 are expressed with quadratic functions, whereas the other indicators mentioned are also expressed with linear functions. All functions are given in the supplementary material.

The third choice is to use science-based targets to quantify the reference value to assess the impact on the target. The basis for the indicator C2.4 is target 2.5 which states “By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals [...]”.

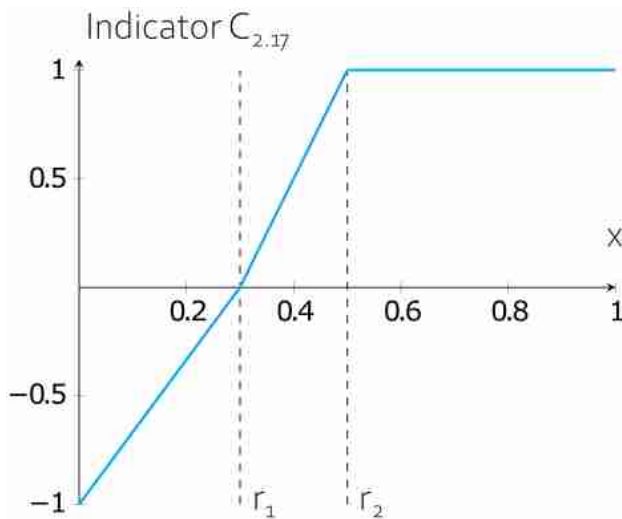


Fig. 4 S-LCIA contribution function for indicator C2.17. x is the share of income spent on R&D

The requirement for the GIF-SDG 2.5.1. (United Nations 2021) for this target is to report on the genetic resources in conservation facilities and the proportion of local breeds being at risk of extinction which, in the view of the involved experts and stakeholders, cannot be transferred to products. Since the reference value can also not be derived directly from the target and the principle “leave no one behind” does not hold here, an assessment based on science-based targets was adopted. A suitable assessment was developed by Lindner (2016) and has already been used in case studies on the assessment of biodiversity impacts (Eberle 2018; Eberle and Lindner 2015; Lindner et al. 2019a). The indicator describes agrobiodiversity and assesses the number of breeds/varieties grown (input parameter). Which and how many different breeds/varieties are cultivated is based on the agricultural practice of the cultivating farm. The more different breeds or varieties are cultivated, the better for the maintenance of genetic diversity. The contribution function (Fig. 3, Eq. (3) [S-LCIA for indicator C2.4]) expresses that the use of just one single variety/breed does not have a positive effect on genetic diversity ($C2.4 = 0$). However, every additional variety/breed increases agrobiodiversity until a certain level of diversity in varieties/breeds is achieved. Then, the marginal biodiversity value decreases and levels out, approaching $C2.4 = 1$. The approach of using science-based targets has also been used for C2.19, which is also expressed with an exponential function as is C2.4.

$$C_{2.4} = \begin{cases} 0, & x < 1 \\ 2 \cdot e^{-\frac{(x-1)^6}{0.7543}} - 1, & x \geq 1 \end{cases} \text{ where } x = \frac{n}{A \cdot t} \quad (3)$$

where n is the number of breeds or varieties cultivated, A is the agricultural area hectare (ha) and t is the number of years (a).

As a fourth choice, the reference value for the impact assessment can be based on the average of the five top performers which can be either companies or countries. C2.17 illustrates such an indicator which is based on target 9.5 “Enhance scientific research, upgrade the technological capabilities of industrial sectors [...]”. The potential contribution of companies is to raise the share of income spent on R&D. The GIF-SDG 9.5.1 proposes to measure “research and development expenditure as a proportion of GDP” which is adapted to products. The maximum impact on the target ($C2.17 = +1$) is reached when the share of income spent on R&D (input parameter) is equal to the average of the five branch leaders in the sector (r_2). However, an expense above the average of five industry leaders does not lead to a value above +1. There is a neutral impact on the target ($C2.17 = 0$) when the expenses spent on R&D are equal to the national country-branch average (r_1). The impact is set as $C2.17 = -1$ when there are no expenses for R&D. The function is expressed in linear terms until the spending of the five industry leaders is reached, as each additional resource spent on R&D represents a positive contribution to the achievement of the target (Fig. 4, Eq. (4) [S-LCIA for indicator C2.17]). The reference value based on the five best performers is also used for C2.14. C2.14 relates to the amount of wastewater treatment, uses the top five performing countries as reference point and is also expressed as a linear function. Both indicators are adapted from the GIF-SDG.

$$C_{2.17} = \begin{cases} 1, & \text{for } x > r_2 \\ x \cdot \frac{1}{r_1} - 1, & \text{for } x < r_1 \\ x \cdot \frac{1}{(1-r_1-r_2)} - \frac{r_1}{(1-r_1-r_2)}, & \text{for } r_1 \leq x \leq r_2 \end{cases} \quad (4)$$

where x is the share of investments in R&D based on income, r_1 is the national country-branch average and r_2 is the average share of 5 industry leaders in the sector.

As a fifth choice, a product-related topic addressed in a target can be included in the sustainability risk management if a quantitative assessment is not (yet) possible. An example of an impact assessment based on sustainability risk management is target 5.1 which aims to “End all forms of discrimination against all women and girls everywhere”. The indicator C2.10 “Equal wages for men and women” was developed which compares the wages of women and men which can be further amended for minorities. However, not all kinds of discrimination can be covered using wages as proxy. Therefore, discrimination was added as a topic for the sustainability risk management. Whether a certain issue is covered comprehensively in the sustainability (risk) management

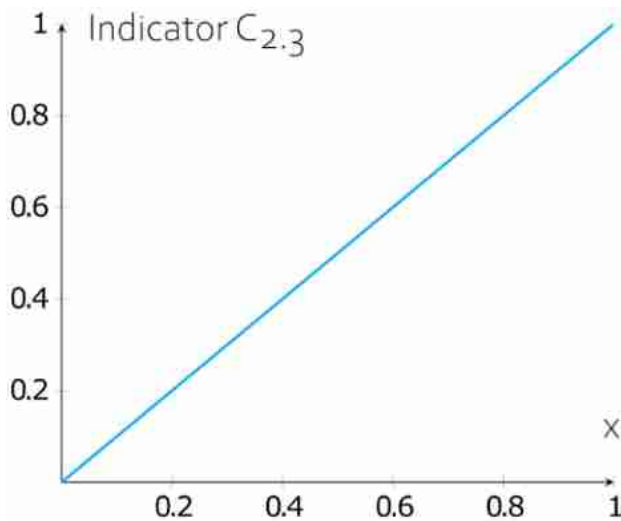


Fig. 5 S-LCIA contribution function for indicator C2.3. x is the degree of fulfilment at the management level for C2.3a-t

of the company is based on the management approach developed by GRI (2016). Summing up the requirements, comprehensive sustainability risk management can be proven by (a) agreeing policies/goals and targets, (b) defining responsibilities/allocating resources and (c) planning concrete actions/measures. Each risk management measure can either be addressed (e.g. $C2.3_1 = 1$) or not (e.g. $C2.3_1 = 0$). The highest possible positive impact on preventing discrimination ($C2.3a = +1$) is achieved when all management measures (policies/goals and targets; responsibilities/resources; specific actions/measures) are covered. No positive impact ($C2.3a = 0$) is assumed when no management measures are covered. Equation (5) (S-LCIA for indicator C2.3a) gives details on the measurement of the indicator regarding discrimination C2.3a.

$$C_{2.3a} = x = \sum_{j=1}^3 C2.3_j \quad (5)$$

where $C2.3_j$ is a Boolean operator (value either 1 or 0) for management measures against discrimination covered, $C2.3_1$ is the policies/goals and targets, $C2.3_2$ is the responsibilities/resources and $C2.3_3$ is the specific actions/measures.

The approach of using the sustainability risk management is also used for other topics addressed in the targets such as C2.3b: driver/passenger safety/reduction of accidents (target 3.6); C2.3c: equal opportunities (target 5.1); C2.3d: water use and scarcity (target 6.5, 6.6); C2.3e: natural resources (target 12.2); C2.3f: food losses (target 12.3); C2.3 g: chemicals (target 12.4); C2.3 h: waste (target 12.4, 12.5); C2.3i: climate change (target 13.2); C2.3j: marine biodiversity (target 14.2); C2.3 k: terrestrial and freshwater biodiversity (target 15.1–15.5, 15.8); C2.3

l: patents, on natural resources (target 15.6); C2.3 m: corruption prevention (target 16.5); C2.3n: human rights (target 8.7, 8.8, 16.a); C2.3o: promotion of environmental sound technologies in developing countries (target 17.7); C2.3p: energy efficiency (target 7.3); C2.3q: small-scale suppliers/industry borrowers in supply chain (particular from least developed countries) (target 9.3); C2.3r: share of products/materials from developing countries (target 17.11); C2.3 s: Investments in conservation and sustainable use of biodiversity/ecosystems (target 15.a, 15.b); C2.3t: Engagement in multi-stakeholder partnerships for sustainable development (target 17.16, 17.17).

These topics (C2.3a-t) are all assessed using the same approach as described for C2.3a. They are then summed up and equally weighted, to give an overall result for indicator C2.3 (Fig. 5, Eq. (6) [S-LCIA for indicator C2.3]).

$$C_{2.3} = x = \frac{1}{60} \cdot \sum_{i=a}^t \sum_{j=1}^3 C2.3_{ij} \quad (6)$$

where $C2.3_{ij}$ is the Boolean operator (value either 1 or 0) for each management measure (policies/goals and targets, responsibilities/resources, specific actions/measures) covered, for each of the 20 topics.

The interval for all indicators was set between -1 and $+1$, except for C2.3 and C2.4. Both indicators range only between 0 and $+1$. For C2.3, no negative impact on the achievement of the target is considered if the mentioned topics are not managed comprehensively. C2.4 is science-based and the range has been adopted directly from the literature (Eberle and Lindner 2015; Lindner et al. 2019b).

4 Discussion

The agenda 2030 with the 17 SDGs poses a powerful frame to guide the world in fostering sustainable development. However, the 169 targets focus mainly on government roles, ignoring the role of businesses and their products (Spangenberg 2016). The main contribution of this paper is to propose a coherent method to measure the contribution of products to the 169 targets. The method involves a systematic approach to identify targets that are related to products, to derive suitable indicators from existing frameworks and to develop an S-LCIA method for the C2-indicators using the targets as a performance reference point. This contributes to science and practice as previous literature has analysed that to date companies often cherry-pick the SDGs they want to focus on (PwC 2015), researchers tend to select the S-LCA indicators mainly on previous studies or on gut feeling (Kühnen and Hahn 2017) and that a method to measure the contribution of products to the SDGs has been lacking in both research and practice. The paper also contributes to the scientific discussions on S-LCIA methods, in particular to the performance reference point approach. Furthermore, the paper contributes to corporate practice as choosing the targets

of the SDGs as reference points allows linking the companies' activities in sustainability management to the SDGs. In the following, the main constituents of the method are discussed.

4.1 Identification of product-related targets

To filter the product-related 169 targets of the SDGs, an approach using two questions was developed. Using this approach to identifying the product-related targets, only 36% of the targets were found to have a reference to products. However, this must not be the case for all products and the authors propose to always screen the 169 targets of the SDGs based on the defined cases regarding the specific product to be analysed. This finding corresponds roughly with the findings of Vermeulen (2018) who analysed that 54% of the goals are formulated as plans, projects or regulations for policy outputs or policymaking. Herrera Almanza and Corona (2020) found that only 17% of the targets were related to the product of their analysis, but they only included social targets as they focused solely on S-LCA. Lisowski et al. (2020) focused their analysis exclusively on ecological indicators used in the GIF-SDG that can be linked to the automotive sector and found that 12.5% of the indicators had a direct relation. Since in this work both environmental and social targets were addressed, a comparison with previous work that focused on either social goals or on environmental indicators is difficult. Previous studies also focused on other products which prohibits a further comparison.

4.2 Selection of suitable indicators

To measure the impact of products on the targets, the GIF-SDG was used as a primary source for reliable and generally accepted indicators. However, the policy focus of the targets also applies to the indicators formulated in the GIF-SDG. Only for 57% of the product-related targets, the GIF-SDG indicators can at least be partly related to products and almost all of them had to be adapted for this purpose. Some targets address topics more broadly than the corresponding GIF-SDG and hence had to be complemented with further indicators to address the diverse aspects of these targets and improve the assessment (e.g. target 6.6). For other targets, product-related indicators were drawn from the EF process, from other sources or were defined specially to assess the potential impact on the respective target (see Tables 1, 2, and 3). The selection of indicators from the EF process is considered to contribute positively to the assessment of the targets, as they address the environmental impact on the targets more directly (e.g. target 2.4). Additional indicators were used or defined in cases where neither the GIF-SDG nor the EF framework provided sufficient coverage.

Even if for 43% of the product-related targets, indicators were taken from the EF framework, other sources or defined specially to assess the potential impact on the respective target, they have the advantage of being oriented as far as possible to a globally accepted reference framework and are not based on any normative goals of their own. This addition of objective indicators is a major contribution to the field of S-LCA, as Kühnen and Hahn (2017) analysed that the indicator selection to date is based mainly on previous studies or on gut feeling of the researcher or practitioner. This study has examined the targets exhaustively for foods. Future research should critically examine these indicators and adjust them for the particular product and aim of the respective study. Additionally, it should be considered whether it would be worthwhile to establish a product-related indicator framework for the SDGs (PIF-SDG) that stakeholders worldwide could agree on, analogous to the GIF-SDG.

4.3 The development of a quantitative S-LCIA method

This study develops a quantitative S-LCIA method taking the SDGs as a normative reference point and following the S-LCA guidelines (UNEP 2020). The method enables its users to assess the potential impacts of products on the targets of the 2030 Agenda, which can support companies in assessing their contribution. The S-LCIA can also help to detect corporate cherry-picking of the targets. Some previous studies have analysed product- or sector-related SDGs and have linked existing indicators to the SDGs (e.g. Herrera Almanza and Corona (2020); Lisowski et al. (2020)). However, the authors are not aware of any other publications that have tried to measure the contribution of products to the SDGs which underlines the novelty of the work. The S-LCIA method is based on an E-LCIA method for biodiversity (Lindner 2016, Lindner et al. 2019a, b; 2021) and allows for assessing a product's impact on the targets. Following this approach, for the 20 S-LCIA indicators, the relevant input parameters were identified and contribution functions were developed to quantitatively assess the impact of products. Since many targets are not precise and the reference value cannot be set precisely, an approach using five different steps to derive a quantitative reference value was adopted. The first four steps are taken directly from the sustainable development report of the SDSN and the Bertelsmann Stiftung (Sachs et al. 2021). As the difference between these steps relates only to the approach to derive a quantitative reference value and the contribution interval was set to be between +1 and -1, the impact assessments of these steps are directly comparable. The fourth step to use the average of the five top performers which can be either companies or countries might cause suspicion, as even the most advanced

companies might not be very advanced in some regards. In this study, only one indicator to measure the expenses in R&D (C2.17) uses the approach to benchmark against the five top companies in the sector. Since expenses in R&D are a common business measure, the suspicion of setting the bar too low was deemed neglectable. However, some targets are too vague and a quantitative reference value could not be derived. Therefore, the fifth step of the S-LCIA method uses a semi-quantitative approach to assess whether the topics addressed in the targets are integrated into the company's sustainability risk management. Whether an issue is comprehensively covered is reviewed based on the management approach developed by GRI (2016). This allows a semi-quantitative assessment for those aspects where a quantitative assessment is not (yet) possible. Since the logic adopted here is different from the first steps, the assessments are not directly comparable. In future studies, more quantifiable assessments should be sought for these indicators to make the assessments comparable.

This is for instance the case for target 5.1 which aims to "End all forms of discrimination against all women and girls everywhere". The indicator C2.10 "Equal wages for men and women" was developed which compares the wages of women and men, which can be further amended for minorities in general. However, not all kinds of discrimination can be covered using wages as proxy. Therefore, discrimination was added as a topic for the sustainability risk management. Other targets directly address issues related to minorities like target 10.2 which aims to "empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status". However, companies in many countries are only under special circumstances allowed to collect data regarding ethnicity or religious beliefs. Measuring the contribution of products to target 10.2 is therefore in many countries not allowed and cannot be included in the S-LCIA. Future research could further test the proposed indicators and examine the feasibility as well as the logic of the proposed approach. For instance, a study from the OECD (2019) uses a four-step approach to measuring the SDGs and uses reference values from other international agreements (e.g. reduce particulate matter pollution to the recommendations of the World Health Organisation) as a second step. The approach of using reference values from international agreements could be reviewed in future studies with the aim to further substantiate the approach adopted in this paper.

Fourteen out of 20 C2 indicators and their reference value derived in this research are not used in the sustainable development report (Sachs et al. 2021). This is because the sustainable development report focuses mostly on the policy and state level, while the C2 indicators focus on products. The

remaining 6 indicators and their matching reference point in the sustainable development report are described in the following. Both C2.1 (Workers earning below the UN poverty line of \$ 1.90 per day) and C2.17 (Investments in R&D) use the same reference point approach as the sustainable development report. For indicator C2.10 (Equal wages for men and women) and C2.14 (Wastewater treatment), the sustainable development report uses the technical optimum as a reference point approach which is not given as an official step to derive target values (Sachs et al. 2021, p. 70). As the report does not give an indication of when to use the technical optimum, this approach was not adopted and the reference points differ for these two indicators. For indicator C2.15 (Employees under 24 years) and C2.18 (Relative poverty rate), the sustainable development report uses the average of the top performers while in this research the principle "leave no-one behind" is applied as it has higher priority (see Sect. 2.4). Hence, even though the approach to setting the reference point is similar to the sustainable development report, the results differ a lot.

The S-LCIA functions developed in this work represent a first proposal on how the contribution to the targets can be measured. The results show that 75% of the contribution functions are linear functions, all of them linked to social impacts on single individuals. Based on the principle to "leave no-one behind", every individual is valued the same, resulting in a rather simple function where every increment in the input parameter results in a change in contribution to the achievement of the target by the same amount. Other types of functions would deviate from this basic principle. Additionally, the types of curves, describing the relationship of the functions, were the result of discussions with experts. On the other hand, linear functions in most cases do not reflect complex side effects, which could amplify or dampen the impact. As the functions represent a first proposal, more complex functions are subject to further research.

As discussed earlier, not all targets formulate quantitative objectives, which makes it difficult to define the reference value. Nevertheless, the procedure described by Lindner et al. (2021) for defining contribution functions for impact assessment in biodiversity can be transferred very well to social indicators. However, the functions defined here have so far been discussed with a small circle of stakeholders and experts and should be discussed with a wider group of stakeholders in the future to further refine them. It would also be of great interest to conduct these discussions in an international setting to exclude a national bias in the definition of the functions. Such a process was already started by Kühnen et al. (2019) and has been continued within the research presented here. However, this should be expanded, as the contribution functions also contain a normative component that is rooted in the guiding principle of sustainable development.

