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# Developing a measurement for corporate environmental sustainability in relation to the UN Sustainable development goals

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## Abstract

Despite extensive research on business contribution to the Sustainable Development Goals (SDGs) and environmental sustainability, the conceptualization, operationalization and empirical evaluation of these constructs remain challenging. This study aims to develop a cross-SDG measurement instrument for corporate environmental sustainability evaluation which is conceptually based on the United Nations (UN) SDGs implementation at the organizational level with a focus on the environmental dimension. By adopting a stakeholder-oriented approach, the instrument is designed to assess employee perceptions of the environmental sustainability in the organization. The measurement instrument is validated on five independent samples consisting of 348 responses in total, with 199 responses from manufacturing and 149 from service organizations. By employing data reduction techniques and Partial Least Squares Structural Equation Modeling (PLS-SEM) as a two-step measurement evaluation process, the paper performs robust measurement validity testing. Combining exploratory and confirmatory procedures the study validates a perceived corporate environmental sustainability measurement as a rigorous, multidimensional instrument adapted for manufacturing and service organizations. Thus, it contributes to the scholarship by providing an instrument for management and sustainability scholars to assess UN SDG implementation in organizations from the environmental sustainability perspective. This study has important practical implications by providing organizations the measurement instrument to benchmark and strategically improve their environmental positioning based on the perceptions of their employees as internal stakeholders.

**Keywords** Corporate environmental sustainability, Sustainable development goals

## 1 Introduction

The introduction of the *2030 Agenda for Sustainable Development United Nations* (UN) set the stage for the pursuit of global environmental sustainability by addressing various global challenges [1]. Represented by 17 Sustainable Development Goals (SDGs) consisting of several associated targets for a wide range of social, economic and environmental issues, it serves as a universal worldwide call to action. Since then, great



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scholarly attention has gone into researching UN SDGs and their implementation from various perspectives [2–5], including management research [6, 7]. To monitor the progress towards SDGs worldwide, international agencies have introduced a number of frameworks consisting of hundreds of indicators. Notwithstanding, it has resulted in rather incomparable findings and unclarity on the extent to which the issues are being addressed on a global scale [4, 8]. However, it soon became apparent that no country was on the right track in meeting the SDGs until the set deadline [9]. With the decade of the 2020s being considered of crucial importance for achieving the targets of SDGs [4], the scientific community is emphatically warning of a possibility of not attaining the UN 2030 Agenda for Sustainable Development objectives without urgent and strong initiatives to accelerate the process [5, 10]. Among such environmental and social aspects as climate change and inequality, irresponsible consumption and production (SDG12) are serious impediments to the progress [8], pointing to more responsibility and initiatives required from the business community or the so-called private sector [5].

The UN SDGs were meant to encourage companies to innovate at scale and thus achieve sustainability at a global level [1, 10–12]. Yet, the organization-level performance mirrors that of the macro level, with research indicating that organizations are ‘cherry-picking’ SDGs they are acting on, while unevenly prioritizing and showing fragmented implementation of the SDGs [11, 13, 14] or are limiting their actions to primarily reducing the negative effects [15]. However, this might be a result of “a lack of a common understanding of how to operationalize the SDGs by firms because the SDGs are designed as country level targets” [16, p. 1001]. Similar to the criticism on numerous frameworks to monitor country-level performance, the tools provided to firms for sustainability reporting are perceived as vague and leaving excessive room and leeway for interpretation on how to integrate the SDGs at the organization level [15–17]. Management scholars were called to explore cross-SDG implementation by considering all SDGs in their research [7]. Therefore, significant efforts in the scientific community have gone into analyzing the implementation of and firm contribution to SDGs [7, 13, 15] and into developing a holistic indicator system or implementation framework [16, 18].

Sustainable development and SDGs are seen as a system with interacting components across environmental, economic and social systems [8, 19] that requires an interdisciplinary approach in its research [2, 12, 20]. Even though sustainable development as a concept has been introduced into a wide range of scientific fields, environmental sciences are less integrated across different disciplines, including management sciences [12, 20]. On the other hand, scholars in management research are still figuring out how to contribute to the sustainable development and SDGs [7, 11, 16, 21], including the environmental goals applied at the organization level.