4.4 S-LCIA in supply chain management

The S-LCIA method presented here carries out the impact assessment at the level of the actors involved along the value chain (e.g. agricultural enterprises, food processing, retail, transport) and then aggregates their respective contributions according to the functional unit taking working hours as reference flow. With this approach, however, it is not only possible to carry out an S-LCIA at the product level, but also to conduct a social organisational life cycle impact assessment (SO-LCIA). Thus, the presented S-LCIA method is a contribution to both S-LCIA and SO-LCIA. As companies can increasingly be legally prosecuted if they fail to meet their responsibilities along the supply chain, such impact assessment tools will become increasingly important. For instance, Germany has just passed a supply chain law. In France, such a law is already in force, and also the Netherlands and the UK incorporate aspects of it, e.g. no child labour or modern slavery in law. The Council of the European Union has just requested the EU Commission to launch an EU action plan by 2021 that focuses on the sustainable design of global supply chains and promotes human rights, social and environmental due diligence standards. The UN Treaty on Business and Human Rights discussed by the UN Human Rights Council could also give human rights due diligence at the international level a legally binding instrument to regulate the activities of transnational corporations and other business enterprises in terms of human rights. Nevertheless, this is currently very controversial.

Nevertheless, the method still requires further validation and application in case studies to substantiate its practicability and scientific foundation. In line with the approach of Lindner et al. (2019b), one limitation is that the stakeholder involvement was limited to a small circle. In the future, the function development should be supplemented by further expert consultations and by broader stakeholder discussions. Selected case studies have been conducted for individual indicators of this method (Kühnen et al. 2019), but no full case study has been carried out yet. Another limitation is that the targets are examined exhaustively only for foods. Future research could examine the indicators for further branches and test their applicability. Furthermore, it is necessary to consider whether and, if so, how the results at the level of the targets can be aggregated into an overall contribution to the respective SDG, e.g. the indicators C2.1 and C2.2 both contribute to SDG 1 of reducing poverty. Additionally, LCC and its possible use for assessing corporate contributions to the SDGs should be considered in further research. Another limitation is that some aspects mentioned in the SDGs could so far not be translated to quantifiable indicators but have been added as issues to be managed in the sustainability (risk) management (C2.3).

Future research could try to further quantify these issues to make the assessments comparable.

5 Conclusion

The approach developed in this paper contributes to the literature by proposing a coherent method to measure the contribution of products to the 169 targets. It enables the implementation of the SDGs at the company level by selecting the targets which can be influenced by products. This can help to detect cherry-picking of the SDGs (and related “SDG-washing”) and can guide researchers and practitioners in selecting targets of the SDGs that are relevant for companies and their products. In line with the UNEP Guidelines for S-LCA (UNEP 2020), the study focuses on developing a method to assess social performance using a reference scale approach (Chhipi-Shrestha et al. 2014). The identified indicators can guide researchers and practitioners in their search for a set of product-related SDG-indicators. Furthermore, the paper adopts a quantitative S-LCIA method.

There is little research on how the 17 SDGs and their 169 targets can be used to assess the social and environmental impacts of products. However, since the SDGs were adopted by all UN member states and thus represent the normative framework for sustainable development worldwide, this is an important avenue for further research. The translation steps that are necessary to make use of the SDGs in S-LCA, because the targets of the SDGs were not explicitly formulated for this purpose, are provided in this paper. All 17 SDGs and 61 of the 169 targets (36%) were evaluated as product-related while the rest are on a policy level. For 57% of the product-related targets, indicators from the GIF-SDGs could be used after slight adaptations, while for the remaining 43% of the product-related targets, indicators had to be added or were taken from the EF framework. In total, 45 indicators have been identified to be suitable for assessing the potential contribution of products to the 61 targets. An S-LCIA method was developed that translates the targets into conditions beneficial or damaging to the achievement of the target to estimate the socio-economic impact of the product using a scale from +1 to –1.

The SDGs are part of the 2030 Agenda and are to be achieved by then. This means that the reference point used here will then become obsolete. Nevertheless, it can be assumed that the international community will set new sustainability goals. The three-step approach presented here (identification of product-related targets, identification of indicators, development of the impact assessment) offers the methodological framework to integrate the newly agreed targets into an impact assessment. This is an important first step to measure the contribution of products to the

SDGs. However, further research to examine the proposed method, the derived indicators and the impact assessment both theoretically and in case studies is strongly encouraged. Especially, there are several targets for which no quantitative assessment has yet been developed and which can therefore only be addressed in the sustainability risk management using the GRI management approach (GRI 2016). Further research could try to find ways to quantify these targets using the suggested approach of this paper.

Concerning the ecological impacts of products, further research could intend to estimate the contribution to the SDGs with the method presented. This would require a further normative “translation step”. The targets for sectors and products presented by the Science-Based Targets Initiative (2020) could possibly fill this gap and be used in the further development of the method for the identified ecological indicators.

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Data availability The authors declare that all data supporting the findings of this study are available within the article and its supplementary material.

Declarations

Conflict of interest The authors declare no competing interests.

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D. Paper 3

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Managing Impacts on Biodiversity – A comprehensive Analysis of Management Control Systems in three pioneer Food Companies

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Abstract

The severity of biodiversity loss is pressuring companies across different sectors to address and manage their impacts on biodiversity. While previous research has engaged with biodiversity reporting and disclosure, an analysis of corporate biodiversity management practices is lacking, so far. This research applies the management control framework of Malmi and Brown (2008) to explore how companies can effectively manage their impacts on biodiversity. The interview- and document-based qualitative analysis is based on three German food companies, which were selected due to their well-known commitment to sustainability and biodiversity. The findings suggest that, even though there is no one-fits-all approach to effective biodiversity management, overarching success factors can be identified. These include (1) relating biodiversity management controls to core business activities, (2) embedding biodiversity management controls into established sustainability management controls, and (3) applying formal and informal controls in a complementary matter. An ideal biodiversity management control package is developed. By concretizing biodiversity management practices, including formal and informal factors, this study provides valuable recommendations for corporate practice and makes an important contribution to the nascent biodiversity management research.

Keywords: Biodiversity Accounting, Corporate Sustainability, Biodiversity Management, management control systems, food company

1. Introduction

There is an urgent need for companies to manage their impacts on biodiversity (Wolff et al., 2017; Schaltegger et al., 2022). Global biodiversity loss has been accelerating (Benton et al., 2021), making it one of the key global risks to society (WEF, 2020). Today, the planetary boundary of biosphere integrity, encompassing ecosystems and genetic diversity, is far exceeded (Rockström et al., 2009; Steffen et al., 2015). Companies along the food supply chain have been identified as prime drivers of biodiversity loss (Wolff et al., 2017; Dudley and Alexander, 2017). Current food production is characterised by intensive agriculture, including monocultures and excessive fertiliser and pesticide use, which leads to the degradation of habitats, higher greenhouse gas emissions, and soil and water pollution (Benton et al., 2021; Crenna et al. 2019). Decreasing such negative impacts requires food companies to adopt effective biodiversity management.

To date, the management of biodiversity impacts has not yet received adequate attention, neither in companies' sustainability practices nor in scientific research. Concerning the former, it has been found that companies consider biodiversity least among sustainability issues (Adler et al., 2018; Schaltegger et al., 2014; 2022). Concerning the latter, management research has begun to address biodiversity by focusing on reporting and accounting (e.g., Boiral, 2016; 2018; Adler et al., 2018; Feger and Mermet, 2020; Maroun and Atkins, 2021; Zhao and Atkins, 2021; Cuckston, 2018). Intraorganizational biodiversity management processes have remained underresearched, even though recent research has explicitly called for more 'guidance on how to manage biodiversity issues' (Schaltegger et al., 2022, 3). Addressing the identified research gap, this paper attends to the question of 'how can companies manage their impacts on biodiversity?'.

Management control systems (MCS) could pose a helpful approach to managing biodiversity impacts of companies. MCS are crucial for steering companies towards achieving their

sustainability goals and strategies (Berry et al., 2009; Crutzen et al., 2017; Crutzen and Herzig, 2013; Guenther et al., 2016). MCS include formal and informal systems and practices that managers implement to direct and influence employee behavior and other organizational resources (Malmi and Brown, 2008). As biodiversity is an essential aspect of environmental sustainability, MCS are expected to be effective in managing biodiversity impacts of companies, too. However, MCS have to our knowledge, so far, not been used as an analytical lens to investigate biodiversity management.

To answer the posed research question, this study conducts qualitative case studies of the biodiversity management controls of three pioneer food companies in Germany (Yin, 2017). In total, 17 qualitative interviews with key managers are conducted jointly with a comprehensive document analysis. Data is analyzed by applying Malmi and Brown's (2008) 'Management Control Systems as a Package' framework. The analysis reveals crucial success factors for effective biodiversity management, thereby contributing to research and practice.

The remainder of the paper is organised as follows. In the next section, key biodiversity management and accounting research is presented, followed by introducing the Malmi and Brown management control framework as an analytical lens. Subsequently, the qualitative method used in this study is explained, followed by a presentation of the results for each control category. Lastly, the results are discussed, an ideal biodiversity management control package is developed, and implications for research and practice are described.

2. Literature review and theoretical frame

2.1 Company engagement with biodiversity

The literature on companies' engagement with biodiversity is still nascent. With a few notable exceptions (e.g., Jones, 1996), the management literature has only begun to address biodiversity impacts of companies a few years ago (e.g., Whiteman et al., 2013; Winn and Pogutz, 2013; Boiral, 2019; Addison et al., 2020; Feger, 2020). A recent systematic literature review identified

only 40 articles on biodiversity and species extinction accounting from 2013 to 2020 (Roberts et al., 2021). The authors conclude that while issues such as climate change (e.g. Schaltegger and Csutora 2012), chemical pollution (e.g. Barnett and King, 2008), or water scarcity (e.g. Christ and Burritt, 2017) have received substantial attention, there is little scholarly consideration of corporate impacts on biodiversity (Roberts et al., 2021).

Much of today's corporate biodiversity literature focuses on accounting and reporting. Evident of this are recent special issues dedicated to 'Accounting and Conservation', amongst others (Cuckston, 2021). Empirical analyses of biodiversity reporting practices in Denmark and China reveal the poor state of companies' biodiversity reporting in terms of quantity and quality (Van Liempd and Busch 2013; Zhao and Atkins, 2021). Similarly, a more extensive study of 182 global firms suggests that performance indicators of biological diversity are still underreported and, in most cases, confined to generic and/or vague statements, with quantitative data and narratives on managing biodiversity being sporadic and limited (Skouloudis et al., 2019). Using sustainability reports from mining companies, Boiral (2016) finds that companies tend to use techniques of neutralization when reporting on their impacts on biodiversity. These companies typically claim a 'net positive or neutral impact on biodiversity, they deny that they have a significant impact, they distance themselves from the impact of their actions, and they play down their responsibilities' (Boiral, 2016, 751). The overall conclusion of these studies is that biodiversity is only considered marginally in corporate reporting and has yet to be defined as a prominent business focus. Seeing the unequivocal empirical evidence, scholars have begun to develop models for biodiversity reporting that can serve as guidance for companies to improve their reporting on biodiversity (Maroun and Atkins, 2021; Büchling and Maroun, 2021).

As of now, there are very little intraorganizational insights into successful corporate biodiversity management. Few articles mention biodiversity management in the sense of the 'methodical design of processes, products, and projects to ensure business success while protecting biodiversity' (Schaltegger and Beständig, 2012, 10). As an exception, Boiral et al. (2018) show

that companies use certifiable standards to react to institutional pressures and maintain social legitimacy, which are often adopted symbolically rather than substantially. Furthermore, intrinsic motivations are rarely mentioned as a reason to engage with biodiversity. However, there are some publications that provide conceptual guidance on how to manage biodiversity internally. In terms of processes, Addison et al. (2020), for instance, have transferred the Plan-Do-Check-Act framework to the biodiversity context, proposing a process framework for companies to manage and assess their biodiversity performance. In terms of concrete managerial approaches, scholars have started to discuss impact assessments (Asselin et al. 2020; Kennedy et al., 2022; Lindner et al., 2019), employee involvement (Boiral et al., 2019), supply chain management (Kashmanian, 2019) and financial decision-making (Nedopil, 2022). To date, however, there is no comprehensive and systematic analysis of biodiversity management at the level of the organization. Such an analysis would include not only measurement systems, standards, and policies, but also organizational factors such as structural design and governance and underlying soft factors such as culture and values.

2.2 Management Controls

MCS provide an adequate conceptual framework to analyze a company's biodiversity management practices holistically. Previous studies have deemed MCS crucial for the organization's comprehensive and effective integration of sustainability and environmental issues (Crutzen et al., 2017; Gond et al., 2012; Guenther et al., 2016). Management controls can be understood as either a system, meaning that different control practices are interdependent, or a package, meaning that the different systems of formal and informal controls are compiled into a complete set (Grabner and Moers, 2013). Due to its comprehensiveness, most scholars research management controls as packages. Here, Malmi and Brown's (2008) framework of 'Management Controls Systems as a Package' has been deemed most comprehensive in terms of the set of systems conceptualised (Dropulic, 2014;

O’Grady and Akroyd, 2015; Crutzen et al., 2017; Rehmann et al., 2018; Berg and Madsen, 2020).

This study applies Malmi and Brown’s (2008) management control framework to analyze companies’ biodiversity management practices. The framework includes formal and informal controls, encompassing five big control areas: planning, cybernetic, reward and compensation, administrative and cultural (Table 1). Planning controls include goals regarding the long-term strategy (long-range planning) and the immediate future (action planning). Cybernetic controls include budgets like financial plans and quantifications as well as financial and non-financial measurement systems. Reward and compensation controls include employee incentives for the achievement of company goals. On the one hand, administrative controls regard organizational design and governance, encompassing the structuring and monitoring of employees. On the other hand, they include procedures and policies related to standards, rules, and process specifications.

Table 1: Management control systems package (adapted from Malmi and Brown, 2008)

Cultural controls					
Clans		Values		Symbols	
Planning		Cybernetic controls			Reward and compensation
Long range planning	Action planning	Budgets	Financial Non-financial Hybrid measurement systems		
Administrative controls					
Organizational design		Governance structure		Procedures and policies	

For the purpose of this study, procedures and policies not only apply to employees of the focal organization but also to suppliers and partners along the food value chain. Cultural controls comprise organizational values, beliefs, and norms. They include value-based controls (vision, mission, norms), symbols (building design, dress code), and clan controls (subcultures and individual groups). Additionally, a fourth control, ‘personnel controls’, is analyzed following

Malmi and Brown's (2008) suggestion. Personnel controls include employee selection and placement as well as training.

While Malmi and Brown's (2008) framework has been applied to corporate sustainability (Crutzen et al., 2017), environmental management (Baker et al., 2018) and circular economy (Svensson and Funck, 2019), this study is the first to apply the framework to the context of biodiversity. Crutzen et al.'s (2017) study of sustainability management controls reveals that companies tend to either focus on formal or informal controls but do not complete the full sustainability management control package. Svensson and Funck (2019), who found similar management control patterns, conclude that focusing on either formal or informal controls is not enough to build a strong corporate sustainability commitment. Their analysis of management controls for circular economy approaches finds that both, fostering a strong circular economy culture through long-term visions and establishing cybernetic controls with a high level of detail is crucial for effectively implementing circular economy principles inside organizations. Baker et al.'s (2018) analysis of environmental management controls stresses the importance of extending controls beyond the company's legal entity and towards its supply chains. Further, their analysis finds that life cycle assessments can become crucial cybernetic controls in sustainability-oriented management. How management control plays out in biodiversity management is left to investigate.

3. Methods

3.1 Research Design

This study adopts an exploratory case study approach (Yin, 2017), analyzing biodiversity management controls in three German food companies. The focus on food companies results from the food sector's enormous impact on biodiversity loss (Wolff et al., 2017; Benton et al., 2021). The three companies were selected for this study as they are all considered sustainability pioneers and already have biodiversity practices in place. All three companies have received or

were nominated for the esteemed Germany sustainability award hosted every year since 2008 by the German government. Additionally, the authors had personal contacts with each company's sustainability managers before conducting the research, which led to a trusting and open atmosphere in the interviews. To secure the anonymity of the case companies, all data is presented here referring to the pseudo names Candies Co., Seeds Ltd., and Foods Plc. (Gioia et al., 2013).

3.2 Data Collection

Data was collected in the form of 73 internal and publicly available documents and 17 semi-structured interviews (Table 2). Documents included sustainability reports, sustainability-related website sections, sustainability-related blog entries, codes of conduct, supplier standards, and questionnaires. Interviews were conducted with selected middle and top managers, whereby the two researchers took turns conducting the interviews. Interviewed middle managers included sustainability managers, innovation managers, production managers, marketing managers, and communication managers.

Table 2: Data collection

	Candies Co.	Seeds Ltd.	Foods Plc.
Documents	40	12	21
Interviews	7	4	6

In all three companies, one interview was conducted with the CEO or Board member. Interview questions were geared towards the five management controls (cultural controls, administrative controls, reward and compensation controls, planning controls, and cybernetic controls) in relation to the topic of biodiversity. Appendix A shows an exemplary interview guideline. Questions were slightly adjusted according to the position and expertise of the interview partner and the need for further questions, depending on the insights from previous interviews. The

interviews were generally transcribed in their entirety. However, to meet this study's analytical needs, text sections that were irrelevant to the topic at hand were excluded from the transcription (McLellan et al., 2003).

3.1 Data analysis

Data analysis followed a qualitative, deductive approach and was structured along two distinct stages. In the first stage, the qualitative data analysis software MAXQDA was used to code the documents and interviews according to the five management control areas (Saldaña, 2015). While the document analysis provided beneficial insights into planning and cybernetic controls, the insights from the interviews added further information on cultural, administrative, and reward and compensation controls. To ensure the validity of data analysis, the coding process was supported by a previously developed codebook, which determined the codes, their definition and their usage, and listed respective examples (DeCuir-Gunby et al., 2011). The codebook and codes were discussed between the two researchers. In the second data analysis stage, codes were compiled in tables for each company separately to allow for a better comparison. Data analysis was validated by the sustainability managers of the three case companies during a workshop, in which the interview findings were presented and discussed.

4. Results

4.1 Aggregated results

The results show that all case companies apply biodiversity management controls, however, with very different foci. We generally found that biodiversity management controls of all three companies are grounded in the companies' strong sustainability cultures and respective strategies. For instance, biodiversity planning controls go hand in hand with the companies' other established sustainability goals, such as CO₂-neutrality, sustainable packaging, and sustainably certified product ranges. Thus, sustainability commitments served as the crucial

basis for explicit biodiversity management controls as formulated in planning and cybernetic controls. The following sections break down each control category for the three companies, showing the different approaches to biodiversity management.

4.2 Results for biodiversity management controls

4.2.1 Planning controls

In terms of biodiversity-related planning, the three companies have put very different emphases (Table 3).

Table 3: Planning controls

Planning controls		
	Long-range planning	Action planning
Candies Co.	<ul style="list-style-type: none"> - Holistic organizational commitment to biodiversity - Increase share of purchases from biodiversity-friendly cultivation methods 	<ul style="list-style-type: none"> - Agroforestry projects - Renaturation/reforestation measures - BD-focused plantation management - Evaluation and adjustment of raw material target systems to better address biodiversity - Biodiversity measures at company location
Seeds Ltd.	<ul style="list-style-type: none"> - Improve suppliers’ biodiversity impacts (improve transparency and supplier progress) 	<ul style="list-style-type: none"> - Make biodiversity new focus topic - Evaluation and adjustment of supplier criteria towards biodiversity - Biodiversity measures at company location (nature-world project)
Foods Plc.	<ul style="list-style-type: none"> - Quantify biodiversity impacts and integrate in decision-making - Implement measures with proven positive impact on biodiversity 	<ul style="list-style-type: none"> - Pilot project: regenerative agriculture - Establish (more) ecological priority areas - Collaborative projects with NGOs - Evaluate and adjust Life Cycle Assessment (LCA) method to include biodiversity - Biodiversity measures at company location - NGO collaboration projects (bees, turtles...)