There is a lack of empirical studies on environmental sustainability of organizations, which is often analyzed merely as a dimension of corporate sustainability [22–24]. Research explicitly on corporate environmental sustainability to achieve SDGs is even more scarce [25], even though the majority of SDG targets are believed to be linked to the environmental dimension [26]. Mirroring the state of SDG implementation research and the ongoing critique regarding the absence of appropriate assessment tools, in the scientific community corporate sustainability continues to be perceived as a complex subject, with no consensus among the scholars on its definition and operationalization [23, 27]. Therefore, the adoption and evaluation of sustainability practices have

generated considerable scholarly attention in the field of corporate sustainability [23]. In a similar manner and notwithstanding an interest among management scholars in the conceptualization and measurement of corporate environmental sustainability, the currently existing research holds significant limitations, including ambiguous construct conceptualization, predominant focus on environmental strategy, operationalization of the measures, and reliance on data disclosure [24].

Hence, a research gap persists at the intersection of sustainable development and organizational sustainability, specifically, the lack of organization-level measurement capable of capturing how organizations operationalize the environmental aspects of the SDGs in practice for environmentally sustainable corporate development. Considering the complexity and the systemic nature of sustainability-related research, and the ongoing challenges in defining it within a single framework or indicator system, this paper focuses specifically on the environmental dimension and its components derived from the SDGs. We apply a systems approach centered on the environmental subsystem [19], aiming to develop an organization-level measurement instrument for corporate environmental sustainability in relation to the SDGs.

Our study contributes to environmental sustainability literature in several ways. First, we develop an environmental sustainability measurement instrument that allows management and sustainability scholars to assess UN SDG implementation in organizations as reflected through employees' perceptions of organizational sustainability practices. This is theoretically meaningful, as employee responses provide insight into organizational manifestations of environmental sustainability commitments, the evaluation of stakeholder environmental obligations, and the observable embedding of institutional pressures such as SDG adoption. The instrument allows to inform agency, stakeholder and institutional theories as the most commonly used theories to study corporate sustainability and its environmental dimension [24, 27]. Second, by employing a stakeholder-oriented approach, the instrument is methodologically designed to assess organizational environmental sustainability from the employees' perspective rather than relying on organizational self-reports [12, 20, 23, 24]. Third, we adapt the organizational environmental sustainability instrument to manufacturing and service contexts and test it empirically. In doing so, we acknowledge a likely difference in the adoption of environmental sustainability and SDGs in organization operations and supply chain management depending on the nature of company activities [11, 28, 29]. These contextual differences are considered in the measurement development, and even though the core underlying construct remains the same, the instrument includes minor contextual adaptations for application in either manufacturing or service-based organizations. Rather than developing a sector-specific tool, this study was explorative in nature and aimed at developing an instrument applicable across manufacturing and service contexts, focusing on employees' perceptions of environmental sustainability practices that reflect organizational engagement with the UN SDGs.

The measurement is validated empirically through five independent samples and a two-step analysis combining exploratory and confirmatory validation procedures. Although sustainability dynamics vary across industries, this study demonstrates that the same underlying construct captures how employees perceive their organization's environmental sustainability practices in relation to the UN SDGs. The goal is not to model all sector-specific differences, but to identify shared organizational patterns that

reflect how environmental sustainability is embedded in everyday business activities within diverse business contexts. By focusing on these common dimensions, the study shows that a comparable structure of perceptions exists across manufacturing and service organizations, providing a starting point for later, more sector-focused refinements or cross-sector generalizable measures in the future studies.

## 2 Theoretical background

While sustainability research is aimed at global challenges in solving complex problems at the interaction between nature and society [12], sustainable development is directed to ensuring responsible utilization of resources and resource base availability for the present and future generations [30]. Sustainable development and corporate sustainability has been studied from different theoretical perspectives: agency, stakeholder, and institutional theories.

The *agency theory* [31, 32] is linked to the corporate sustainability by considering managers as specific agents managing organizational resources in their custody on behalf of others, with a duty to manage and utilize the resources for the greater good of society and the environment, but not necessarily doing so [33, 34]. While the agency theory originally focuses on economic benefits and contributes to the economic dimension of corporate sustainability [32], in recent years it has been increasingly used to study the governance aspects of environmental sustainability [24]. In this context, managers may act opportunistically by prioritizing short-term gains over long-term environmental performance, while formal environmental commitments can serve as governance mechanisms that limit their discretion and align decision-making with broader societal and stakeholder interests [24]. This study relies on the agency theory only to the extent of considering organizations as agents entrusted with environmental resources and accountable for their use. Employee perceptions are particularly relevant in this context, as they can reveal the extent to which managerial commitments to environmental sustainability are translated into everyday organizational practices.