Candies Co., in the long run, aims to increase the share of biodiversity-friendly cultivation and purchasing. For instance, the share of the main raw material sourced from the company-owned agroforestry plantation was targeted to increase from currently 9% to 25-30% in the next 4-5 years. Having a company-own plantation is regarded as particularly effective, as Candies Co. ‘can track the biodiversity measures in the best possible way. They are directly related to the

company's product and are thus tangible for everyone' (Global sustainability communication manager, Candies Co.). For other supplier relations, the company aims to make the sourcing of the main raw material 100% traceable through direct purchasing. To achieve its long-term goal, Candies Co.'s most prominent action planning control is evaluating the companies' raw material target systems and adjusting the criteria towards biodiversity. Target systems have been formulated for the company's five main raw materials. The goals (e.g., 'We promote the conservation and development of flora and fauna in producing areas and their environment') and respective milestones (e.g., '1 million shade trees until 2028') laid down in these systems are regarded as main guidance and are regularly discussed with suppliers and partners.

Seeds Ltd. focuses on sustainable purchasing and aims to assess and improve its suppliers' biodiversity impacts. In this regard, the company's CEO stresses the importance of activities at the source of production:

We have also supported local projects for one or two years with an amount X for a flower meadow for bees. It is also important and valuable, but in fact, I see a bigger importance and our focus in the agriculture of the countries where our products come from. (CEO, Seeds Ltd.)

The company has developed a comprehensive sustainability questionnaire (see section **4.2.2 Cybernetic Controls**), and biodiversity impacts form a core part (questions include e.g., 'Do you have measures to increase the species richness at the plantation?'). Thereby, it aims at assessing and improving the performance of its suppliers until 2023. Respective action planning controls include the evaluation and potential adjustment of the company's supplier questionnaire and, based on this, the development of supplier criteria.

Taking a different approach, Foods Plc. aims at evidence-based decision-making for biodiversity-friendly production. To achieve this goal, the company plans to integrate biodiversity into its enterprise resource planning (ERP) system using product LCA and, thus, to quantify the company's biodiversity impact (see also section **4.2.2 Cybernetic Controls**). As Foods Plc. has just started integrating biodiversity into the ERP, the company's action

planning controls currently focus on biodiversity measures unrelated to the company's core business of food production. These include setting up flower meadows and bee hives at the company headquarters, establishing ecological priority areas on nonagricultural land, and collaborating with NGOs in bee saving, climate protection, and ocean littering projects.

4.2.2 Cybernetic Controls

Due to the novelty of biodiversity as a business topic and the complexity of biodiversity issues, cybernetic controls are one of the more rarely applied management controls in our case studies. For instance, none of the investigated companies has set a budget for biodiversity measures (Table 4). Respective activities are financed through the companies' sustainability funds (Candies Co., Foods Plc.) and/or other company funds, depending on the area most impacted by the measure (Seeds Ltd., Foods Plc.). At the same time, interviewees express a great future potential for increasingly considering measurement systems. The interviews reveal that all three companies are eager to find ways to measure their biodiversity impacts. A board member of Foods Plc. expresses this very vividly:

What would interest me is the measurement. How can I, how can we, with the biodiversity areas, evaluate what we are doing there? [...] How can I get the suppliers to ensure this with us? And how can I measure this, in turn? That it becomes tangible. (Board, Foods Plc.)

The companies are either in the starting stages of measuring their impacts or have not yet found ways to do so.

Candies Co. uses cybernetic controls by collaborating with an independent institute to assess their biodiversity areas through a bi-annual plant and animal census. The impact measurement is directly connected to the company's agricultural production of the main raw material, however, on only a small piece of land compared to the whole raw material production of the company.

Table 4: Cybernetic Controls

Cybernetic Controls		
	Budgets	Measurement systems
Candies Co.	<p>No specific biodiversity budget (except compensation payments via gold standard certificates)</p> <p>Purchasing department can spend 10-15% more money on sustainability measures than on other measures</p>	<ul style="list-style-type: none"> - Raw material target systems (incl. biodiversity) - BD monitoring of agroforestry system (report)
Seeds Ltd.	No specific sustainability or biodiversity budget; project-based financing	<ul style="list-style-type: none"> - Materiality matrix (incl. biodiversity) - Supplier questionnaire
Foods Plc.	<p>No specific biodiversity budget</p> <p>Decentralised financing of biodiversity measures; managed by company locations via marketing budget, sustainability budget..</p>	<ul style="list-style-type: none"> - Monitoring of flowering strips, ecological priority areas, bee population ('save the bee project') - Materiality matrix (incl. biodiversity) - Product LCA (to date without biodiversity flinocus)

Seed Ltd. has started to evaluate their supplier practices through questionnaires strongly focused on biodiversity topics, including pesticide and fertiliser use, water management, cultivation system, etc.. The process of data collection, however, has proven challenging:

Every year, another person completes the questionnaire and they evaluate themselves very differently.

Therefore there is no consistency in the data which they provide. (Sustainability Manager, Seeds Ltd.)

The company is currently attempting to adapt the questionnaire in a way that it can generate reliable data on the biodiversity performance of suppliers.

Similar to Candies Co., Food Plc. engages independent institutes for an animal census. The assessments, however, merely regard the biodiversity areas on nonagricultural land. To connect impact assessments to the core business, Foods plc. currently collaborates with university researchers to test a method to integrate biodiversity issues into their product life cycle assessment. The evaluations are based on the method developed by Lindner et al. (2019). The method focuses on evaluating the impact of land uses and management practices on biodiversity.

4.3.3 Rewards and Compensation

Rewards and compensation controls are the least applied biodiversity management controls (Table 5). While Candies Co. and Seeds Ltd. do not have any biodiversity-related incentives in place, Foods Plc. has held one-time events such as an idea competition with biodiversity as one of the core themes.

Table 5: Rewards and Compensation

Rewards and Compensation	
Candies Co.	No biodiversity-related incentives, but - Supplier award
Seeds Ltd.	No biodiversity-related incentives
Foods Plc.	- Idea competition for sustainability and biodiversity - Institutionalised idea management

The interviews reveal the main reason why rewards and compensation might be the least applied biodiversity management control. Due to the already existent strong sustainability commitment in all three companies, many of the interviewed managers regard their own personal interest as sufficient for an increased engagement with biodiversity and do not think formalised incentives are needed. In his regard, the head of agricultural production of Candies Co. emphasises the importance of intrinsic motivation:

If it is not purely out of intrinsic motivation, then it will be difficult to implement in the company. I don't think it makes any sense to put a biodiversity director at the front and hope that the orchestra will whistle along if they are not interested. Instead, there really has to be an intrinsic motivation to accompany, shape, and implement the whole issue. And that is something that ultimately makes for success. (Head of agricultural production, Candies Co.)

4.3.4 Administrative Controls

In all three companies, administrative controls for biodiversity are firmly embedded in sustainability-focused administrative controls (Table 6). While all companies have defined

organizational structures and responsibilities for sustainability issues in general (sustainability manager(s); sustainability teams), there are no specifications in terms of biodiversity.

Table 6: Administrative Controls

Administrative Controls		
	Organizational Design and Governance	Policies and Procedures
Candies Co.	No position for biodiversity but - Cross-functional sustainability teams for raw materials (incl. biodiversity) + steering committee - Sustainability manager with biodiversity focus	- Standards and certification (Roundtable on Sustainable Palm Oil (RSPO), Rainforest Alliance, etc.) - Target systems - Supplier audits
Seeds Ltd.	No position for biodiversity but - Project-based team allocation - Sustainability manager as staff unit below top management	- Strict supplier requirements (e.g., negative list for pesticides) - Supplier monitoring; bi-annual supplier questionnaire - Certified organic product range
Foods Plc.	No position for biodiversity but - Three-member coordination unit for sustainability - Cross-functional and cross-location sustainability team - Project-based responsibilities - Key roles of plant manager and cultivation advisors	- Supplier requirements beyond legal requirements (e.g., pesticide use: 30% of legally allowed amount; exclusion of endangered fish species) - Purity command - Supplier audits

Candies Co. has established permanent cross-functional sustainability teams for the five main raw materials. While the teams formulate and discuss all sustainability-related measures, biodiversity is treated as an essential topic. Here, interviewees mention the sustainability manager as the main driver of biodiversity issues within the teams. Regarding policies and procedures, Candies Co. uses its target systems for raw materials to formulate specific biodiversity requirements towards suppliers. Most of these requirements go back to common sustainability standards like RSPO, which already include biodiversity criteria. As a further commitment, Candies Co. particularly promotes agroforestry as a biodiversity-friendly production method. It is no formal requirement, though.

Seeds Ltd applies a project-based allocation of responsibilities. Biodiversity projects are thus handled by relevant staff from different departments, depending on the needs of the respective project. In terms of policies and procedures, Seeds Ltd. has not yet put concrete biodiversity criteria in place. However, the supplier questionnaire is seen as the first step in this direction:

The potential [of the questionnaire] is that we set impulses. If we, as strong buyer, attach great importance to this, our partners will perhaps deal with it more intensively. And we want to get the ball rolling without imposing 100 regulations because we are not the experts in this area either. (CEO, Seeds Ltd.)

Similar to Seeds Ltd., Foods Plc. allocates responsibilities depending on the project. Regarding biodiversity projects, interviewees stress the particular importance of plant managers and cultivation advisors at the production sites, as they can influence management practices in the fields. Concerning policies, Foods Plc. generally goes beyond legal requirements (e.g., only 30% of legally allowed pesticides) and acts according to a so-called company-own ‘purity command’, meaning that all products are free from additives, flavor enhancers, chemically modified starches and hydrogenated fats.

4.3.5 Cultural Controls

Besides fostering strong sustainability values, the three companies focus on different other cultural controls for biodiversity (Table 7). Similar to administrative controls, we found that biodiversity-related cultural controls are embedded in the three companies’ wider cultural controls for sustainability. All companies display a strong commitment to sustainability, with all three having formulated ecological and social guiding principles. In fact, nature forms an integral part of all three companies’ values (e.g., Candies Co.’s slogan ‘Working in harmony with people and nature’). In addition, other cultural controls are used to foster an awareness of biodiversity within and beyond organizational boundaries.

Table 7: Cultural Controls

Cultural Controls				
	Values	Symbols	Clans	Personnel controls
Candies Co.	<ul style="list-style-type: none"> - ‘Working in harmony with people and nature’ as guiding principle - Targeted commitment to BD protection - 80% of communication regarding cultivation biodiversity-focused 	<ul style="list-style-type: none"> - Sustainability Mascot with BD-focus - Biotope and nature park - Animal and plant images in communication 	<ul style="list-style-type: none"> - Raw material working groups - BD-focused trainee projects (bird houses; biotope; bee hives) 	<ul style="list-style-type: none"> - BD training for purchasing department - Raising employee awareness of BD through theme weeks, projects etc.
Seeds Ltd.	<ul style="list-style-type: none"> - ‘Respect for nature, people and cultural diversity as guiding principle - Careful use of resources for intergenerational equality 	<ul style="list-style-type: none"> - Nature world project 	<ul style="list-style-type: none"> - ‘Natural world ambassadors’ (cross-functional team) 	/
Foods Plc.	<ul style="list-style-type: none"> - ‘Purity demand’ as guiding principle - Biodiversity core topic in Italian company location 	<ul style="list-style-type: none"> - Visible biodiversity projects at company location (flower meadows etc.) - Separate biodiversity chapter in sustainability report 	<ul style="list-style-type: none"> - Informal teams for biodiversity projects - Interactions on intranet platform 	<ul style="list-style-type: none"> - Regenerative agriculture training - Encouragement of employees to bring in their ideas

In addition to value-based controls, Candies Co. works particularly with symbols to raise awareness of the topic amongst employees and customers. It has created a company-own sustainability ambassador in the form of a tropical animal, through which the company communicates its agroforestry activities and, with it, biodiversity issues. Additionally, the company has established a biotope and flower meadows at the company location, advertises with plant and animal images, and has hosted regular biodiversity theme weeks in the canteen. In images, video clips and blog entries, the ‘mascot’ explains the concept of agroforestry and

its benefits for biodiversity on the company-owned farm: '[The mascot] stands for everything that we do differently there.' (Blog, Candies Co.)

Seeds Ltd. focuses on similar cultural controls as Foods Plc. In terms of symbols, the company places particular importance on external communication on their website by establishing so called 'product stories' and dedicating a separate sub-section of their website to biodiversity. In terms of clan controls, Seeds Ltd. has established so called 'nature world ambassadors' - a formalised group of people responsible for promoting sustainability in the company. However, interviewees remark that the voluntary nature of these activities comes with challenges:

If you are a natural world ambassador, you have to block time to come to the meetings. If you get an assignment, no one shouts hurray, because that comes on top of your other tasks. I personally have found out that it's more fun in the project organization, where we make much more progress in terms of content.
(Sustainability manager, Seeds Ltd.)

Foods Plc. focuses on both symbols and clan controls. Concerning the former, the company has established beehives, raised beds and flower meadows at the company headquarters. In addition, it dedicates a separate sub-chapter of the sustainability report to biodiversity, thus giving it extra visibility. Concerning clan controls, Foods Plc. has several informal employee teams responsible for initiating and conducting sustainability and biodiversity initiatives at the company location. According to the innovation manager, the success of these group initiatives is due to employees' high motivation:

Generally, it is seen positively by all colleagues and everyone gets involved where they can. Whenever we call for projects, we always have many colleagues who want to participate. (Innovation manager, Foods Plc.)

5. Discussion

While previous research dealing with corporate engagement with biodiversity has remained focused on specific areas such as reporting and accounting (e.g, Zhao and Atkins, 2021; Büchling and Maroun, 2021), our analysis of companies' control packages allows for a

comprehensive overview of biodiversity management practices spanning various control areas. Our analysis shows that, despite adopting vastly different approaches to biodiversity management, all three case companies adopt almost complete control packages, including formal and informal factors. In this regard, three observations are of particular importance. Firstly, the data shows that major biodiversity goals and measures are targeted toward the companies' core activity, i.e., food production. This includes increasing biodiversity-friendly production methods (Candies Co.), measuring the biodiversity impact of production (Foods Plc.) and improving the biodiversity index of suppliers (Seeds Ltd.). Second, control packages are either mainly focused on biodiversity with a strong link to sustainability or the other way around. Biodiversity-oriented cultural controls (e.g., focus on biodiversity in the sustainability report), for instance, are firmly embedded in the already established sustainability culture of each company (e.g., extensive sustainability-oriented communication). In any case, there is a strong link between new biodiversity and established sustainability management controls. And third, the case companies apply formal and informal controls in a complementary way. For instance, the companies use informal controls like symbols (e.g., sustainability mascot) to increase the external awareness of formal biodiversity measures (e.g., agroforestry systems). We go on to subsume the three observations under the following headlines: (1) core business integration, (2) embedded commitment, and (3) formal-informal complementarity. The following subsections will explain each of the three factors in more detail and relate them to the established literature.

5.1 Core business integration

In contrast to previous research findings that biodiversity commitment tends to be symbolic rather than substantial (e.g., Boiral et al., 2018), interviewed managers of this study explicitly emphasise the integration of biodiversity into the core business activity of food production (see *4.2.2 Cybernetic Controls*). The examined companies have either done so already (agroforestry-

based production at Candies Co.) or are planning to do so soon (biodiversity-integrated LCA at Foods Plc.; biodiversity-focused purchasing at Seeds Ltd.). While all three companies also employ symbolic controls such as planting trees or setting up bee hives, these are extended by formal and extensive planning and cybernetic controls targeting the upstream part of the food production chain, specifically through biodiversity-friendly agricultural production. Adding to the nascent and hitherto scattered literature on internally oriented biodiversity management (e.g., Addison et al., 2020; Boiral et al., 2019; Nedopil, 2022), this study's data provides concrete, practical insights into *how* core business integration is facilitated across various control areas. It thereby approaches a more comprehensive picture of biodiversity management practices. Specific facilitating factors shown by the case examples include, amongst others:

- strong sustainability-oriented culture with values grounded in nature
- company-owned lands and production sites, which increase control and support the implementation of measures
- long-term supplier partnerships, which allow for joint biodiversity commitments
- direct purchasing, which guarantees traceability of measures
- biodiversity impact measurement on production sites, which can actively inform business decision-making

In addition, we find that core business integration implies formalizing resource allocation for biodiversity, including budget and staff, and, thus, goes beyond voluntary initiatives. While previous research has emphasised voluntary and informal initiatives for biodiversity (Boiral et al., 2018), interviewees in this study remarked that the voluntary character of some biodiversity initiatives might prevent effective results and high company commitment. Thus, defining clear responsibilities and establishing formalised biodiversity teams will give biodiversity measures the necessary visibility and emphasises the company's seriousness. Candies Co., with its cross-functional sustainability teams, sets a respective example.

5.2 Embedded commitment

The results show that the biodiversity management controls of all three companies are firmly embedded in the companies' sustainability management controls, particularly related to cultural controls, cybernetic controls, and administrative controls. This suggests that biodiversity cannot stand separate from sustainability but is heavily reliant on a company's respective commitment. In other words, effective biodiversity management requires or goes along with a company's sustainability measures, values and goals. This finding is hardly surprising considering that research has shown the strong interlinkages between biodiversity loss and sustainability issues such as climate change and land system change (Persson et al., 2022; Steffen et al., 2015). Respectively, biodiversity management researchers and practitioners have regarded biodiversity as inherent to sustainability management (Addison et al., 2020) or corporate social responsibility (Overbeek et al., 2013). Besides being a necessity, already established sustainability measures may serve as crucial facilitators for implementing biodiversity-related controls. For example, in the case of Foods Plc, the company's already existing ERP software allowing for an instant product LCA now serves as the base for integrating biodiversity. Similarly, Seeds Ltd.'s supplier questionnaire and Candies Co.'s target systems do not need to be developed from scratch but need to be adjusted and enhanced to include biodiversity criteria. By making biodiversity-sustainability interlinkages more explicit, this study adds to previous biodiversity management studies, in which such interlinkages are inherently assumed but not further specified.

5.3 Formal-informal complementarity

As shown by the case study data, the investigated companies apply a combined package of formal and informal management controls, whereby informal controls were related mainly to sustainability in general as opposed to biodiversity in particular. In contrast to Crutzen et al.'s (2017) finding of a lack of full control packages, our case companies employed almost full

packages of sustainability- and biodiversity-related controls. This might be because all three companies are regarded as sustainability pioneers. Within their control packages, sustainability-related informal controls, especially values and symbols, effectively complement formal biodiversity-related controls. For instance, Candies Co.'s introduction of its mascot was an effective way to communicate biodiversity measures and, thus, increase internal and external awareness of respective issues. The identified importance of employing formal and informal controls in a complementary matter goes along with Crutzen et al.'s (2017, 1299) concluding remarks that 'focusing only on one kind of management control, either formal or informal, involves a risk of internal organizational conflict'. Thus, for companies seeking to apply effective biodiversity management, considering the complementary nature of formal and informal controls is key. As both can reinforce each other, overall commitment to biodiversity is substantially increased. Importantly, this study's findings suggest that general sustainability-related informal controls suffice to support and supplement a company's formal biodiversity management controls. By including intraorganizational factors such as organizational design, culture, and incentive systems in the analysis, our study also goes beyond process- and practice-oriented insights of previous studies (Addison et al., 2020; Boiral et al., 2018).