The study much more firmly relates to the stakeholder and institutional theories in that the measurement instrument links to organizational management of environmental sustainability – whether as an obligation to the stakeholders or due to the pressures they are experiencing. The core idea of *stakeholder theory* is that companies have to consider the needs of their stakeholders, and are required to address their economic and social interests [35]. It has recently evolved to address environmental management and meeting environmental obligations to the stakeholders [24, 32]. Employees, as internal stakeholders, not only implement environmental practices but also observe their authenticity and consistency, making their perceptions meaningful indicators of organizational commitment [24, 32]. Thus, stakeholder theory provides the primary conceptual foundation for the measurement instrument, emphasizing the role of internal stakeholders in perceiving and shaping corporate environmental practices. An *institutional theory* perspective complements this view by emphasizing that organizations perceive normative pressures, such as social obligation, a logic of appropriateness and moral governance, leading them to act sustainably or adopt SDGs [11, 36–38]. Environmental sustainability practices are often adopted as a response to institutional expectations, becoming part of organizational routines, reporting structures, and decision-making.

This study presents the measurement instrument that captures how organizations manage environmental sustainability both as a stakeholder-driven responsibility and as an institutional response to societal expectations, operationalizing it through employees' perceptions of their organization's environmental engagement. Although stakeholder and institutional theories serve as the conceptual rationale for why organizations pursue environmental sustainability, this paper is primarily aimed at contributing to the scholarship of management and sustainability by providing a measurement instrument to enable future research to empirically examine and inform these theoretical perspectives, recognizing employees as internal stakeholders whose perceptions indicate how organizations enact sustainability commitments [32, 39].

Corporate contribution to SDGs was mostly empirically analyzed based on sustainability reports [11, 13, 18] or self-assessment [15, 25] even despite the criticism regarding the reliability of such data [13]. With the objective to reduce the complexity associated with the assessment of the implementation of or contribution to SDGs, there have been multiple attempts in the scientific literature to group them by assigning themes, shared attributes or dimensions [12, 15, 16, 18, 19], including environmental sustainability [10, 26]. Originally, the UN SDGs were listed as follows: 1 – No poverty; 2 – Zero hunger; 3 – Good health and well-being; 4 – Quality education; 5 – Gender equality; 6 – Clean water and sanitation; 7 – Affordable and clean energy; 8 – Decent work and economic growth; 9 – Industry, innovation and infrastructure; 10 – Reducing inequalities; 11 – Sustainable cities and communities; 12 – Responsible consumption and production; 13 – Climate action; 14 – Life below water; 15 – Life on land; 16 – Peace, justice and strong institutions; and 17 – Partnerships for the goals [1]. This study adopts a systems approach to sustainable development as an intersection of three interlinked systems – environmental, economic and social, where SDGs encompass the goals of each system [19]. The paper focuses on the environmental dimension of SDGs manifested in firm operations and resource management in order to “mitigate a firm's impact on the natural environment” [40, p. 73], also defined as environmental sustainability.

Environmental sustainability of organizations has so far received limited attention in the scientific literature, with scholars mostly studying it under the umbrella of corporate sustainability [22–24], including related measurements. Similar to the implementation of SDGs, corporate sustainability and its measurement are perceived as highly complex in the scholarly experience [23]. There is no standard definition of corporate sustainability that would be universally adopted in the literature [27], nor clarity in its measurement, with some scholars integrating sustainability and various other dimensions [21, 41], whereas some authors separate it into dimensions and groups [23]. In their systematic literature review on corporate sustainability studies with an orientation towards environmental sustainability, de Oliveira et al. [23] observed that the adoption and evaluation of sustainable practices in companies have lately been the core focus in the scientific literature. This demonstrates united efforts to establish clarity in corporate sustainability measurements taken by the scientific community.

Prior research on corporate environmental sustainability has predominantly concentrated on strategic and performance-related indicators, and has overall rarely studied it empirically as a separate construct [24]. Studies empirically linking corporate environmental sustainability and SDGs are even more scarce (see Nishitani et al. [25]). Aguilera et al. [24] in their literature review highlight significant limitations in the existing

literature due to “ambiguous conceptualizations of environmental sustainability constructs” [24, p. 1] and emphasize the prevalence of studies focusing on environmental strategy, performance, and self-reporting. While it still has no accepted measurement, some scholars rely on more established corporate sustainability scales and extract only indicators on environmental sustainability [22]. Cowan et al. [42] extracted components of environmental sustainability programs reported by companies. Closely related to the UN SDGs, their environmental sustainability components focus on resource management (solid waste and water conservation), energy management (energy conservation, renewable energy, GHG emission reduction, energy efficient construction) and product sustainability (product transportation, supply chain audit, product stewardship and a life-cycle program) [42]. Management scholars mainly focus on strategic management of environmental corporate sustainability and its associated activities [25, 43, 44]. Similarly, Nishitani et al. [25] link environmental activities to achieving SDGs by measuring environmental performance through CO<sub>2</sub> emissions, resource efficiency, energy consumption, waste production, hazardous waste production, water use and pollution emissions. They measure the incorporation of SDGs into business targets using a single-item scale and rely on self-assessment by company representatives.

Related empirical studies measuring SDG implementation in firms adopt diverse methodologies to overcome complexity associated with SDGs, ranging from qualitative systematic categorization [13], to computer-aided text analysis of companies’ sustainability reports based on their SDGs-related vocabulary [11], disclosure-based scoring [18], and assessment by company representatives of merged SDG targets [15]. Thus, they mainly rely on highly criticized self-reporting or disclosure data [13]. All of these works are a significant addition to the scholarship on the corporate SDGs implementation; they point out, however, to a lacking common understanding of constructs, their operationalization empirically, and measurements on SDGs adoption in firms.

This study is set to develop an instrument to measure perceived corporate environmental sustainability that – at its core – integrates SDGs, rather than strategies, company self-reports or other suggestive indicators based on activities and practices – all of which received criticism for conceptual ambiguity when building the construct to be included as a scale or a measurement [24]. The indicator system draws on the descriptions for each of the 17 goals retrieved from the UN Sustainable Development website [45], while focusing on the environmental perspective of the goals. The measurement system also adopts the framework for corporate environmental sustainability measurement developed by Naidoo and Gasparatos [46]. Even though their paper focused on strategies and aimed at the retail sector, the developed framework lists corporate environmental sustainability activities grouped in three sub-categories: (i) internal operations, encompassing energy management, GHG emissions reduction, integrated waste management, and water conservation; (ii) supply chain management, incorporating sustainable sourcing, certification, take-back mechanisms, transportation efficiency, and water conservation; and (iii) stakeholder engagement, including customer engagement, staff training, shareholder and investor relations. In contrast to prior research, this study extends these conceptual foundations by operationalizing an empirically testable, perception-based measurement instrument to evaluate corporate environmental sustainability and engagement in UN SDG framework.

Building on Whittingham et al. [11], who show that company engagement with the SDGs differs depending on the nature of the company’s activities, we therefore account for differences in operation and supply chain management for sustainability between manufacturing and service-based organizations [28]. Accordingly, the measurement is developed by adapting it for manufacturing and service-based organizations (see Table 1). In a similar manner to Gupta & Gupta [22], the statements are formulated so that the instrument can be administered for employees to evaluate the perceived corporate environmental sustainability of an organization while remaining conceptually comparable across sectors. To ensure clarity and contextual relevance, minor adaptations were introduced in the examples provided to respondents from each sector. Therefore, the

**Table 1** Corporate environmental sustainability measurement (adapted from UN [45] and Naidoo and Gasparatos [46])

Manufacturing organizations		Service-based organizations	
Item	Statement	Item	Statement
CES_1	My organization's internal operations focus on energy management and greenhouse gas emissions reduction	SCES_1	My organization's internal operations focus on energy management and greenhouse gas emissions reduction (e.g., our buildings)
CES_2	My organization's internal operations are focused on waste reduction, such as packaging (e.g., prevention, reduction, recycling, reuse)	SCES_2	My organization's internal operations are focused on waste reduction, such as printouts (e.g., prevention, reduction, recycling, reuse)
CES_3	My organization's internal operations ensure efficient use of water and natural resources	SCES_3	My organization's internal operations ensure efficient use of water (e.g., beneficial water reuse, practices to minimize water use for irrigation)
CES_4	My organization's supply chain management applies sustainable sourcing (e.g., mostly sourcing certified raw materials, choosing local suppliers)	SCES_4	My organization's service supply chain management applies sustainable sourcing (e.g., mostly sourcing from certified suppliers or products with environmental certifications)
CES_5	My organization's supply chain is focused on circularity (e.g., by offering take-back mechanisms to clients and customers for broken or not functioning components, packaging return/refund)	SCES_5	My organization's service supply chain is focused on circularity (e.g., by applying reuse, sharing, 2nd life strategies)
CES_6	My organization ensures sustainable transportation efficiency in its supply chain (e.g., by choosing the best transportation mode for products)	SCES_6	My organization ensures sustainable transportation efficiency in its service supply chain (e.g., by choosing the best transportation mode for service delivery, by rethink strategies, by using digital technologies instead of travel)
CES_7	My organization collaborates with suppliers that are using water and natural resources efficiently	SCES_7	My organization collaborates with suppliers that are using water and natural resources efficiently
CES_8	My organization is investing in engaging customers for achieving sustainable consumption (e.g., by recycling, return/refund, buying the more environmentally friendly product with the lowest CO <sub>2</sub> impact or free from plastic, discouraging wasteful consumption practices)	SCES_8	My organization is investing in engaging customers to achieve sustainable consumption (e.g., education, discouraging wasteful consumption practices)
CES_9	My organization offers staff training for environmental sustainability	SCES_9	My organization offers staff training for environmental sustainability
CES_10	My organization is engaging with shareholders and investors for reaching environmental sustainability goals	SCES_10	My organization is engaging with shareholders, investors and stakeholders for reaching environmental sustainability goals
CES_11	My organization's efforts are oriented towards climate change mitigation	SCES_11	My organization's efforts are oriented towards climate change mitigation