5.4 Ideal biodiversity management control package

Coming back to the initially posed question of how food companies can effectively and comprehensively manage their impacts on biodiversity, the findings suggest that there is no one-fits-all approach. The three case companies all pursue very different goals and measures, and each places particular importance on different controls. However, despite the diverging approaches in the three case companies, crucial commonalities could be observed, allowing for identifying best practices for each control category. Based on the previous sections and identified success factors, Table 8 summarises the points mentioned above to compile an exemplary ideal biodiversity management control package.

Table 8: Ideal biodiversity management control package

Cultural Controls					
<i>Values</i>		<i>Symbols</i>	<i>Clans</i>	<i>Personnel controls</i>	
Strong overall sustainability commitment with sustainability vision, values, and goals.		Biodiversity mascot/ ambassador	Formalised project teams (part of job description; beyond voluntary initiatives)	Recruitment criteria: strong personal interest/intrinsic motivation	
Putting nature at the heart of activities		Separate emphasis on biodiversity in external communication			
		Visible measures at headquarters			
Planning Controls		Cybernetic Controls			Reward and Compensation
<i>Long range planning</i>	<i>Action planning</i>	<i>Budgets</i>	<i>Measurement systems</i>		General sustainability-related incentives
Long-term goals related to core business	Biodiversity promoting measures at production sites	Project-based; decentralised budgets	LCA integration Questionnaires (continuous monitoring)		
Administrative Controls					
<i>Organizational Design and Governance Structure</i>			<i>Procedures and Policies</i>		
Cross-functional teams (project-based or formalised) Decentralised decision-making			Ambitious biodiversity-specific criteria for partners and suppliers		

The ideal biodiversity control package would include, for cultural controls, strong sustainability-and nature-oriented corporate values, symbols including extensive external biodiversity communication - ideally through some form of ambassador -, formalised biodiversity or sustainability project teams, and staff recruitment focused on high intrinsic motivations. Planning controls, both long-term and action, would be strongly related to the companies' core business activity. For cybernetic controls, the ideal control package would suggest project-based, decentralised allocation of budgets as well as biodiversity impact

measurements with regard to products (through integration in LCA) and with regard to supply chains (through supplier questionnaires). Our proposed focus on life cycle assessments and an incorporation of supply chain factors is supported by Baker et al.'s (2018) findings for the context of environmental management. As reward and compensation controls, general sustainability-related incentives would suffice due to the overall strong intrinsic motivation of employees (covered by cultural controls). Finally, the ideal control package would include administrative controls such as setting up cross-functional teams as organizational design and formulating criteria and specifications for partners and suppliers that go beyond legal requirements and common sustainability standards.

6. Conclusion and implications

The objective of this study was to analyze biodiversity management control practices based on a qualitative study of three pioneer food companies in Germany.

The findings indicate that effective biodiversity management presupposes three important considerations: (1) relate biodiversity management controls to core business activities rather than consider them as supplementary or voluntary (core business integration), (2) embed biodiversity management controls into overarching strong sustainability values, goals and measures (embedded commitment), and (3) apply formal and informal biodiversity management controls in a complementary manner to maximise biodiversity commitment (formal-informal complementarity). While informal controls for biodiversity can be focused on sustainability in general, formal controls need to be explicitly designed for biodiversity issues. As specific best practices, this study could identify the integration of biodiversity in life cycle assessments to better inform decision-making (cybernetic control), the use of symbols, like, for instance, a mascot, to effectively communicate biodiversity measures (cultural control), and the establishment of cross-functional teams (permanent or project-based) to develop and monitor biodiversity measures (administrative control).

Our study makes important contributions to research by providing comprehensive insights into effective biodiversity management practices spanning both formal and informal factors. It brings together and extends current biodiversity management studies, which have focused on isolated aspects or processes of managing biodiversity. Our insights also have valuable practical implications, as they provide in-depth insights into the management practices of three pioneering companies and offer concrete managerial recommendations for companies on how to approach each biodiversity management control area.

This research comes with several limitations related to the nature of exploratory case-study research. Due to the focus on three pioneer food companies, the generalizability of this study's findings in terms of the food industry or other industries is uncertain. Future research could conduct larger empirical investigations of the further application of biodiversity management controls in different industries. As companies have just recently started to consider biodiversity as a separate focus topic, these studies can provide further valuable insights into how companies can successfully manage their impacts on biodiversity.

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The authors report there are no competing interests to declare.

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Appendix A

Interview guide example

Introduction

1. To what extent are you dealing with biodiversity in your everyday work?

Planning controls

2. Which measures for protecting biodiversity are currently implemented by your company?
3. Which long-term biodiversity goals have been formulated?

Cybernetic controls

4. Which tools are used to measure and evaluate the success of biodiversity measures?
5. Is there a specific budget for biodiversity measures?

Rewards and compensation

6. Which incentives have been put in place to encourage employees to engage with biodiversity?

Administrative Controls

7. Which departments and functions are mainly responsible for formulating and tracking biodiversity measures?
8. How is biodiversity communicated to partners and suppliers along the value chain?

Cultural Controls

9. Through which communication channels do you send or receive biodiversity-related information?
10. To what extent is biodiversity visibly 'lived' in the company?
11. To what extent does biodiversity form part in job postings, the on-boarding process and training period?
12. Is your company offering any educational formats related to biodiversity?

Closing the interview

13. Is there anything related to the biodiversity activities of your company that you would like to add?

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E. Paper 4

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Path dependence of accountants: Why are they not involved in corporate sustainability?

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Abstract

Accounting has been identified as a key area to inform managers seeking to transform businesses towards sustainability. Empirical research, however, shows that management accountants are scarcely involved in sustainability accounting. This paper contributes to understanding their barriers, using path dependence theory as a theoretical framework to empirically investigate how accountants have become “locked in” by self-reinforcing mechanisms. Based on semistructured interviews with 33 management accountants in Germany, the paper identifies three interrelated self-reinforcing mechanisms that inhibit accountants from sustainability involvement. A strong focus on financial priorities and incremental improvements driven by top management expectations hinder the consideration of sustainability beyond its direct costs. Specialization is another barrier, as is an understanding of sustainability as peripheral rather than a core business. Contrary to prior literature, accountants express eagerness to learn, though rarely about sustainability. They rarely question assumptions about sustainability and their role, leading to missed opportunities for double-loop learning and more transformative change.

KEYWORDS

corporate sustainability, management accounting practices, management control systems, path dependence theory, performance measurement, sustainability accounting

1 | INTRODUCTION

Sustainability management accounting and control offers many (potential) benefits for organizations, like improving environmental and economic performance (Chaudhry & Amir, 2020; Gunarathne et al., 2021; Naranjo Tuesta et al., 2021), enabling comprehensive risk management (Arjaliès & Mundy, 2013), contributing to process innovation (Ferreira et al., 2010), and supporting decisions to stay in the space of planetary boundaries (Schaltegger, 2018). With the recent

introduction of the sustainable finance taxonomy by the European Union (European Commission, 2020), sustainability management accounting and control may gain even wider relevance for corporate decision-making in practice. Academia echoes this regulatory development with an increasing number of publications in this field of research (Guenther et al., 2016; Parker, 2011; Traxler et al., 2020) and recent calls for a broader understanding of the accounting function, changing it from a mere technical practice to a moral and social one (Carnegie et al., 2020).

Abbreviations: EBIT, Earnings Before Interest and Taxes; EU, European Union; M&A, Mergers & Acquisitions; R&D, Research & Development; SDGs, Sustainable Development Goals; VP, Vice President.

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The role of management accountants has been discussed with regard to their potential in promoting sustainability in companies. Williams (2015, p. 281) argues that it is important to involve accountants in corporate sustainability due to “their technical expertise, key reporting competencies, and ability to analyze and translate data into accessible measurements”. Management accountants are responsible for management accounting and control systems, and especially their conventional accounting skillset could make sustainability projects more robust and prominent in organizations. Wilmshurst and Frost (2001) furthermore argue that accountants can make financially focused sustainability metrics more reliable and accurate, thereby underlining their importance. Accountants might also promote sustainability by improving the decision utility of accounting-related technologies (Lambert & Sponem, 2011). Due to their important position in organizations and their close relation to top management, management accountants also know the characteristics of key performance indicators and top management's decision-making processes (Schaltegger & Zvezdov, 2015). Based on the perception of an ever-changing business environment, Hoang (2018) underlines that the rise of integrated reporting gives accountants an important role to play in providing sustainability information to stakeholders. Furthermore, EU regulations like the emissions trading system, the corporate social reporting directive, or the corporate sustainability due to diligence directive drive companies into accounting, reporting, and managing sustainability impacts. Recent research shows that in this context, chief financial officers can help promote sustainability in the organization (Asiaei et al., 2022). The dynamic business environment, however, does not only concern financial officers and accountants: It also calls for an increased professionalization of internal accounting processes to create the necessary data that will support management decisions and therefore requires the involvement of management accountants.

In contrast to these calls for involving management accountants more closely in corporate sustainability management, empirical investigations of corporate practice show that they are rarely involved in sustainability accounting (Bennett et al., 2013; Caron & Fortin, 2014; Egan & Tweedie, 2018). The collection, analysis, and use of sustainability information seem to instead spread among various roles and business functions in a company (e.g., Albelda, 2011; Schaltegger et al., 2015). In cases where management accountants are involved, they often act as gatekeepers to top management (Schaltegger & Zvezdov, 2015). While accounting is thought to be a key area to inform managers seeking to transform businesses towards sustainability (e.g., Gray et al., 1995) and general “road blocks” to establishing environmental and sustainability accounting have been identified (Burritt, 2004), there has been relatively little investigation into the actual role of management accountants in corporate practice. Even though the lack of contributions by management accountants to corporate sustainability has been mentioned in the literature (e.g., Burritt et al., 2011; Caron & Fortin, 2014; Egan & Tweedie, 2018; Lovell & MacKenzie, 2011), the reasons for this behavior have rarely been analyzed empirically and in-depth. In particular, barriers from the perspective of accountants have so far not been subject to wider empirical investigations, analyzing both the accountants and their organizational contexts.

This paper aims to fill this research gap by empirically investigating barriers preventing management accountants from becoming involved in sustainability accounting and from integrating environmental and social issues into conventional accounting. The following empirical analysis aims to enhance our understanding of accountants' perceptions of their roles in organizational change and their interdependencies within the organization (Wolf et al., 2020). The present analysis is guided by a theoretical framework based on organizational path dependence theory, which has been applied as a useful theoretical lens in organizational research to investigate barriers to changing organizational and individual behavior (Garud et al., 2010; Sydow et al., 2009, 2020; Vergne & Durand, 2010). It is based on interviews with 33 management accountants of medium-sized and large companies in a wide range of industries in Germany. Based on the analysis, approaches to overcoming these barriers and to supporting the integration of sustainability into the work of accountants are discussed.

The focus of the following analysis is on management accountants who are in responsible for management control and support managerial decision-making. Malmi and Brown (2008) differentiate between accountants that contribute to an accounting system that supports corporate decision-making at any organizational level and accountants that contribute to a management control system. The latter are in charge directing employee behavior and maintaining or altering management patterns in organizations (Simons, 1994). Hence, they have a greater influence and a larger scope of action than the former (Malmi & Brown, 2008). In the literature, they are generally called management accountants or in the European context sometimes called “controllers” (Hartmann & Maas, 2010). Luther et al. (2010) found in their empirical investigation that controlling practices in German-speaking countries are somewhat different to management accounting practices in the UK and other Anglophone countries. In Germany, the focus tends to be more on financial figures than would be the case elsewhere. However, they also note that “the functions of controlling and the roles of controllers are moving in directions that will be more familiar to management accountants” (Luther et al., 2010, p. 4). This article focuses on professionals responsible for internal accounting processes in the sense of controlling practices and adopts the term “management accountant,” or just “accountant” as a short version of management accountant.

This article is structured as follows: Section 2 draws on current literature and reviews reasons for involving accountants in corporate sustainability and barriers to their involvement. Section 3 contains the theoretical framework drawing on path dependence theory. In Section 4, details on the research design and methods are presented. The results are presented in Section 5 and discussed in Section 6 where they are also placed in the context of the literature, and implications for research and practice are developed.

2 | LITERATURE REVIEW

The term “sustainability management accounting” is understood as the process of collecting, analyzing, and communicating sustainability-

related information (Maas et al., 2016). The data, measures, and indicators are mainly internally motivated and are used to improve sustainability performance. Sustainability management accounting focuses on material indicators for decision-making purposes (Beske et al., 2020). Material matters are those that substantively affect the organization's ability to create value over the short term, medium term, and long term (IIRC, 2021). Sustainability management accounting uses not only monetary data, often drawn from the same database as financial accounting and reporting data, but also nonmonetary (physical) data, as this often reflects the drivers of monetary outcomes (Burritt et al., 2002).

2.1 | Reasons for involving management accountants

While accountants working with management accounting systems already contribute to many business functions and departments (Byrne & Pierce, 2007), a large body of literature agrees that accountants should be involved in sustainability management accounting too (e.g., Albelda, 2011; Maas et al., 2016; Schaltegger & Burritt, 2018; Wilmschurst & Frost, 2001). Accountants possess skill sets that allow them to play an important role in organizations, which supports the argument that accountants should be involved in sustainability management accounting systems. Reasons for involvement found in the literature can be structured using a widely acknowledged classification by CIMA (2005) between accountants as methodological experts, as authorities and gatekeepers, and as knowledge experts.

A range of different reasons to involve accountants in sustainability management have been proposed in the literature (Table 1). First, accountants can serve as methodological experts by collecting data and defining information properties, (key) performance indicators, and

methods (Schaltegger & Zvezdov, 2015). This is an important skill in conventional management accounting that drives more data-driven and rigorous decision-making. Organizing data, being familiar with adequate methods of data collection, and processing large data quantities to a reasonable set of indicators are acknowledged as a valuable expertise of accountants (Pierce & O'Dea, 2003). Increasingly, management accountants are also involved in data analytics and visualization using advanced statistical tools such as cluster analysis and Monte Carlo analysis, which can be useful in analyzing complex data sets (Oesterreich & Teuteberg, 2019). Sustainability management accounting systems require profound methodological expertise, as physical data are often more difficult to handle and calculate than monetary data. Empirical research has shown that some accountants already fulfill this role and work with environmental data, especially on carbon emissions and water usage (Lovell & MacKenzie, 2011; Schaltegger et al., 2015). Accountants can help organizations decrease the costs of information collection and improve data quality (Bennett et al., 2013; Burritt et al., 2011). They can also support management decisions regarding a "green strategy" (Parker, 2001). The role of the methodological expert has also given accountants the image of a "bean counter" and "number cruncher" (Byrne & Pierce, 2007; Mistry et al., 2014). Wilmschurst and Frost (2001) stress that accountants' methodological expertise does not depend on being experts in environmental or social issues, as they also work with other departments such as sales and engineering without being experts in those fields either.

Another reason to involve accountants is their authority in a gatekeeper function of providing information to top management and other important decision-makers in organizations. In this role, accountants are increasingly perceived as business partners who support managers in becoming more strategic, forward-looking, and collaborative (Mistry et al., 2014). However, this powerful broker role enables

TABLE 1 Skills and roles of accountants related to sustainability management accounting

Reasons for involvement	References
Use of accounting skills for measuring, recording, monitoring, and verifying data as well as handling information in general	Lovell and MacKenzie (2011), Wilmschurst and Frost (2001), Pierce and O'Dea (2003)
Decrease costs of information collection and improve data quality with established accounting systems	Bennett et al. (2013), Burritt et al. (2011)
Define objectives, performance measures, and key performance indicators	Bennett et al. (2013)
Support strategic decisions concerning the suitability, adoption, and implementation of a "green" strategy	Parker (2001)
Collate and interpret sustainability information in an economic context, translate it for top management, and thereby address its (non)importance	Albelda (2011), Egan and Tweedie (2018), Schaltegger and Zvezdov (2015)
Act as facilitators of corporate sustainability for top management	Mistry et al. (2014)
Legitimize the work of environmental managers and lend internal credibility	Albelda (2011), Adams (2002)
Identify key problems by means of environmental audits to assess risks and compliance and give feedback for improvement	Wilmschurst and Frost (2001)
Include environmental and social costs in systems and structures	Adams (2002), Albelda (2011), Wilmschurst and Frost (2001)
Use sustainability data for integrated reporting to external stakeholders, which could also assist internal management	Albelda (2011)
Apply checks and controls to sustainability data to improve quality and validity	Bennett et al. (2013)

them to advance or suppress certain information or actors in the company. For example, accountants can interpret sustainability information in an economic context for top management (Albelda, 2011; Egan & Tweedie, 2018). This can have both positive and negative impacts on corporate performance, depending on what information is forwarded (Schaltegger & Zvezdov, 2015). If, however, accountants choose to engage with sustainability data, this can legitimize and lend internal credibility to such matters (Adams, 2002; Albelda, 2011).

The role as a knowledge and information expert comprises the accountants' knowledge of what kinds of information are relevant to managing a company successfully (e.g., Jack & Kholeif, 2008). In this role, accountants are often perceived as actors with no other interest than to improve the rationality of management activities (Deegan, 2013). As they are the process owners of financial accounts and as many environmental impacts are also likely to have a financial impact, it would be irresponsible of management not to involve accountants in the process of considering these costs and revenues in accounts, reports, and decision-making (Adams, 2002; Wilmshurst & Frost, 2001). Adams (2002) shows that conventional accounting systems can be used to effectively manage and analyze sustainability-related data instead of implementing entirely new systems. Similarly, Albelda (2011) finds that integrating environmental costs into the existing costing system had the desired effect of decreasing energy consumption and waste. As accountants are the experts in managing those systems, they can also apply checks and controls to sustainability data to improve its quality and validity (Bennett et al., 2013).

In their role as knowledge and information experts, management accountants can provide information on business cases for decision-making to top management. Identifying and developing business cases of and for sustainability has been proposed as one of the possible reasons for involving management accountants in sustainability accounting. Four different types of business cases have been distinguished: reactionary, reputational, responsible, and collaborative business cases (Schaltegger & Burritt, 2010, 2018). The reactionary business case of sustainability focuses on maintaining business as usual and only allows for sustainability measures if they increase profitability. The reputational business case of sustainability aims for reputational benefits that translate into financial benefits. The responsible business case for sustainability strives for operational excellence and is based on best management practices. The collaborative business case for sustainability calls for engaging in stakeholder collaborations to develop new, effective sustainability solutions as future business. These different types of business cases can be identified, analyzed, and developed by management accountants to support top management decision-making.