Likert scale: 1 – strongly disagree; 7 – strongly agree.

main difference in the statements for manufacturing and service-based organizations is in the provided examples to ensure that they are understandable and relatable to the employees in each industry. Measurement is further empirically validated, which shall be discussed in the next sections.

### **3 Methodology**

This study is descriptive in nature due to its aim to develop a measurement system for corporate environmental sustainability in organizations. Methodologically, it was designed by following a systematic process of creating, refining, and validating the measurement instrument [47, 48].

#### **3.1 Instrument development**

Building on the existing literature on the corporate environmental sustainability and the knowledge domain on UN SDGs, an initial list of statements was developed to later empirically measure corporate environmental sustainability in organizations via primary data collection. These statements were then reviewed and discussed with academic and industry experts in the field of sustainability management, including experts from the organizations willing to participate in the study. By including experts in domain and target populations in the evaluation of the initial statements, we aimed for content validity in this first step of measurement development [47, 49, 50]. In these discussions with experts from the organizations involved, it became apparent that the initial measurement items should be refined to accommodate peculiarities in service-based organizations. Certain examples in the items were hard to relate and evaluate for the employees in service contexts. To ensure conceptual clarity and contextual relevance, the wording of some statements was slightly adapted while maintaining their theoretical meaning and underlying construct. It resulted in two measurements for corporate environmental sustainability, intended specifically for either manufacturing or service-based organizations. Thus, the instrument is designed to be contextually adaptable across organizational environments rather than sector-specific or comparative in nature.

Prior to the launch of the data collection, separate pre-tests were conducted in the organizations willing to participate in the study on a smaller sample of 5–10 employees [47, 48]. Based on the expert feedback, the final items were edited and refined for the final questionnaires. Since the data collection was conducted consecutively in the case companies, the first case company in manufacturing and later in services served as pilot studies before full-scale administration of the questionnaire to the random sample [51]. With 56 responses from a manufacturing company and 47 from a service-based company, the sample sizes were sufficient for a pilot test [48]. As the tests for the sampling adequacy and normality of data, and dimension reduction analysis were conducted each time the questionnaire was administered at a company participating in a study, and satisfactory results of these analyses led to the research instrument remaining the same throughout the data collection process.

The final instrument – the questionnaire – consisted of two parts: (i) question blocks on the general sustainability measures; and (ii) specific sustainability measures in the organization. The first part included questions measuring the organizational sustainability-oriented purpose and corporate environmental sustainability, which are discussed

in this paper. The respondents were asked to indicate the degree to which they agree with the statements provided in Table 1. The answers were measured in a 7-point Likert scale with '1' standing for *strongly disagree* and '7' denoting *strongly agree*. The second part of the questionnaire aimed to identify to what extent the respondents are affected at work by specific sustainability measures applied at their companies. Due to a high variability, these statements were excluded from the corporate environmental sustainability measurement. Organizational questions (tenure, role, department, country) at the beginning of the questionnaire for a random sample included a filter question to determine whether the statements measuring corporate environmental sustainability should relate to manufacturing or service-oriented organization, and to control for the employment status. When collecting the data from the case companies, the measurement was selected automatically, depending on its type. The questionnaire was concluded with the demographic questions about the respondent (age, gender, education, marital status, household income).

### 3.2 Sampling and data collection

Due to the aim of creating a reliable and valid measurement instrument for companies, the data were collected in five independent samples. Company A ( $n = 56$ ) and Company B ( $n = 102$ ) represented manufacturing, whereas Company C ( $n = 47$ ) and Company D ( $n = 40$ ) represented service organizations. The random sample ( $n = 103$ ) included respondents from both and allowed for assessing item performance across different organizations. The combined dataset resulted in 348 responses, with 199 on manufacturing and 149 on service-based companies (see Table 2). Although the total sample is distributed across two sectors, sector-specific subsamples and the combined dataset exceed the thresholds recommended for the applied exploratory and confirmatory validation procedures to achieve statistical power [52]. Each sector-specific subsample meets the criterion of at least 10 observations per item in the variable [53], and the total sample size surpasses the suggested minimum sample size of at least 300 observations for robust measurement testing [47–49]. The sample size of this study ensures sufficient statistical power for the two-step validation process described in the next sections.

**Table 2** Data sample

	Manufacturing organizations		Service-based organizations	
	Company A	Company B	Company C	Company D
Sector/ Industry	Fast-moving consumer goods	Renewable energy industry	Higher education (private)	Research and higher education (private)
Size	Large (> 250 employees)	Large (> 250 employees)	Medium (< 250 employees)	Large (> 250 employees)
Headquarters	Northern Europe	Western Europe	Eastern Europe	North America
Sustainability-related information	ISO 14,001 Standard; Multiple sustainability certifications for products and processes	ISO 14,001 Standard; Rated high for environmental, social, and governance (ESG) performance; Multiple sustainability certifications for products and processes	Sustainability and environment related initiatives	Sustainability Tracking, Assessment & Rating System (STARS) Gold; Multiple sustainability- and environment-related initiatives
<i>n</i>	56	102	47	40
Random sample ( <i>n</i> )		41		62
Combined dataset ( <i>N</i> )		199		149

All case companies are large organizations, except for Company C, which is a medium-sized company. Manufacturing case companies are multinational organizations operating in the fast-moving consumer goods sector (Company A) and renewable energy industry (Company B). Service-based companies are represented by private research and higher education organizations known for their internationality. All four company cases are different in their sustainability goals, with one per manufacturing and service-based organization group portraying more solid sustainability-related achievements as compared with the other case. Companies A, B and C have headquarters in Europe, respectively in Northern, Western, and Eastern Europe, whereas company D is based in North America. The fact that all case companies are international, with English being one of their main languages, allowed to conduct research in English.

The data were collected by surveying employees in the case companies in a consecutive manner before administering the survey to a random sample targeting the employed individuals. The survey was administered via the web-based online surveying tool *Qualtrics*, with a consent form included in the title page of the survey. The invitation included the information sheet to the respondent and an anonymous link to the survey. In those case companies which gave the permission to survey their employees, the invitation was distributed by company representatives contacting employees as potential respondents via internal channels and newsletters. The survey was distributed to a random sample via the mailing list of the alumni of one of the international universities in Western Europe.

### 3.3 Methods for data analysis

Data analysis followed the methods for measurement development [47, 48] and was conducted by employing *SPSS version 29.0* and *SmartPLS 4* for statistical data analysis. A two-step validation approach was employed to establish the structural consistency and validity of the developed measurement instrument. First, the aspects of item reduction and exploration of the number of latent constructs that fit the observed data, testing of dimensionality of a measurement between independent samples, reliability and validity of the measurement were assessed with *SPSS*. In this step, the Cronbach's alpha coefficient was used to assess the internal consistency reliability of the measurement items, and validity was measured by assessing the construct validity. The measurement for manufacturing and service-based organizations was evaluated separately. This stage involved examining whether the same underlying component structure emerged across independent and sectoral samples, thereby evaluating the measurement's cross-contextual consistency. Employing *Partial Least Squares Structural Equation Modeling* (PLS-SEM) as a second step of measurement evaluation allowed for more robust validity testing by conducting redundancy analysis for convergent validity [54]. PLS-SEM is particularly suitable for complex, formative constructs and moderate sample sizes, offering a robust approach for evaluating new measurement instruments [52]. In this study, PLS-SEM is used as a confirmatory test in the validation process, ensuring that the measurement accurately captures employees' perceptions of corporate environmental sustainability across different organizational settings [55]. Together, the exploratory and confirmatory steps provide a rigorous validation process, surpassing the single-step exploratory factor analysis procedures commonly used in the studies.

Before data analysis, multiple tests were conducted to ensure data quality. The cases with a major share of responses (more than 10%) missing were deleted from the dataset,

and PLS-SEM models were set to case-wise deletion by adopting missing value treatment. Harman's one-factor technique was applied to test for common method variance, i.e., all the items were loaded onto a single factor examining the un-rotated factor solution [56]. In the sample of manufacturing companies, a single factor explained 29% variance, whereas, in service, a score of 23% was obtained. The factorability of the data before continuing with data reduction techniques was verified by inspecting the Bartlett's test of sphericity for the normality of data, and the Kaiser-Meyer-Olkin (KMO) test was applied for the sampling adequacy.