The changing roles of management accountants have also been discussed widely in the conventional accounting literature. For instance, the transition from the accountant as a "bean counter" predominantly processing data to a "business partner" supporting top management's decision-making has been discussed since the 1990s (e.g., Bougen, 1994) and is still debated today (Karlsson et al., 2019; Wolf et al., 2020). Research shows that especially smaller organizations still employ accountants mostly as data processors (bean counters) (Oesterreich & Teuteberg, 2019), but also in larger organizations,

many accountants are concurrently involved in both data processing and business partnering (Burns & Baldvinsdottir, 2005; Karlsson et al., 2019), suggesting they have multiple identities (Wolf et al., 2020). Multiple role identities could also allow accountants to become involved more closely in sustainability issues. However, the difficult transition to the business partner role shows that, due to role ambiguity, it would be misleading to think that shifting among multiple identities is easily accomplished (Wolf et al., 2020). However, several requirements of the business partner role, such as providing strategic and long-term information for decision-making, are in line with addressing corporate sustainability as well.

The literature review shows that management accountants have a wide array of useful skills and play important roles that could help companies in fostering their sustainability performance (Table 1). However, empirical research shows that in corporate practice management accountants rarely participate actively in sustainability management (e.g., Albelda, 2011; Mistry et al., 2014), and if so, mainly in a gatekeeper role for top management (Schaltegger & Zvezdov, 2015). A large international survey in 11 countries reveals that accounting and finance departments were ranked last among all corporate departments in promoting sustainability (Schaltegger et al., 2014). This lack of engagement in sustainability by accountants, despite numerous compelling reasons to do so, makes clear that there must be barriers to involvement, which in his conceptual overview Burritt calls "roadblocks on the way to the green and pleasant land" (2004, p. 13).

2.2 | Barriers to involving management accountants

An analysis of the accounting literature reveals few articles that focus systematically and in-depth on the barriers to involving accountants in corporate sustainability (Table 2). For instance, some consider organizational aspects and investigate the role of professional accounting bodies (Lovell & MacKenzie, 2011), the accountant's intention to engage in sustainability accounting (Kwakye et al., 2018), or deal with general role shifts (Lambert & Sponem, 2011). While Mistry et al. (2014) highlight the complexity of sustainability and the challenges of integration into existing accounting systems and organizational structures, Lovell and MacKenzie (2011) point out a lack of similarity between sustainability-related processes and the current activities of accountants.

Others discuss the personal characteristics of accountants and emphasize differences between accountants and sustainability managers in ideology, mindset, and culture as well as perceptions of sustainability's relevance and strategic importance in general (Kwakye et al., 2018). Lambert and Sponem (2011) find a lack of creative or innovative thinking among accountants, which would be required to integrate sustainability issues into conventional accounting approaches. Accountants might also be afraid that their power would be threatened and therefore use their position for gatekeeping purposes (Schaltegger & Zvezdov, 2015). An in-depth case study on the involvement of accountants in sustainability management initiatives by Egan and Tweedie (2018) finds that nonaccountants see

TABLE 2 Barriers to the involvement of accountants in corporate sustainability

Barriers	References
Methodological difficulties with including sustainability in costing systems and organizational structures	Mistry et al. (2014)
Complexity of sustainability and many aspects to consider	Adams (2002)
Lack of similarity with current activities	Lovell and MacKenzie (2011), Mistry et al. (2014), Wilmshurst and Frost (2001)
Ideological and cultural differences	Larrinaga-Gonzalez and Bebbington (2001), Schaltegger and Zvezdov (2015)
Lack of mindset that sustainability requires overly focused on cost control and profit maximization; a tendency to constrain sustainability to a safe and controllable issue	Egan and Tweedie (2018), Kwakye et al. (2018)
Perceived lack of strategic importance or irrelevance; no connection to financial success	Adams (2002), Albelda (2011)
Sustainability poses a threat to the power and organizational influence	Schaltegger and Zvezdov (2015), Larrinaga-Gonzalez and Bebbington (2001)
Lack of training	Parker (2000); Schaltegger and Zvezdov (2015), Spence et al. (2012)

accountants as simply unwilling or unable to engage with sustainability, both in the practical sense of visiting production facilities as well as intellectually in understanding the interconnectedness of sustainability issues. Similarly, Adams (2002) conducted interviews in seven companies involved in corporate social reporting and finds that neither were accountants involved in data collection nor were they considered appropriate people to be involved, mostly based on their inability to understand sustainability data and their perceived irrelevance. Furthermore, several authors (e.g., Schaltegger & Zvezdov, 2015; Spence et al., 2012) see a lack of training and education as a possible cause for the lack of involvement of accountants. Albelda (2011), in turn, conducted case studies of six factories and did find evidence for a close collaboration between accountants and environmental managers but only with regard to data concerned with capital and operating expenditures. This was attributed to the accountant's underlying values emphasizing profit orientation. Another study using a single case study reports a hostile relationship between accountants and sustainability managers due to different goals and ideologies (Larrinaga-Gonzalez & Bebbington, 2001). In this case study, accountants appeared to find environmental issues irrelevant, and using accounting systems for sustainability purposes did not help to boost sustainability's internal importance (Larrinaga-Gonzalez & Bebbington, 2001).

Overall, the literature review provides a multitude of potential reasons why accountants do not contribute to sustainability. However, despite almost half a century of social and environmental accounting research (Burritt & Schaltegger, 2010; Parker, 2011), few articles have systematically addressed barriers to integrating sustainability into the work of accountants. Research either normatively expresses the desire to further develop corporate sustainability with accounting concepts and tools (e.g., Schaltegger & Zvezdov, 2015) or, based on empirical research, is characterized by consternation at the lack of involvement by accountants (e.g., Gray et al., 1995). The few empirical studies that systematically analyze why accountants largely fail to contribute to corporate sustainability are based on case studies

and use small sample sizes (Adams, 2002; Albelda, 2011; Egan & Tweedie, 2018; Larrinaga-Gonzalez & Bebbington, 2001). While current research has helped to improve understanding of potential barriers to the sustainability involvement of accountants, their own perceptions of what key barriers are have so far not been empirically investigated in a larger sample of companies and industries.

The following qualitative research addresses this gap by investigating in a larger number of companies from various industries which barriers hinder the sustainability involvement of accountants in corporate practice. The analysis specifically considers internal organizational processes, the interplay of accountants with other organizational actors, and their reasons not to learn about and engage with sustainability. The analysis is guided by path dependence theory, which is summarized in the following section.

3 | THEORETICAL FRAMEWORK

While this research utilizes both deductive and inductive approaches, as explained in the methods section, theory is used as a framework to guide the study and data analysis (Anfara & Mertz, 2015; Saldaña, 2015). One theory that systematically addresses why organizations or organizational subunits fail to change and what mechanisms and barriers could be underlying causes for this inertia is organizational path dependence theory (Garud et al., 2010; Sydow et al., 2009, 2020; Vergne & Durand, 2010). Recent research by Gunarathne et al. (2021), Chaudhry and Amir (2020), as well as Wang et al. (2019) shows that institutional pressures can be important for promoting sustainability and environmental management accounting. Institutional theory is used as a theoretical lens to illustrate how power and institutions constrain change and can be regarded as the foundation of path dependence theory. Path dependence theory builds on this insight to show how past events and practices (can) influence future action and decision-making. However, the theory goes beyond the notion of "history matters" (Rowlinson et al., 2014) by analyzing processes with self-reinforcing

mechanisms that lead organizations to strategic persistence and operational rigidity (Sydow et al., 2009; Wenzel, 2015). Although path dependence theory has been applied in accounting research (e.g., Pittroff, 2021), it has not been used to understand why accountants do not engage in sustainability accounting. As the theory addresses both individual processes (such as learning) and organizational dependencies (on other actors), it was considered suitable for as a theoretical framework. Despite some conceptual and methodological disagreements in the organizational path dependence literature (Dobusch & Kapeller, 2013; Garud et al., 2010; Sydow et al., 2009; Vergne & Durand, 2010), most researchers agree that path dependency is characterized by the following three phases: (1) path emergence, (2) self-reinforcing mechanisms, and (3) lock-in (Figure 1).

In the path emergence phase, companies have the most strategic and operational options and are not bound to any specific one. However, small contingent events or actions may unintentionally cause nonergodic, self-reinforcing processes (Dobusch & Kapeller, 2013; Vergne & Durand, 2010; Wenzel, 2015) and lead to “a critical juncture” (Mahoney, 2000, pp. 513), which then initiates the second phase. In this phase, self-reinforcing mechanisms increasingly narrow down the scope of action and lead to “path inscription” (Koch, 2011; Sydow et al., 2009). These mechanisms are termed “self-reinforcement” (Arthur, 1994; Vergne & Durand, 2010) or “increasing returns” (Arthur, 1989; Pierson, 2000), but all relate to a circle of positive feedback that leads to increased inertia. Decisions remain contingent, and actors may still choose from a narrower range of different options. In the third phase, the lock-in phase, the dominant decision pattern becomes fixed. This constriction does not necessarily lead to inefficiency, as the environment may remain similar for a long period, and decisions may still be as valid as in the first phase (Rothmann & Koch, 2014). However, when a business's environmental conditions alter, such as the emergence of sustainability challenges, the dominant decision pattern will most likely become inadequate and inefficient (Schreyögg et al., 2011). An organizational state of lock-in is not characterized by total rigidity, but instead, it leaves a certain degree of variance, as behavior is never completely fixed (Fortwengel & Keller, 2020; Sydow et al., 2020).

At the core of this narrowed scope of organizational activities in the second phase are self-reinforcing mechanisms. Different terms are used for these effects; however, their self-reinforcing nature is found in almost all seminal contributions to path dependence theory (Arthur, 1989; David, 1985; Garud et al., 2010; Pierson, 2000; Sydow et al., 2009; Sydow & Schreyögg, 2013; Vergne & Durand, 2010). Sydow et al. (2009) distinguish four major effects that cause positive feedback loops: coordination, complementary, learning, and adaptive expectation effects. Table 3 provides an overview of three of these self-reinforcing mechanisms with examples, as well as a description of their application to the accountants' context.

These effects have been developed and discussed in the literature dealing with inertia, rigidity, and self-reinforcing mechanisms (Schreyögg & Kliesch-Eberl, 2007; Shapiro & Varian, 1999). Related effects are, for instance, direct and indirect network effects (Katz & Shapiro, 1985; Shapiro & Varian, 1999) and economies of scope (Teece, 1980).

A fourth self-reinforcing mechanism, the complementary effect, results from synergies of interrelated activities that become more attractive each time they are combined. A number of departments may form a dominant cluster that drives the behavior of an entire organization and each time they cooperate their routines and practices become more effective. As this mechanism is mainly applicable to organizations and not individuals, who are the focus of our research, it is not considered further. According to Sydow et al. (2009), an empirical analysis does not have to cover all self-reinforcing mechanisms as not all mechanisms fit all contexts and the existence of a single self-reinforcing mechanism is sufficient to identify path dependence.

Each mechanism needs to be analyzed within its specific context of application (Sydow et al., 2009). Dobusch and Kapeller (2013) note that positive self-reinforcing mechanisms in organizations vary in intensity and pattern. Therefore, self-reinforcing mechanisms, which hinder organizational change, and their effects need to be analyzed within a specific organizational context. The next section explains the research design and methods chosen for the empirical study of barriers that could prevent the involvement of accountants with sustainability.

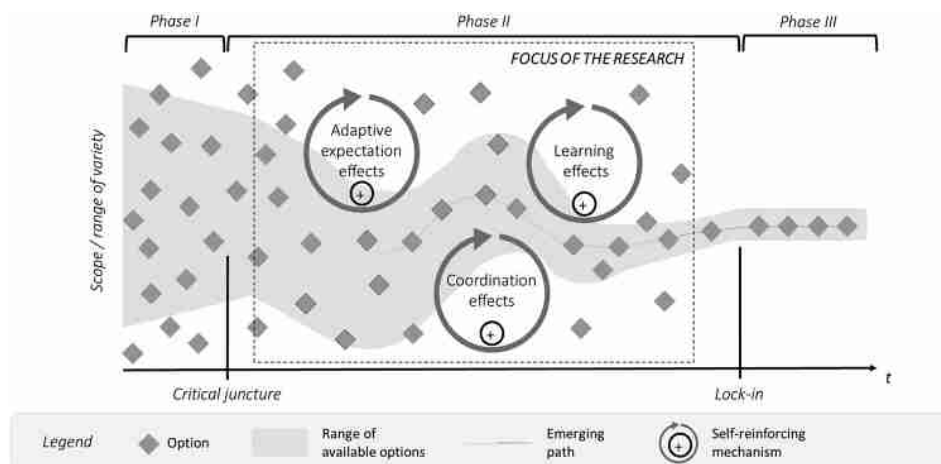


FIGURE 1 Organizational path dependence (based on Sydow et al., 2009, p. 692)

TABLE 3 Self-reinforcing mechanisms and application to the accountants' context

Self-reinforcing mechanisms	Application to the context of accountants (theses)
<i>Coordination effects</i> emerge when different organizational actors are willing to conform to the same (set of) rules. Continuous repetition most likely results in more efficient interaction among different actors, which further reinforces the dominance of this rule.	Accountants focus on financial indicators like profitability and are efficient in working with them. Given their expertise, they impose these financial rules on other business units and neglect issues related to sustainability.
<i>Adaptive expectation effects</i> describe varying preferences of individuals in response to the expectations of others. When organizational members are uncertain about their decisions, they often adopt routines or practices to meet the expectations of others.	Management accountants prioritize tasks and routines in line with the expectations of their key stakeholders (e.g., top management). When those stakeholders do not require sustainability to be considered in internal accounting reports, accountants feel affirmed in continuing to neglect sustainability.
<i>Learning effects.</i> Each iteration of a specific action or routine increases its efficiency, making it less attractive to switch to a different one. Steps leading to past success are often repeated and refined until it seems there is no other option than to continue reproducing the pattern.	Accountants execute existing routines without seriously questioning their validity. They are unwilling to learn or take on new tasks as they replicate successful routines focussed on financial outcomes. This makes it increasingly difficult for accountants to engage with sustainability.

Note: Adapted from Sydow et al., 2009.

4 | RESEARCH DESIGN

The lack of large-scale empirical studies and the complexity of investigating organizational path dependence, and as previous conceptualizations of self-reinforcing mechanisms (Dobusch & Kapeller, 2013; Sydow et al., 2009), call for a qualitative research design. In the following analysis, interviews with management accountants were conducted to understand (1) whether and what kind of self-reinforcing mechanisms hinder management accountants from involvement with sustainability management accounting and (2) what further barriers might exist. To ensure a diverse sample, the interviewees were selected based on the following characteristics: company size, industry, hierarchical position of accountants, gender, and company commitment to sustainability (high ranking or awards).

This study uses both inductive and deductive aspects for research design, data collection, and analysis. Combining both inductive and deductive approaches is common (Miles et al., 2020; Schönwälder & Weber, 2022; Siems & Seuring, 2021). In the present study, theory is used as a framework to deductively guide the research design and understanding of the sustainability accounting context. Including the theoretical framework early in the study “guides the nature of the questions asked and answered” (Creswell & Plano Clark, 2018, p. 44). Inductive approaches were used to develop the questionnaire and in the coding process to analyze further barriers. In line with Siems and Seuring (2021), we followed a clear operational structure for data collection and analysis. For further details, see the following sections on data collection and data analysis.

4.1 | Data collection

To investigate why management accountants do not contribute to corporate sustainability, 33 management accountants from German companies were interviewed in semistructured interviews, either in person (64%) or by phone (36%) if they were not available for a

personal meeting. Using different interview modes is common in research (e.g., Goodman et al., 2017). While in-person interviews can offer a view into their desktop and work environment as well as give social cues (Opdenakker, 2006), such information is not included in the following analysis. The topics were discussed in a comparable manner and scope across both interview modes. Phone interviews were only 2 min shorter on average than in-person interviews. The interviews had an average duration of 54 min, and they took place over a period of approximately 6 months in 2019.

The interview questions focused on the scope of consideration of environmental and social aspects in accounting and applying the self-reinforcing mechanisms in path dependence theory to the accounting context (including possible learning effects, adaptive expectations, and coordination effects). Interview questions were developed based on a theoretical understanding of the self-reinforcing mechanisms and a transfer of these mechanisms to a management accounting context. However, the use of additional open questions allowed space for interviewees to express other reasons for their involvement with sustainability accounting or lack thereof. The interview guide is included in the Appendix. All interviewees were assured confidentiality.

Since the understanding of corporate sustainability in this paper assumes that all accountants ought to be involved in addressing sustainability challenges within their responsibilities, this research adopts the broad understanding of the accounting function according to Carnegie et al. (2020), and hence, different types of management accountants were interviewed. The sampling strategy followed three principles following Miles et al. (2020): convenience, sequential, and purposive sampling. Initially, a convenience sampling strategy was used by approaching management accountants in companies affiliated with the researchers' universities. After conducting these interviews, it was decided to undertake sequential sampling to achieve a large variation in different characteristics, such as leadership role, gender, industry, and company size. Purposive sampling was undertaken to include management accountants not involved in sustainability accounting (typical cases) and management accountants with high,

routine involvement in sustainability accounting (exceptional cases). Of the 33 sampled accountants, 54% were in a leadership position, and 73% were male. They represented companies of varying sizes and industries: 16% from small and medium-sized companies (up to 250 employees), 52% from companies with 250 to 5000 employees, and 32% from large companies (more than 5000 employees). Of all companies in the sample, 58% were multinational companies (based on Kogut's (2001) criteria of business activities in more than two countries). In terms of industry, 24% were in the mechanical and electrical engineering sector, 18% each in logistics as well as services and trade, 15% in consumer goods, 15% in construction and chemistry, and nearly 10% in banking, insurance, and real estate.

The sample is therefore adequate to investigating why accountants in a wide range of organizational contexts fail to contribute to corporate sustainability. Table A1 in the Appendix provides an overview of the interviews including anonymized interviewee characteristics and contexts. All interviews were recorded and transcribed.

4.2 | Data analysis

Both deductive and inductive approaches were used to identify the extent to which self-reinforcing mechanisms can hinder an accountant's involvement with sustainability. Deductive coding was first completed before inductive coding was undertaken (Siems & Seuring, 2021). First, a coding scheme based on the three self-reinforcing mechanisms as described in the organizational path dependence literature was developed deductively and applied as a priori codes (Miles et al., 2020). Second, separate descriptive codes were developed to capture how each of the mechanisms might appear in the accounting context (for some examples, see Table 3). This coding scheme allowed for coding both positive instances of self-reinforcing mechanisms, as well as negative or discrepant instances indicating an absence of these mechanisms (Maxwell, 2013). The deductively developed codes were used as impulses or "sensitizing concepts" (Brinkmann & Kvale, 2015, p. 269) for the data analysis, rather than definitive concepts. Additional barriers that emerged throughout the coding process were captured inductively, first as *in vivo* codes (Saldaña, 2010), then as themes. Allowing for coding of negative instances as well as additional inductive codes was done in order to avoid an overreliance on theory and to ensure researcher openness to alternative explanations of the phenomena (Miles et al., 2020). The coding process was supported using MAXQDA software.

Validity is ensured in qualitative research by using different approaches and criteria (e.g., Creswell & Plano Clark, 2018; King et al., 2019). We follow Creswell and Plano Clark (2018), who recommend choosing at least three approaches. First, member checking involves asking interview partners to decide whether the results accurately reflect their positions (see also Miles et al., 2020). The research results were presented and discussed in a workshop with 42 management accountants, of which 36 had not been previously interviewed.

The workshop was used to gain feedback from interviewees as well as from other management accountants who were not involved in providing data and insight up to that point. This approach provided a "member check" (Miles et al., 2020, p. 303) and a "community for a dialogue on validity" (Brinkmann & Kvale, 2015, p. 285). Second, disconfirming evidence was noted and reported. Both types of statements, positive instances of self-reinforcing mechanisms and negative instances, were coded and analyzed. Both results are reported in the results section. The third approach according to Creswell and Plano Clark (2018) is to ask peers to examine the data and approaches. The data, codebook, process, and results were shown for examination to two other researchers with expertise in sustainability and accounting and who were not co-authors. They approved the process and results. Aside from these three criteria, this study also utilizes several of Miles et al.'s (2020) criteria for internal and external validity. These include a clearly characterizing a diverse sample, commenting on congruency with results from other studies, and specifying appropriate settings for further research.

Miles et al. (2020) suggest various criteria to ensure reliability throughout the whole research process. This study used the following of their criteria: stating a clear research question, conducting the data collection in settings suitable to the research question, using peer reviews, and ensuring intercoder reliability. Creswell and Plano Clark (2018) consider reliability less relevant than validity in qualitative research since subjective interpretations in the data are central to the approach. However, reliability can be achieved to a certain extent by ensuring intercoder agreement. The authors suggest the following steps to ensure intercoder agreement: establishing a codebook, simultaneous coding of the same transcript by all coders, and comparing codes. The method of this study included these three steps. Before coding, a codebook (Saldaña, 2010) was written based on the deductively developed codes. The same transcript was coded by the two coders and then compared. To ensure intercoder agreement between the two coders in subsequent transcripts, coded transcripts were discussed in weekly meetings to build consensus on the consistent use of codes (Harry et al., 2005). This process can be considered code-confirming (King et al., 2019), where coded transcripts were scrutinized by the other authors. The codebook was refined as a shared understanding of the codes emerged, leading to clearer definitions (Miles et al., 2020). After the initial coding, all interview data and codes were reviewed by one of the researchers, comparable with Schönwälder and Weber (2022).

The analysis searches for possible explanations for lack of involvement by accountants with sustainability accounting by (i) comparing similarities and (ii) comparing differences across interviews. In the first approach, statements made by a majority of accountants are denoted with "nearly all" (no more than two accountants differing) or "most" (more than 75% of the accountants agreeing). For more divergent results, the share of accountants in agreement is provided for each result. In the second approach, coded interview segments were compared for different accountant characteristics and contexts and noted in this section.

5 | RESULTS

This section summarizes briefly results on the involvement or noninvolvement of the accountants with sustainability accounting, the results on the self-reinforcing mechanisms, further barriers identified inductively, and which have not been so far discussed in path dependence theory.

The interviews reveal that most of the accountants did not deal with sustainability issues in their work (59%) or only provide ad hoc analyses for special projects like identifying cost savings from resource efficiency measures (36%). Only two accountants routinely dealt with environmental or social matters (6%) because sustainability was considered either part of the company's business strategy or unique selling proposition. Using the accountants' qualitative statements, interviewees were placed in three groups—no involvement, ad hoc involvement, and routine involvement—based on the classification of Bennett et al. (2013) (see Table A1 in the Appendix for the interviewees' characteristics including involvement with sustainability accounting).

5.1 | Coordination effects

Nearly all interviews (31/33) reveal that rules played a large role for the management accountants. When asked about criteria to evaluate the success of either specific projects or the whole company, all accountants stated financial rules like profitability, return on investment, staying within budgets, or positive contribution margins. Most interviewees (29/33) did not question the underlying assumption of the centrality of financial rules in accounting. The remaining four accountants questioned financial evaluation criteria only when fostering relationships with special or niche customers. By contrast, more than half of the accountants with whom this was discussed (19/31) viewed sustainability efforts either as irrelevant for the business's value creation or even equated them with additional costs. About three quarters of these statements came from accountants (14/19) who described themselves as not being involved with sustainability accounting, indicating a strong overlap between this mindset and a lack of involvement. Furthermore, accountants in logistics, services, and trade, as well as in construction industries, were more focused on the costs of sustainability efforts than accountants in other industries. Only four of the accountants referred to sustainability as a clear driver of revenues or as related to other opportunities beyond reputation management. Of these accountants, two worked in companies where sustainability is part of the core business strategy and the other two noted the growing relevance of sustainability criteria in their customers' purchasing decisions. All but one of them were in leadership positions. A little more than a third of the accountants (14/33) mentioned cost reductions as direct financial benefits of sustainability efforts, such as increasing fuel efficiency or improving employee retention. More than two thirds of these accountants (10/14) were involved with sustainability accounting on a routine or ad hoc basis. Interviewees with routine involvement with sustainability accounting discussed tracking sustainability performance indicators and

identifying their connection to the core business, value creation, and financial impact. Interviewees with ad hoc involvement focused on whether and how sustainability performance should be included in project-based analyses.

In line with their financial focus, a quarter of the accountants admitted that they did not collect or use nonfinancial data at all: "No, [nonfinancial data] do not exist. These are manual data collection processes and more guesswork by employees, so not hard data" (Interviewee 10). About a third of the accountants (10/33) explained that nonfinancial, social, and environmental information was demanding to work with because it was a challenge to integrate into existing software systems. An additional four accountants specified that this type of data was difficult, if not impossible, to aggregate, as the data were not easily validated and were difficult to evaluate, because causal chains were unclear or the necessary data were missing. These statements all came from accountants in medium and larger companies (more than 250 employees). Accountants in smaller companies (fewer than 250 employees) saw the challenge in funding, upgrading, and utilizing software to collect and analyze financial, social, and environmental data.

Of the accountants that stated, they collected and used nonfinancial environmental or social data, most (14/18) did so under two conditions: when the environmental or social information was related to financial outcomes or when sustainability was part of the core business strategy. Using the example of CO₂ emissions, one accountant stated:

This CO₂ story will not find its way into management accounting, but something like electricity or diesel consumption will, because these non-financial performance indicators lead to costs. ... It's not the highest priority, but ... as soon as it has financial consequences, we will take a look at it. (Interviewee 27)

In one company where sustainability was part of the core business strategy, an accountant stated that environmental and social issues were explicitly addressed in the accounting function. This accountant specifically mentioned that the United Nations Sustainable Development Goals were integrated into the company goals: "[The SDGs are] part of our goal system—and I have my hands on everything that involves a goal [laughs]" (Interviewee 23). These types of statements, connecting nonfinancial environmental or social data with the business strategy or identifying them as drivers for financial outcomes, were made more frequently by accountants in a leadership position compared to those at other hierarchical levels.

In 19/33 interviews, management accountants stated that they considered themselves in a position to impose their financial rules and priorities on other parts of the organization. They defined their tasks as ensuring data consistency within the organization, harmonizing structures and processes, and improving analytical skills in functional departments. This topic was brought up particularly by accountants in large multinational companies with more than 5000 employees. The following statement indicates how accountants can set the financial rules that steer behavior in the organization:

[Our task is] to further harmonize processes: that is, in the reporting systems, how we collect data, how the planning processes work ... and above all to have data and analytics more deeply embedded in the departments. So how to get this thinking and these methods into the organisation. (Interviewee 4)

5.2 | Adaptive expectation effects

The interviews identify adaptive expectations for management accountants regarding top management. Top management (in particular the chief executive and/or board of directors) was named in most interviews (26/33) as their most influential stakeholder. While accountants in smaller companies with less than 250 employees stated they worked closely with the director or owner, accountants in the largest companies with more than 5000 employees reported to different top management positions as well as cooperating horizontally with project managers, heads of business units, or other functional departments. Most accountants (29/33) stated that they adjusted their work behavior and the information they delivered to meet the perceived expectations and needs of their key stakeholders. This included jointly defining relevant indicators to monitor and manage corporate financial performance with top management and also discussing and adapting major changes to reporting content to comply with top management requests. One interviewee illustrated this process as follows: “As accountants, we aren't expected to produce new report ideas all the time, because management has very specific ideas and expects these to be fulfilled” (Interviewee 1).

Three quarters of the interviewees (25/33) described these processes as leading to effective workflows for both accountants and managers, particularly since accountants provide necessary information for decision-making. In these situations, accountants listened to the needs of top management and, if necessary, skillfully adjusted the requests so they made sense to the accountants and supported effective decision-making. However, nine accountants also described inefficiencies in adjusting to expectations, including manual data extractions using standard software or rushing to deliver work in response to ad hoc requests. Two accountants stated that they strictly followed management expectations, even if they did not consider this to be beneficial for the company or if it contradicted their understanding of their role and tasks:

When top management advances EBIT as an argument, then everything below is geared to EBIT ... So the company is aligned to the preferences of the man or men [sic] at the top. This has something to do with preferences and gut feeling, and not with rational thinking. (Interviewee 13)

These adaptive expectations intersect with the coordination effects described above. Three quarters of the accountants (25/33) stated explicitly that their financial focus is in line with the

expectations of top management. All accountants with whom this aspect was discussed were able to provide an answer as to whether and how sustainability is relevant to top management, although these answers varied. Accountants who saw a low relevance of sustainability for top management were either not involved in sustainability accounting, focused on efficiency analyses only, or described challenges in providing the results of their analyses. They also described the company's commitment to sustainability as rather low. Seven accountants even explicitly mentioned adapting to top management expectations as the cause for their lack of involvement with sustainability accounting, for example:

I think the [sustainability topic] is important, but in our company, it is unfortunately very dependent on the manager. If the manager does not think it's important, it is not done. That's kind of the weak spot. (Interviewee 15)

There were two instances of accountants who said that despite a lack of clear prioritization of the topic by top management, they had started to work on tracking environmental performance and proposing improvements. Both reported strong resistance to their proposals by top management, even when positive financial outcomes were identified as a result of improving environmental performance. In contrast, two accountants with a higher routine involvement with sustainability accounting stated a high relevance of sustainability for the business. They reported a shared understanding with top management of what sustainability performance indicators were relevant for evaluating the core business.

In addition to these two patterns—low relevance of sustainability connected to low involvement, and high relevance of sustainability connected to high involvement—there was a third pattern that emerged. The eight accountants that fit into this last pattern perceived a high relevance of sustainability for top management but did not perform sustainability accounting as part of their tasks. The stated reason for their low involvement was that other employees or departments were already involved in sustainability accounting. This reason is analyzed in more detail in the section on further barriers.

5.3 | Learning effects

The analysis of the interviews with accounting practitioners reveals strong routines in management accounting. Data collection, planning, and also parts of periodical reporting that focus on key performance indicators are highly standardized. For example, one accountant stated “the report as such is always identical. There are no discrepancies, we work according to standards” (Interviewee 11). Nearly half of the management accountants (15/31 with whom the topic was discussed) described existing routines even as inflexible and inefficient, an evaluation based on the perceived need to satisfy addressee expectations (8/15; e.g., reporting only on paper), the necessity to meet regulatory accounting requirements (5/15), or software

limitations (4/15). The other half of the accountants (16/31) still stated a need to adhere to standards but described routines as flexible, mostly due to software adaptability (13/16).

Despite these routines and inflexibilities, most of the accountants (26/31) stated a pressure to improve data and information quality while adhering to standards and regulations that only allow for incremental changes. Similarly, most accountants (28/33) question and update their routines regularly to continuously improve management control processes. Two thirds of the accountants (21 of 31 with whom the topic was discussed) stated that they would only adjust their reporting to manage recipient expectations with the knowledge or even approval of their key stakeholders. While accountants in leadership positions implemented changes in coordination with top management, accountants without a leadership position needed approval. Only one third of the accountants (10/31) were allowed to adjust their reports independently as long as they comply with legal regulations. This was particularly the case for ad hoc or situational analyzes or when the accountants had long experience in the firm. Their reasoning for changing routines was described by one accountant as follows:

We change the [reports] all the time. Sometimes you realize that something may not be as important as it once was, or that you need to go deeper into something. We also have changes in international accounting and reporting standards, so you have to find ways to adapt to them. That means that we are constantly changing. (Interviewee 18)

All accountants described changes in routines; however, more than two thirds of them (23/33) focused on faster and more automated data collection and analysis with the aim of incremental optimization of existing routines. For these accountants, technological advances such as process digitalization, predictive analytics, or big data played an important role. About one third of the accountants worked on leaner reporting structures with fewer indicators (11/33) and providing generally better decision-making information (12/33). While accountants in smaller companies with fewer than 250 employees discussed questioning routines in the context of new software projects, accountants in larger and multinational companies saw changes in routines in the context of digitalization, the level of detail, and external standards.

Besides changing their routines, more than two thirds of the accountants (22/30) expressed a high willingness to take on new tasks in the organization. Nearly half of them (9/22) indicated an interest in other management accounting functions, such as moving from cost accounting to cash flow accounting. Even though these statements show that two thirds of the interviewed accountants changed routines and considered taking on new tasks, fewer than a third of them said they systematically questioned the assumptions behind their work or that they envisaged a larger scope of change. Of these 10 accountants, seven questioned assumptions regarding changes to their processes due to changing markets or business strategy; the

others actively questioned the effectiveness of their reporting structure and processes. Less than a third (9/33) of the interviewees actively questioned whether environmental or social aspects should be further integrated into their data collection, planning, and reporting processes, or become a new task. Most of them (7/9) were focused on the topic of climate change—on evaluating the impact of greenhouse gas emissions or on their ability to maintain customer relationships or on the profitability of renewable energy investments. For example, one interviewee in the insurance industry described questioning the increasing role of environmental and social issues in financial investments and his involvement in a committee on sustainable investments.

Most interviewees (28/33) stated that they expected no changes in the core financial processes in the future. Of the five that did expect changes, three indicated an even stronger focus on working capital, cash flow, and economic value added. One saw an increased integration of compliance topics in their processes. Only one accountant, in the insurance industry, stated that they would change their processes by increasing their use of sustainability criteria in evaluating investments. However, when asked explicitly whether they could imagine considering sustainability in management accounting, three quarters (24/31) stated that they would be open to sustainability accounting. One interviewee stated enthusiastically:

I have always enjoyed getting into new topics. Now I am doing accounting for glasses ... Well, with potatoes I had other challenges. With climate change ... there are other drivers than for glasses, but it is always interesting to adapt to other areas. (Interviewee 17)

Additionally, all 26 accountants with whom the topic was discussed considered continuous learning in their field important, and they all had regularly attended training courses and workshops. The most frequent topics of these courses were soft skills such as project management or conflict resolution (10/26) or learning new software applications (8/26). However, when asked as an open question, none of the accountants mentioned sustainability accounting as an area of interest for future learning.

5.4 | Further barriers

An inductive approach to analyzing the interview data revealed two further barriers preventing management accountants from becoming involved with sustainability issues, which go beyond the self-reinforcing mechanisms described in the academic literature: (i) the responsibility of others for sustainability and (ii) an emotional distance to sustainability issues.

When asked directly about reasons for the limited sustainability involvement of the accounting function, most interviewees (28/33) stated that other departments such as public relations or marketing were already addressing this topic, indicating specialization as a potential barrier. In these instances, the role of other departments

included collecting, evaluating, and reporting sustainability accounting data. When asked directly, none of the accountants expressed the wish to take over the evaluation and accounting of sustainability data from another department. One third of the accountants (11/33) also stated that they did not think they could add value to sustainability accounting, and nearly all of them (10/11) stated that the reason for this is that they saw this area was well taken care of elsewhere.

A third of the accountants (11/33) made statements that portrayed sustainability as an unfamiliar topic they would prefer not to deal with. The most cited reasons were that the norms and evaluation criteria differed from financial accounting; specific topical knowledge was required, and causal chains were unclear. When asked whether accounting included sustainability, one accountant expressed relief that he was not involved in sustainability: “Fortunately not. The audit department is in charge” (Interviewee 7). Another accountant called the topic of sustainability “emotionally laden” and a topic “where you cannot win” (Interviewee 1), while another interviewee described it as qualitative compared to his usual quantitative approaches, and yet another referred to it as marketing:

There were some marketing events now and then, which provoked smiles like the ceramic mug, but well ... [sustainability] was designed as a function in its own right ... and I was comfortable with it that way. (Interviewee 3)

These types of emotional distancing statements made by 12 accountants indicated that at least a third of all interviewees (12/33) felt uneasy about sustainability issues and that they were relieved other departments were responsible for sustainability, which they considered to be outside of the core business.

6 | DISCUSSION, IMPLICATIONS, AND FURTHER RESEARCH

Research on the involvement of management accountants in corporate sustainability management has developed in three areas: reasoning why and how accountants should and could be involved, proposing a range of potential barriers to involvement, and investigating these in a selection of case studies. A broader empirical analysis of perceptions of management accountants themselves about the barriers has, however, so far been missing. Based on interviews with a diverse sample of accountants in various organizational contexts and in a broad range of companies, this qualitative study fills this gap by investigating perceived barriers preventing management accountants in corporate practice from becoming involved in sustainability management accounting. The results were validated through a “member check” (Miles et al., 2020, p. 303) in a workshop with accountants. Based on these results, this final section discusses the empirical findings on the three self-reinforcing mechanisms as possible barriers to accountants' sustainability involvement, each followed by recommendations for path-breaking. The need for further research is also discussed.

The results show that coordination effects influence management accountants to focus on rules and priorities concerning financial outcomes, while sustainability issues are only included to the extent they are perceived to be explicitly related to immediate financial outcomes. While the perceived trade-off between sustainability and financial performance reflects a limited and reactionary view of possible business cases, recent research provides a more nuanced discussion of different types of business cases of and for sustainability (e.g., Carroll & Shabana, 2010; Schaltegger & Burritt, 2018) than those identified among the interviewed accountants. Although some accountants mentioned potential reputational benefits of dealing with sustainability, most did not seem to perceive this as contributing to a (reputational) business case of sustainability and to be sufficiently important to be dealt with in the accounting department. Only accountants with stronger sustainability involvement expressed the perspective that adopting best practice sustainability measures (e.g., of energy efficiency) would create a responsible business case for sustainability. While this finding raises the question of whether “sustainability is safe in the hands of accountants” (e.g., Gray & Bebbington, 2000), this analysis highlights that self-reinforcing mechanisms may be a key explanation for blind spots that prevent management accountants from recognizing connections between sustainability and a company's core business. Our results reveal that underlying cognitive biases could indeed both reinforce rules and practices preventing accountants from becoming involved with sustainability and explain why accountants ignore or are unaware of the existence of different types of business cases for sustainability. As most of the accountants interviewed do not see a connection between sustainability and the core business, they do not integrate sustainability outcomes sufficiently in organizational rules and priorities. This connection is, however, crucial to improving sustainability performance (e.g., Egan & Tweedie, 2018; Larrinaga-Gonzalez & Bebbington, 2001). Aside from a stronger involvement with sustainability accounting, occupying a leadership position and a higher perceived company commitment to sustainability affected the type of business cases of and for sustainability that accountants discussed. Management accountants in a leadership position also made stronger connections between sustainability data and the business strategy.