The methods of data reduction included *Principal Component Analysis* (PCA) for formative measures, and common factor analysis (*Principal Axis Factoring*) was employed for a reflectively measured construct used in the PLS-SEM convergent validity test [57]. Corporate environmental sustainability was specified as a formative measurement, as each item in the construct represents a separate aspect based on UN SDGs, and the variance in responses in one indicator may not have any impact on the other indicators in the construct [58, 59]. Opposite to reflective indicators, which can be interchangeable, formative indicators each represent a part of a construct [58]. In other words, an organization might score high for some of the indicators according to the view of a respondent while not covering some aspects related to UN SDGs and thus receiving a fairly low evaluation for the other indicators. This formative specification of the corporate environmental sustainability measure defines its operationalization by using PCA as a data reduction technique and component extraction method with the orthogonal rotation method *Varimax*, where the components remain uncorrelated since they are formed, but they do not affect cause indicators [57]. The exploratory factor analysis method principal axis factoring with the oblique rotation method *Promax* enabled to explore the possible underlying factor (latent variable) in a reflective measurement structure through shared variance between the items [48, 57]. In this analysis, the items were evaluated based on multiple criteria: communalities, items loadings, no significant cross-loadings, a minimum of three salient loadings, factor reliability levels, and parsimony [48].

#### 4 Data analysis

Sampling adequacy and the normality of data for the manufacturing and service-based organizations' data samples are tested as a first step in data analysis prior to the application of data reduction techniques. The Kaiser-Meyer-Olkin (KMO) test as a sampling adequacy measure should hold a minimum threshold value of 0.60, and the Bartlett's test for the normality of data should be significant at a probability not above 0.05 [60–62]. With the Bartlett's measure being highly significant ( $p < 0.001$ ) in both data samples, and KMO with the value of 0.936 in the sample of manufacturing and 0.870 in the sample of service-based organizations, it is appropriate to conduct data reduction statistics for the data samples.

Principal component analysis (PCA) with *Varimax* rotation is then administered separately for manufacturing and service-based organizations in order to extract components of formatively measured constructs on corporate environmental sustainability and to measure the construct validity. First, the analysis is performed for the manufacturing organizations, by conducting computations separately for company cases A and B, the random sample, and, consequently, for a combined dataset (see Table 3). Separate computations allow observing any discrepancies in the parameters such as item loadings

and the composition of the principal component in each company case versus the random sample, and, finally, in comparison to the combined dataset. This is a crucial step of the dimensionality test to determine whether the measurement is the same across independent samples [47]. This sequential design allowed comparison of component composition across independent and sectorial samples, thus serving as an empirical test of measurement consistency.

To achieve the so-called ‘strong data’, the analysis aimed at uniformly high communalities (loadings) without cross-loadings or several variables loading strongly onto each component [63]. Communalities (loadings) common in the social sciences, i.e., low-to-moderate communalities of 0.40 to 0.70 [63], were considered to be acceptable loadings. Items having communalities below 0.40 or cross-loadings at 0.32 or higher on two or more components [64] were to be excluded from the analysis.

**Table 3** Assessment of the measurement for manufacturing organizations

Item	Statements	Com- pany A	Com- pany B	Random sample	Com- bined dataset
<i>N</i>		56	102	41	199
CES_1	My organization’s internal operations focus on energy management and greenhouse gas emissions reduction	0.754	0.746	0.874	0.770
CES_2	My organization’s internal operations are focused on waste reduction, such as packaging (e.g., prevention, reduction, recycling, reuse)	0.708	0.807	0.717	0.773
CES_3	My organization’s internal operations ensure efficient use of water and natural resources	0.729	0.877	0.855	0.833
CES_4	My organization’s supply chain management applies sustainable sourcing (e.g., mostly sourcing certified raw materials, choosing local suppliers)	0.838	0.797	0.719	0.782
CES_5	My organization’s supply chain is focused on circularity (e.g., by offering take-back mechanisms to clients and customers for broken or not functioning components, packaging return/refund)	0.789	0.791	0.592	0.757
CES_6	My organization ensures sustainable transportation efficiency in its supply chain (e.g., by choosing the best transportation mode for products)	0.813	0.837	0.845	0.824
CES_7	My organization collaborates with suppliers that are using water and natural resources efficiently	0.765	0.863	0.870	0.834
CES_8	My organization is investing in engaging customers for achieving sustainable consumption (e.g., by recycling, return/refund, buying the more environmentally friendly product with the lowest CO <sub>2</sub> impact or free from plastic, discouraging wasteful consumption practices)	0.798	0.733	0.876	0.774
CES_9	My organization offers staff training for environmental sustainability	0.761	0.712	0.764	0.721
CES_10	My organization is engaging with shareholders and investors for reaching environmental sustainability goals	0.724	0.796	0.861	0.776
CES_11	My organization’s efforts are oriented towards climate change mitigation	0.806	0.694	0.806	0.697
<i>Cumulative % of the variance explained</i>		59.663	62.200	64.454	60.452
<i>KMO</i>		0.864	0.929	0.853	0.936
<i>Bartlett’s Test (p value)</i>		<0.001	<0.001	<0.001	<0.001
<i>Cronbach’s Alpha</i>		0.931	0.937	0.942	0.933