The finding on the management accountants' role in co-creating and disseminating the financial rules and priorities of the organization contradict Gray et al.'s (1996) conclusions that accountants are simply rule followers. Our results provide evidence of a more proactive role that involves shaping rules, albeit often jointly with top management. Furthermore, accountants with a high level of sustainability involvement—those who see a strong connection between sustainability efforts and the core business—were able to develop and implement sustainability rules and goals.

These findings can be used for path-breaking—disrupting existing path dependences and reclaiming a wider scope of possible behaviors (Sydow et al., 2009). Sydow et al. (2020) show that actors are able to use their agency despite being influenced by self-reinforcing mechanisms. Top management and accountants would need to broaden their prevailing understanding of the relationship between

sustainability and financial goals beyond existing clichés. They could do this by conducting an analysis of relevant business cases for sustainability as well as identifying triple-win situations and resolving trade-offs. Furthermore, governments, international professional accounting, and standards organizations can contribute to changing rules and priorities within companies through the formal integration of sustainability into international accounting standards, voluntary or mandatory, and regulations.

The results show that adaptive expectation effects prevent sustainability involvement of management accountants. Adjustment to top management expectations is not a new empirical result, and given that the relationship between the interviewed accountants and top management is hierarchical (Egan & Tweedie, 2018; Mistry et al., 2014), it is rational behavior. However, the literature also shows that accountants often have difficulties in interpreting management expectations (Morales & Lambert, 2013; Wolf et al., 2020). Our research adds to the role of accountants as information gatekeepers discussed by Schaltegger and Zvezdov (2015), who suggest two possible reasons for gatekeeping: a lack of knowledge about sustainability and a fear of losing power. A finding of this study suggests an additional reason: namely, the perception that top management does not want accountants to deal with sustainability. Accountants would require a strong position and social capital—specifically, social relationships and resources (Egan & Tweedie, 2018)—to act contrary to top management expectations. The interviews show that the reason, at least in part, that accountants do not become involved with sustainability is not due to their lack of willingness “to understand sustainability issues in a constructive way” (Schaltegger & Zvezdov, 2015, p. 353) but rather that they lack power to argue against perceived management expectations. Many even explicitly stated that they would be open to engaging in sustainability accounting.

Members of an organization adopt best practices when they expect others will do so as well and they want to end up “on the side of the winners” (Sydow et al., 2009, p. 700). If top management considers sustainability relevant for the organization, it needs to communicate explicitly how sustainability is part of the core business and explicitly demand the involvement of the management accountants. However, our results also show that top management's consideration of sustainability is a necessary but not a sufficient condition for accountants to become involved in sustainability. Management also needs to make measuring sustainability performance an explicit accounting responsibility.

Recent research (Chaudhry & Amir, 2020; Gunarathne et al., 2021; Negash & Lemma, 2020) provides empirical evidence that external institutional pressures can be important drivers for sustainability and environmental management accounting. For instance, the increasing relevance of sustainability investments (e.g., Fink, 2020) could drive such a shift. To strengthen the “winning side” and enhance the involvement of accountants requires a stronger sustainability push by other stakeholders. These stakeholders include regulators, who could require sustainability due diligence in supply chains, sustainability pioneers, who lead market transformations, professional accounting organizations, who could include sustainability in their

education and training, or customers, who could demand sustainable products and services. These findings highlight also the importance of internal management expectations for accountant involvement.

Regarding learning effects, management accountants show a high willingness to optimize financial processes, as well as to learn and to take on new tasks in accounting in general, while conforming to existing standards and balancing them with efficiency goals. The identified negative instances challenge the notion of a “lack of willingness to learn” or a general self-reinforcing mechanism based on learning effects in management accounting, which was contrary to the authors' expectations. However, our findings show that learning effects still seem to be a barrier for accountants to become involved in sustainability: The scope of change they envisage for their work and the areas of learning they are interested in were limited to finance and conventional accounting. Accountants were not willing to learn how sustainability influences, or could influence, business success. This is an important barrier to learning and change as there is significant evidence demonstrating that sustainability can have a substantial business impact and strategic relevance (e.g., Carroll & Shabana, 2010; Schaltegger & Burritt, 2018).

Based on earlier studies, one would expect accountants to strongly resist learning and changing routines (Gray et al., 1995). While routines do indeed play an essential role in accounting, the findings of this study provide evidence that although accountants are willing to question and change routines, with some variation depending on leadership position and company size, this is mostly limited to incrementally optimizing existing financially oriented processes. Several accountants interviewed were found to engage in single-loop learning (e.g., Agyris, 2005; Van Grinsven & Visser, 2011), regarding both sustainability and financial aspects, for example, when they identify the cost-saving measures of sustainability projects or when they support the sustainability department in analyzing data more efficiently. By contrast, double-loop learning questions, in this case, the purpose of work and being willing to subsequently modify rules. Here mental models, norms, and policies are questioned and changed, a process that is particularly important in a changing environment (van Grinsven & Visser, 2011), as well as for the transformational change needed for sustainable development (e.g., Mitchell et al., 2012). However, fewer than a third of all accountants questioned their attitudes and underlying assumptions regarding sustainability and financial outcomes and thus engaged in double-loop learning. This lack of questioning and changing routines related to sustainability links our findings to previous research that accountants might not have a sufficiently innovative mindset to integrate sustainability into their tasks and responsibilities (e.g., Bebbington et al., 1994; Bebbington & Larrinaga, 2014; Egan & Tweedie, 2018).

Several authors suggest that more sustainability-related training is needed (e.g., Parker, 2000; Schaltegger & Zvezdov, 2015; Spence et al., 2012). However, since many accountants do not identify sustainability accounting as an area that is relevant to the core business or the accounting function, such calls for sustainability training might be futile. Learning about sustainability accounting requires that accountants be convinced that expertise on this topic is expected of

them by management and that it is an important part of their responsibilities and expertise. Critical analysis of the interviews reveals these interlinkages among the self-reinforcing mechanisms. The interview data show that coordination effects are influenced by adaptive expectation effects, which shape rules and priorities, and that learning effects limit double-loop learning regarding sustainability. Since top management expectations and business rules do not involve sustainability, management accountants do not consider it worthwhile to learn about sustainability or consider it part of their responsibility. Thus, our findings show that these three self-reinforcing mechanisms are interlinked, leading to stabilization and reinforcement of all three self-reinforcing mechanisms. The interlinkages among individual self-reinforcing mechanisms thus create a “dominant action pattern” (Sydow et al., 2009, p. 691) in the second phase of organizational path dependence. These interlinkages between coordination, learning effects, and adaptive expectations underline that path dependence cannot be broken down in isolated efforts but needs to be addressed comprehensively. Sustainability accounting and its tools as well as learning how to identify and create business cases for sustainability should become standard topics in management accounting curricula. The aim should be to foster the perception that corporate sustainability is part of the core business and measuring its performance is a relevant area of expertise for accountants.

Further barriers identified in inductive analysis include evidence that the mindset of accountants, in particular an emotional distance to sustainability, is a barrier that prevents them from further engaging with sustainability. Sydow et al. (2009) argue that self-reinforcing patterns can also stem from emotional reactions. Indeed, in our sample some accountants stated their wish to not become involved with sustainability, a topic they considered outside their role and responsibilities, some even citing emotional reasons. This mental positioning of sustainability issues as “other” could be rooted in a fear of the complexities and uncertainties that sustainability issues can involve. However, accountants in our research denied this was the barrier keeping them from sustainability accounting. The interviewees rather stated that specialization was the reason.

The interview results provide evidence that specialization as a new self-reinforcing mechanism hinders accountants in organizations from more effectively engaging with sustainability. Such a division of labor is widely recognized in management theory, including as an organizational form of bureaucracy (Weber, 2007). Several interview statements correspond with Weber's ideas of specialization, technical competence, defined responsibilities, rules, and professionalism. The interviewees saw sustainability accounting as a specialization outside of the accounting function. While such a division of labor can increase efficiency, it also entails the danger that larger, more complex topics such as sustainability are neglected in the accounting function. This is particularly relevant for corporate sustainability if a contribution to sustainable development is considered part of the core business and corporate purpose. The argument of specialization defies this call for integration.

The finding that specialization is a self-reinforcing mechanism represents a novel contribution to the organizational path

dependence literature. The results of this research reveal that division of labor and responsibilities can act as a self-reinforcing mechanism that creates a barrier for accountants to become involved with sustainability, as other specialists (e.g., sustainability, public relations or marketing managers) are considered responsible. The perception that each specialist should stay in their own sphere of competence may create a barrier stronger than any wish from accountants or plea from top management to become more involved with sustainability. The specialization barrier highlights the key relevance of top management to not just integrate sustainability into corporate strategy but also to change the organizational structures, responsibilities, and incentives accordingly.

This study has some methodological limitations, which can be addressed in future research. The interviews were conducted solely with management accountants, and do not include the viewpoints of top managers or other employees in the organization. When talking to accountants about their “expectations of expectations” (Sydow et al., 2009, p. 701) of top management, the study did not triangulate the results with statements by top management. Further research could profitably compare the perspectives of accountants with those of top management. Also, while different characteristics and contexts of the management accountants were considered in the results, not all background variables were covered. In particular, prior education, family life, closely held values, and religious perspectives might affect the interviewees' perspectives on sustainability and power relationships to top management. This study also focuses on management accountants in a German context; future research could interview accountants from other countries to compare different cultural, educational, and regulatory influences on the accountant's involvement. Finally, the data in this study provide a static snapshot view of the experiences of accountants. Further research should investigate the magnitude and interactions of these mechanisms in quantitative and longitudinal studies showing how path dependences evolve over time and how they can be overcome.

Following the arguments by Malmi and Granlund (2009) that the purpose of management accounting research and theory should be to inform and guide practice, this qualitative empirical research identifies key barriers preventing management accountants from becoming more involved in sustainability accounting and contributing to corporate sustainability. By widening their view of possible business cases for sustainability and by questioning their assumptions about sustainability, management accountants can identify opportunities beyond cost savings. However, our findings show that to increase sustainability involvement of management accountants, top management needs to set explicit business goals for sustainability, and to change organizational structures, responsibilities, and incentives to drive transformative change.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX A

A.1 | Interview guideline

This guideline was translated from German. As it is common in semistructured interviews, the order and questions asked in each interview varied. The interview also consisted of an introductory phase, additional follow-up questions not included here (such as asking for examples or further explanations), and some closing questions.

- What are your main tasks at the moment?
 - Who are your main stakeholders? Who do you report to?
 - How easy or difficult is it for you to fundamentally reorganize or rethink any recurring tasks? How do you involve your key stakeholders in these processes?
 - What is your role when working with top management (or other key stakeholders)?
 - To what extent does your work in management accounting influence decision-making in your company?
 - What changes in the tasks of a management accountant do you expect in the next five years and how are you preparing for these changes?
 - What types of external or internal forms of learning and continuing education do you attend? What are the main topics?
- Could you imagine taking on new areas of responsibility and familiarizing yourself with new areas of work? What kind of areas would they be?
 - To what extent and for what purposes are non-financial data and key figures collected and used in your company's management control systems?
 - To what extent do you think that top management takes sustainability into account when making decisions? How does this show in your work as a management accountant?
 - To what extent and for what purposes are environmental and social data and key figures collected and used in your company's management accounting?
 - Do you also work with or exchange data and information from environmental or sustainability management?
 - To what degree can you imagine collecting and analyzing environmental and social data?
 - To what extent do you think that closer or less close cooperation between management accounting and sustainability management would be beneficial for the company?
 - In your opinion, what are the reasons why management accounting has not had any involvement with environmental and social sustainability to date?



TABLE A1 Overview of interviews

No.	Job Title ^a	Leadership role	Gender	Involvement with sustainability accounting ^b	Relevance of sustainability for company ^b	Industry	Company size (no. of employees)	Multinational company ^f	Date of interview	Interview modus	Length (minutes)
1	Controller	No	Male	No	High	Mechanical and electrical engineering	250–5000	Yes	02/28/2019	By phone	75
2	R&D Controller	No	Male	No	High	Mechanical and electrical engineering	More than 5000	Yes	03/17/2019	In person	45
3	Controller	No	Female	Ad hoc	Low	Services and trade	Less than 250	No	03/20/2019	In person	50
4	Head of Controlling	Yes	Male	No	Medium	Services and trade	More than 5000	Yes	04/08/2019	In person	55
5	Head of Group Controlling	Yes	Male	No	High	Consumer goods	More than 5000	Yes	04/24/2019	In person	60
6	Assistant Director Controlling	Yes	Male	No	Medium	services and trade	250–5000	No	04/29/2019	By phone	38
7	Head of Controlling	Yes	Male	No	Medium	Construction and chemistry	250–5000	No	04/30/2019	In person	52
8	Head of Controlling	Yes	Male	No	Medium	Construction and chemistry	250–5000	Yes	05/03/2019	In person	32
9	Controller	No	Male	Ad hoc	Low	Mechanical and electrical engineering	Less than 250	No	05/08/2019	In person	45
10	Marketing Controlling	No	Female	No	Medium	Mechanical and electrical engineering	250–5000	Yes	05/13/2019	By phone	45
11	Head of Controlling	Yes	Male	No	Low	Construction and chemistry	250–5000	No	05/15/2019	In person	70
12	Performance Controlling	Yes	Female	Ad hoc	Medium	Mechanical and electrical engineering	More than 5000	Yes	05/17/2019	In person	42
13	VP of Finance and Controlling	Yes	Male	No	Medium	Mechanical and electrical engineering	More than 5000	Yes	05/17/2019	By phone	103
14	M&A Controlling	No	Male	No	High	Banking, insurance, and real estate	Less than 250	No	05/20/2019	In person	43

TABLE A1 (Continued)

No.	Job Title ^a	Leadership role	Gender	Involvement with sustainability accounting ^b	Relevance of sustainability for company ^b	Industry	Company size (no. of employees)	Multinational company ^c	Date of interview	Interview modus	Length (minutes)
15	Controller	No	Male	Ad hoc	Medium	Mechanical and electrical engineering	Less than 250	No	05/21/2019	In person	82
16	Controller	No	Male	No	Medium	Construction and chemistry	250–5000	No	05/22/2019	By phone	45
17	Head of Operative Controlling	Yes	Female	No	High	Consumer goods	More than 5000	Yes	05/27/2019	In person	63
18	Group Controlling	No	Female	No	High	Consumer goods	250–5000	Yes	05/29/2019	In person	23
19	VP of Finance and Controlling	Yes	Male	Routine	High	Consumer goods	250–5000	No	05/29/2019	In person	67
20	Head of Controlling	Yes	Female	No	Low	Construction and chemistry	250–5000	Yes	06/04/2019	In person	52
21	Team leader Controlling	Yes	Female	Ad hoc	High	Consumer goods	250–5000	Yes	06/05/2019	By phone	23
22	Head of Controlling and Risk Management	Yes	Male	Ad hoc	HIGH	Banking, insurance, and real estate	250–5000	Yes	06/06/2019	In person	68
23	Head of Controlling	Yes	Male	Routine	High	Services and trade	250–5000	No	06/07/2019	By phone	57
24	Controller	No	Male	Ad hoc	High	Logistics	250–5000	Yes	06/11/2019	By phone	44
25	Business Unit Controller	No	Male	Ad hoc	Medium	Logistics	More than 5000	Yes	06/18/2019	In person	35
26	Inventory Controlling	No	Female	Ad hoc	High	Logistics	More than 5000	Yes	06/18/2019	By phone	38
27	VP of Finance and Purchasing	Yes	Male	Ad hoc	High	Logistics	250–5000	No	06/19/2019	In person	70
28	Controlling	No	Male	Ad hoc	High	Logistics	250–5000	No	06/19/2019	In person	70
29	Area Manager Controlling	Yes	Female	No	Medium	Logistics	More than 5000	Yes	06/21/2019	By phone	60
30	VP of Finance and Controlling	Yes	Male	No	Medium	Services and trade	Less than 250	No	06/25/2019	In person	85

(Continues)



TABLE A1 (Continued)

No.	Job Title ^a	Leadership role	Gender	Involvement with sustainability accounting ^b	Relevance of sustainability for company ^b	Industry	Company size (no. of employees)	Multinational company ^c	Date of interview	Interview modus	Length (minutes)
31	Group Leader Controlling	Yes	Male	No	High	Services and trade	More than 5000	Yes	07/23/2019	By phone	60
32	Head Office Controlling	No	Male	Ad hoc	High	Banking, insurance, and real estate	250–5000	No	07/23/2019	By phone	49
33	Group Controlling	Yes	Male	No	High	Mechanical and electrical engineering	More than 5000	Yes	09/20/2019	In person	53

^aControlling and controller as part of the job title were not translated.

^bCategorized based on statements by interviewed management accountants.

^cThe multinational company definition is based on Kogut's (2001) criteria of having business activities in more than two countries.

F. Paper 5

Petersen, H., Lühn, M., Nuzum, A.-K., Schaltegger, S., & Wenzig, J. (2021). Controller als Partner im Nachhaltigkeits-Management. *Controlling & Management Review*, 65(3), 8–15

Controller als Partner im Nachhaltigkeits- Management

Noch immer ist das Controlling selten in das Nachhaltigkeits-Management von Unternehmen involviert. Ein Wissenschaftsteam sucht nach den Gründen und macht deutlich, mit welchen Hebeln die Zusammenarbeit zwischen Controllern, Nachhaltigkeits-Managern und Top-Managern verbessert werden kann. Unternehmen können ihr Nachhaltigkeits-Management so optimieren.

Holger Petersen, Michael Lühn, Anne-Katrin Nuzum, Stefan Schaltegger, Julius Wenzig

Über Jahrzehnte hat das Nachhaltigkeits-Controlling eine ausgereifte Methodik entwickelt, um die Bewertung ökologischer und sozialer Sachverhalte mit betriebswirtschaftlichen Auswirkungen zu verknüpfen, sodass sich Nachhaltigkeitsleistungen als Kosten- oder Erfolgstreiber erkennbar steuern lassen (vergleiche Schaltegger 2011). Zu nennen wären hier beispielsweise die Umweltkostenrechnung, die Öko-Effizienz-Analyse, die Sustainability Balanced Scorecard oder die Materialflusskostenrechnung. Diese Methoden und Instrumente werden zwar im Nachhaltigkeits-Management eingesetzt, allerdings von Nachhaltigkeits-Managern und in nur wenigen Fällen von Controllern (vergleiche Schaltegger et al. 2015; Egan/Tweedie 2018). Controller sind vielmehr nur selten am Nachhaltigkeits-Management beteiligt.

Das ist verwunderlich, denn wer das Nachhaltigkeits-Management bis an seine Anfänge in den späten 1970er Jahren zurückverfolgt, der gelangt zum Umwelt-Controlling, der ökologischen Buchhaltung und dem ökologischen Rechnungswesen. Auch Fachliteratur zu diesen Themen reicht zeitlich weiter zurück als erste Lehrbücher zum Umwelt-Management. Der Einfluss von Unternehmen auf die Umwelt wurde demnach zuerst mit Ansätzen des Controllings und Rechnungswesens untersucht (vergleiche Hallay/Pfriem 1992; Müller-Wenk 1978; Schaltegger/Sturm 1992).

Die geringe Resonanz von Controllern auf Nachhaltigkeitsthemen und ihre geringe Beteiligung am Nachhaltigkeits-Management bis in die Gegenwart sind vor diesem Hintergrund erstaunlich. Auch weil immer wieder Weckrufe in Richtung Nachhaltigkeits-Controlling laut wurden, wie beispielsweise die von Weber und Schäffer (vergleiche 2012, S. 61 ff.), die Nachhaltigkeit 2012 zu einem der wichtigsten Zukunftsthemen des Controllings kürten. Fakt ist: Bisher hat das Thema diese Zukunft nicht erreicht. Stattdessen nehmen Controlling und Rechnungswesen unter allen Abteilungen den letzten Platz ein, wenn es darum geht, betriebliche Nachhaltigkeitsziele zu unterstützen (vergleiche Schaltegger et al. 2014; ähnlich Egan/Tweedie 2018).

„Unsere Untersuchung zeigt, dass Top-Manager selten nachhaltigkeitsbezogene Informationen vom Controlling einfordern.“

Hindernisse für Controller

In einer empirischen Studie haben die Autoren 33 Controller aus deutschen Unternehmen unterschiedlicher Branchen und Größen interviewt, um herauszufinden, ob diese mit Nachhaltigkeitsthemen befasst sind. Fast zwei Drittel der Befragten erklärten, selten oder nie mit Nachhaltigkeit zu tun zu haben. Die genannten Gründe für die Zurückhaltung der Controller beim Thema Nachhaltigkeit waren dabei sehr vielschichtig. Sie lassen sich im Wesentlichen in den drei Rubriken „Selbstverständnis“, „Arbeitsroutinen“ und „Psychologische Vorbehalte“ fassen.

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Die Beschäftigung mit Nachhaltigkeitszielen stärkt die Rolle des Controllers als strategischer Berater und Impulsgeber.

Im Folgenden werden im ersten Schritt die Ergebnisse der Befragungen dem Verständnis des Controllings, wie es in den Grundsätzen des Internationalen Controller Vereins (ICV) und der International Group of Controlling (IGC) festgehalten wurde, für diese drei Rubriken gegenübergestellt. Im zweiten Schritt folgen mögliche Lösungsansätze für eine Verbesserung der Zusammenarbeit von Controllern und Nachhaltigkeits-Managern.

Selbstverständnis

Laut den Grundsätzen des ICV besteht die wesentliche Funktion des Controllers darin, Handlungsalternativen vom Ziel her zu durchdenken und alle Entscheidungen an entsprechenden Erfolgswirkungen auszurichten (vergleiche Gänßlen et al. 2012). Das Spektrum möglicher Ziele reicht demnach über die Gewinnerwartung hinaus: Controller folgen dem Anspruch, Rationalität im Entscheidungsverhalten des Managements umfassend auch zu nicht monetären Zielen zu gewährleisten (vergleiche Weber/Schäffer 1999). Weichen Manager aus Eigeninteresse davon ab, hat das Controlling demnach die Aufgabe, sie partnerschaftlich in die Schranken zu weisen (vergleiche Gänßlen et al. 2012).

Vielfach verstehen sich Controller hingegen lediglich als Dienstleister, welche die Wünsche des Top-Managements nach Kennzahlen bedienen, auch wenn sie die geforderten Informationen zur Steuerung selbst für sachlich ungeeignet halten. Ein Controller als Sparringspartner, der dem Management gegenüber auch konträre Argumente anführt, ist dagegen selten anzutreffen. Das zumindest legen die Ergebnisse der durchgeführten Interviews nahe. Demnach setzt im Machtverhältnis zwischen Top-Management und

„Controller überlassen nachhaltige Themen oft anderen Abteilungen.“

Controlling das Top-Management die Agenda. Einige der befragte Controller gaben gar an, ihre Methodik und die von ihnen gelieferten Informationen weitgehend den wahrgenommenen Erwartungen des Top-Managements anzupassen. Relevante Indikatoren zu Leistungssteuerung und Berichtsformen werden laut ihren Angaben mit dem Top-Management und nach dessen oft sehr spezifischen Vorstellungen ausgewählt. Ein Controller führte aus, dass sein Controlling „auf die Präferenzen des oder der Männer an der Spitze ausgerichtet“ sei. Er subsumierte, dass dies etwas mit Vorlieben und Bauchgefühl zu tun habe und nicht mit Ratio.

Top-Manager – so das Ergebnis unserer Untersuchung – fordern selten nachhaltigkeitsbezogene Informationen vom Controlling ein, auch wenn sie Nachhaltigkeit bei anderer Gelegenheit berücksichtigen. Systematisch einbezogen werden Controller nur dort, wo Nachhaltigkeit zum Kerngeschäft gehört und die Wettbewerbsfähigkeit nach eigenem Dafürhalten maßgeblich mitbestimmt.

Arbeitsroutinen

Controller sollen das Management umfassend in allen Führungsaufgaben begleiten, auch dort, wo Führungsentscheidungen nur indirekt auf ökonomische Ziele und Zahlen einwirken (vergleiche Gänßlen et al. 2012). Es ist laut Grundsatzpapier des ICVs nicht sinnvoll, „blinde Flecken“ aufgrund weicher Erfolgsfaktoren in den Bereichen Strategie, Organisation und Kultur zu akzeptieren.

Die Einschätzungen der Interview-Partner weichen auch hierzu deutlich ab. Demnach prägen feste Regeln und Routinen den Arbeitsalltag der Controller. Laut Befragung geben regelmäßige Berichtszyklen zu klar definierten Themen den Rahmen für eine Auswahl zu liefernder Kennzahlen vor. Direkte finanzielle Auswirkungen der Geschäftstätigkeit stehen demnach im Vordergrund. Sie werden überwiegend eher kurzfristig betrachtet. Indirekte, längerfristige Wirkungen etwa auf die Reputation, den Markenwert, die Innovationsfähigkeit oder Arbeitgeberattraktivität werden hingegen oft ausgeblendet. Das Controlling agiert demnach überwiegend operativ, wodurch strategische oder gar normative Unternehmensziele aus dem Blickfeld geraten können.

Beim Thema Nachhaltigkeit vertritt ein kleinerer Teil der befragten Controller sogar den Standpunkt, Bemühungen um Nachhaltigkeit seien entweder ökonomisch irrelevant oder verursachten lediglich Kosten. Sie beurteilen es als schwierig, nichtfinanzielle, soziale und ökologische Informationen zielführend zu verdichten, und führen aus, dass Kausalketten unklar seien und notwendige Daten für eine ökonomische Bewertung fehlten. Mehrheitlich tragen Controller Nachhaltigkeitsthemen nicht aktiv an die Geschäftsleitung heran – selbst dann nicht, wenn sie diese persönlich für wichtig halten. Nur wenige Controller benennen den konkreten finanziellen Nutzen von Nachhaltigkeitsleistungen wie die Steigerung der Ressourceneffizienz oder die Verbesserung der Mitarbeitergesundheit.

Psychologische Vorbehalte

Neben inhaltlicher Skepsis haben manche Controller auch psychologische Vorbehalte gegenüber dem Thema Nachhaltigkeit. Einige der Befragten äußerten von sich aus, sie fühlten sich mit Nachhaltigkeitsthemen unwohl und wären froh, andere Abteilungen dafür zuständig zu wissen. Das Thema wurde demnach mental außerhalb des Controlling-Kerngeschäfts angesiedelt. Interviewte assoziierten beim Thema Nachhaltigkeit zum Beispiel Baumpflanzaktionen oder Aufrufe zum Papiersparen und vermuteten, ihre Mitarbeit könne solchen Prozessen keinen zusätzlichen Nutzen verleihen. Das wiederum wirkt sich selbstverstärkend auf das eigene Selbstverständnis und die darin verankerten Arbeitsregeln aus. Die befragten Controller zeigten sich nur selten motiviert, ihren Kompetenzbereich eigenständig in gesellschaftliche Themenfelder weiterzuentwickeln. Infolgedessen fehlen im Controlling grundlegende Kenntnisse und Erfahrungen, um ökologische und soziale Leistungen sowie ihren Beitrag zum Unternehmenserfolg zu messen und zu bewerten.

Als Rationalitätssicherer können Controller das Nachhaltigkeits-Management besser im Kerngeschäft verankern.

Zusammenfassung

- Nachhaltigkeits-Controlling findet in vielen Unternehmen zwar statt, liegt jedoch zumeist nicht in der Zuständigkeit von Controllern, sondern von Nachhaltigkeits-Managern.
- Eine Studie bestätigt dies und geht den Gründen dafür nach. Als Ursachen werden das Selbstverständnis der Controller, ihre Arbeitsroutinen und psychologischen Vorbehalte identifiziert.
- Sie zeigt, dass es in der Verantwortung des Top-Managements liegt, das Thema Nachhaltigkeit strategisch zu positionieren und so Controller stärker in das unternehmerische Nachhaltigkeits-Management zu integrieren.

Controller – so das Ergebnis der Befragung – überlassen nachhaltige Themen oft anderen Abteilungen. Dies, so die Schlussfolgerung daraus, entlastet sie, und um diese Entlastung möglichst aufrechtzuerhalten, meiden sie den Austausch mit den für Nachhaltigkeit zuständigen Kollegen eher, als dass sie ihn suchen. Kenntnisse im Nachhaltigkeitsbereich, die Controller aus dem Austausch erwerben könnten, fehlen folglich, was Vorbehalte und Berührungängste mit dem Thema verfestigt.

„Je bedeutender Nachhaltigkeitsfragen für Unternehmen werden, desto wichtiger ist für alle Beteiligten eine solide Informationsbasis.“

Chancen für das Nachhaltigkeits-Management

Engagiert sich das Controlling nicht bei den Themen Nachhaltigkeit und Nachhaltigkeitsziele, verfehlt es dadurch seine eigentliche Aufgabe der Rationalitätssicherung. Das Nachhaltigkeits-Management wiederum verzichtet auf die sachliche Distanz und die Methodenkompetenz von Controllern. Die Ergebnisse der Interviews zeigen drei Hebel für eine positive Veränderung der Zusammenarbeit von Controllern und Nachhaltigkeits-Managern und der stärkeren strategischen Verankerung in Unternehmen auf:

Positionierung des Top-Managements

Je stärker Unternehmen in ihrem Kerngeschäft auf nachhaltigkeitsorientierte Produkte setzen, Geschäftsmodelle an ihrer Nachhaltigkeit ausrichten und sich ambitionierte Nachhaltigkeitsziele setzen, desto mehr interessieren sich auch Controller für das Thema und desto häufiger kooperieren sie mit dem Nachhaltigkeits-Management. Dafür muss jedoch das Top-Management Verantwortung für das Thema Nachhaltigkeit übernehmen, es auf seine Agenda setzen und sich so klar positionieren.

Das Top-Management muss das Controlling und insbesondere den Finanzvorstand in die Nachhaltigkeitsberichterstattung einbinden und die Teilnahme auch aktiv einfordern. Kompetenzen des Controllings sollten für eine integrierte Steuerung so eingesetzt werden, dass finanzielle und nicht-finanzielle Kennzahlen mit dem bestehenden betriebswirtschaftlichen Reporting verknüpft werden. Wünschenswert ist ein offener Diskurs zwischen Controlling und Management, in dem Ansichten frei geäußert werden können und nicht von vornherein an Erwartungen des Top-Managements angepasst werden müssen.

Controller als Business Partner

Wollen Controller angesichts der zunehmenden Automatisierung operativer Aufgaben durch Künstliche Intelligenz zukünftig stärker in die strategische Beratung einsteigen, gehen von gesellschaftlichen Nachhaltigkeitszielen etwa im Klimaschutz strategisch wichtige Impulse aus. Darauf deu-

Controller müssen nicht zu Nachhaltigkeitsexperten werden, um das Nachhaltigkeits-Management methodisch zu unterstützen.

ten unter anderem finanzielle und regulatorische Weichenstellungen durch den Green Deal, ein EU-Konzept mit dem Ziel, bis 2050 als erster Kontinent klimaneutral zu werden. Es wäre deshalb fahrlässig für Controller, ökologische und soziale Themen allein Nachhaltigkeits-Managern zu überlassen, die vielleicht nicht alle wirtschaftlichen Zusammenhänge gleichermaßen im Blick haben. Vielmehr sind Controller in ihrer Rolle als Business Partner gefragt. Denn die weitreichende Lösung ökologischer und sozialer Probleme lässt sich nur erreichen, wenn ihre ökonomischen Wirkungen mit gesteuert werden.

Controller sind in ihrer Rolle als Rationalitätssicherer wertvoll. Sie ermitteln, welche Nachhaltigkeitsaktivitäten in welcher Ausgestaltung welche wirtschaftlichen Wirkungen auslösen. Zudem bestimmen sie, welche Ziele das Unternehmen dafür definieren und in Planungs- sowie Steuerungssysteme integrieren sollte.

Stärkung der Zusammenarbeit

Je bedeutender Nachhaltigkeitsfragen für Unternehmen werden, desto wichtiger ist für alle Beteiligten eine solide Informationsbasis. Nur so können Nachhaltigkeitsziele mit Kernindikatoren und Leistungsdarstellungen auf strategischer und operativer Ebene verfolgt werden. Dies sicherzustellen, ist das Ziel der Zusammenarbeit zwischen Nachhaltigkeits-Managern und Controllern. Nachhaltigkeits-Manager kennen die zentralen sozialen und ökologischen Themen und wissen, wie entsprechende Probleme behoben werden können. Sie kennen sich auch mit Datenquellen und der Interpretation von Nachhaltigkeitsdaten aus. Controller verfügen wiederum über Methodenkompetenz und wissen, welche Arten von Informationen wie aufzubereiten sind, um im Unternehmen Gehör zu finden. Ihre Nähe zum Top-Management verleiht ihnen eine wichtige Stellung mit Einfluss auf unternehmerische Entscheidungen.

Schlussbetrachtung

Controller müssen nicht zu Nachhaltigkeitsexperten werden, um das Nachhaltigkeits-Management methodisch zu unterstützen. Schließlich arbeiten sie auch mit anderen Abteilungen wie Vertrieb und Entwicklung zusammen, ohne Experten auf diesen Gebieten zu sein. Wie dort sollten sie ihre Expertise in Sachen Methodik und Analyse auch im Nachhaltigkeits-Management aktiv einbringen. Manchen Nachhaltigkeits-Managern wird es vielleicht zunächst schwerfallen, die Datenerhebung, Aufbereitung und Auswertung von Nachhaltigkeitsinformationen aus der eigenen Hand an Kollegen im Controlling weiterzugeben, die dem Thema vielleicht leidenschaftslos oder kritisch gegenüberstehen. Aus ihrer Sicht könnten mit der stärkeren Integration von Controllern die Gefahr einer Vernachlässigung von Themen und die Schwächung der eigenen Position einhergehen. Um dieses Dilemma zu überwinden, ist das Top-Management gefordert, klare Nachhaltigkeitsziele zu entwickeln und deren Bedeutung für den unternehmerischen Erfolg deutlich an alle Beteiligten zu kommunizieren.

Das Top-Management muss Nachhaltigkeit zum strategischen Ziel erklären, um das Controlling stärker einzubinden.

Handlungsempfehlungen

- Engen Sie als Top-Manager Controller nicht durch bestehende Erwartungen und Routinevorgaben ein.
- Binden Sie Controller aktiv in die strategische Umgestaltung zum nachhaltigen Unternehmen ein.
- Nehmen Sie als Controller die Rolle eines kritischen Rationalitätssicherers auch gegenüber dem Top-Management selbstbewusst ein.
- Entwickeln Sie eine fundierte Position zu strategisch wichtigen Nachhaltigkeitsthemen.
- Gehen Sie als Nachhaltigkeits-Manager aktiv auf Controller zu.
- Gewinnen Sie sie als kritisch-wohlwollende Sparringspartner, und profitieren Sie von ihrer Methodenkompetenz und dem kühlen Sachverstand.

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Annex

I. Author contributions to dissertation papers and publication status (§16 of cumulative dissertation guideline)

Paper No.	Title	Author contributions	Author status	Weighting factor	Publication status
1	Corporate sustainability management accounting and multi-level links for sustainability – A systematic review	StS: conceptualization, article analysis, writing of substantial parts of the paper, review KC: article analysis, writing, review JW: data collection, conceptualization and writing of methodology, article analysis, writing, review RB: article analysis, writing, review	Co-author with important contribution	0,5	Published in <i>International Journal of Management Reviews</i> Double-blind peer-reviewed VHB JQ3: B ABDC: A IF: 8.958 (2021)
2	Assessing the contribution of products to the United Nations' Sustainable Development Goals: a methodological proposal	UE: conceptualization, writing, review JW: conceptualization, writing of substantial parts of the paper, review NM: review	Co-author with pre-dominant contribution	1.0	Published in <i>The International Journal of Life Cycle Assessment</i> Single-blind peer-reviewed VHB JQ3: / ABDC: / IF: 5.257 (2021)
3	Managing Impacts on Biodiversity – A Comprehensive Analysis of Management Control Systems in Three Pioneer Food Companies	CH: conceptualization, literature review, data collection and analysis, writing, review JW: conceptualization, literature review, data collection and analysis, writing, review	Co-author with equal contribution	1.0	Major revision in <i>Social and Environmental Accountability Journal</i> Double-blind peer-reviewed VHB JQ3: C ABDC: B IF: /
4	Path dependence of accountants: Why are they not involved in corporate sustainability ?	JW: conceptualization, literature review, data collection and analysis, writing, review, AN: conceptualization, literature review, data collection and analysis, writing, review, StS: supervision, writing, review	Co-author with equal contribution	1.0	Published in <i>Business Strategy and the Environment</i> Double-blind peer review VHB JQ3: B ABDC: A IF: 10.801 (2021)
				SUM:	3.5

SS: Prof. Dr. Dr. Stefan Schaltegger; KC: Dr. Katherine L. Christ; JW: Julius Wenzig; RB: Prof. Dr. Roger L. Burritt; UE: Dr. Ulrike Eberle; NM: Nico Mumm; CH: Charlotte Hübel; AN: Anne-Katrin Nuzum
 IF: Impact Factor; VHB JQ3: Verband der Hochschullehrerinnen und Hochschullehrer für Betriebswirtschaft - JOURQUAL3; ABDC: Australian Business Deans Council Journal Quality List 2022

II. Presentations related to this dissertation

Related Paper No.	Date	Conference/ Colloquium	Title
3	November 2022	European BMBF-Forschungsinitiative zum Erhalt der Artenvielfalt (FEa) Conference, Online	Business and Biodiversity - An Extended Framework for Managing Biodiversity Impacts
3	June 2022	Environmental Management Accounting Network (EMAN) Conference, Donostia-San Sebastian, Spain	Addressing the drivers of biodiversity loss – A comprehensive analysis of management control systems in three pioneer food companies ¹
2	September 2021	The International Conference on Life Cycle Management, Stuttgart, Germany	Sustainability evaluation of products – identifying product related SDGs and indicators
3	July 2020	CSM Research Colloquium	Biodiversity in corporate practice: What role do management control systems play?
4	November 2019	EMAN Conference, Prague, Czech Republic	Accounting, sustainability, and path dependence: Why are accountants not involved in sustainability management?
4	June 2019	CSM Research Colloquium	Path dependence of accountants: Why are they not involved in sustainability?

¹ Due to a severe injury shortly before the conference the paper was presented only by Charlott Hübel.

III. Declaration

(§16 of cumulative dissertation guideline)

I declare that all information given in this annex is true in each instance and overall.

Julius Wenzig