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

All computations (in separate case and in combined samples) result in a single principal component consisting of the same 11 items. With all of the loadings above the threshold forming a single component, none of the items had to be excluded from the analysis, and the initial list of items remains. In a combined dataset of manufacturing organizations, item loadings vary from 0.697 to 0.834, with the communalities of 0.80 or greater considered high [65]. With cumulative variance explained by this single component over 60%, it goes beyond a threshold for a measurement to explain at least 50% [66, 67] or 60% [68] of the total variance. As a result of the PCA, the construct validity to measure corporate environmental sustainability in manufacturing organizations is ensured. The capacity of meeting the aforementioned criteria shows that only those items that are intended to measure the construct are included, and it does not consist of the items which do not explain the construct well enough or show high uniqueness. Most importantly, the measurement items were the same in three independent samples and in a combined dataset.

The reliability of the measurement is evaluated on the grounds of the internal consistency. Cronbach's alpha is calculated to ensure the consistent results of responses across grouped statements in the instrument [69]. For new self-developed measurements, as in this case, the threshold for the coefficient is 0.60 [70], but  $> 0.90$  is recommended [71]. Cronbach's alpha with the value of 0.933 in the measurement for manufacturing organizations shows internal consistency reliability of that statement block.

Following the same logic, PCA is then performed for the measurement for service-based organizations, separately for company cases C and D, the random sample, and for a combined dataset of responses sourced from service-based firms (see Table 4). All computations result in a single principal component consisting of 11 items. Item loadings meet a benchmark, and thus none item from the initial list was excluded from the analysis. In a combined dataset, the item loadings vary from 0.613 to 0.791, which is lower compared to the measurement for manufacturing organizations, but which still indicate moderate to high communalities. Cumulative variance explained by these items is also lower compared to a previous construct; it was determined at around 52%, which is above the threshold of 50% [66, 67], but it is still below 60% [68]. Therefore, PCA proves construct validity in its ability to measure the construct that was intended to be measured, but it also indicates that the measurement represented by this component falls short in explaining the variance in the dataset of service-based organizations. On the other hand, Cronbach's alpha with a value of 0.904 shows internal consistency in the responses and the statement block being reliable. Also, the measurement items show consistency throughout three independent samples as well as in the combined dataset.

Across all computations, i.e. independent samples, combined datasets and sectorial subsets, a single principal component consistently emerged, comprising the same 11 items. The identical component composition across samples provides strong evidence of structural equivalence between sectors and supports the robustness of the instrument's dimensionality.

After the confirmation of the items composing formative measurements of corporate environmental sustainability for manufacturing and service-based organizations, formative measurement models are further assessed by employing PLS-SEM as an additional step to validate the measurement. Since each indicator measures a separate aspect of the construct based on UN SDGs, this means that the responses or variance in one indicator

**Table 4** Assessment of the measurement for service-based organizations

Item	Statements	Com- pany C	Com- pany D	Random sample	Com- bined dataset
<i>N</i>		47	40	62	149
SCES_1	My organization's internal operations focus on energy management and greenhouse gas emissions reduction (e.g., our buildings)	0.730	0.636	0.684	0.674
SCES_2	My organization's internal operations are focused on waste reduction, such as printouts (e.g., prevention, reduction, recycling, reuse)	0.767	0.782	0.789	0.773
SCES_3	My organization's internal operations ensure efficient use of water (e.g., beneficial water reuse, practices to minimize water use for irrigation)	0.733	0.445	0.817	0.682
SCES_4	My organization's service supply chain management applies sustainable sourcing (e.g., mostly sourcing from certified suppliers or products with environmental certifications)	0.797	0.814	0.802	0.791
SCES_5	My organization's service supply chain is focused on circularity (e.g., by applying reuse, sharing, 2nd life strategies)	0.795	0.863	0.696	0.757
SCES_6	My organization ensures sustainable transportation efficiency in its service supply chain (e.g., by choosing the best transportation mode for service delivery, by rethink strategies, by using digital technologies instead of travel)	0.654	0.434	0.795	0.613
SCES_7	My organization collaborates with suppliers that are using water and natural resources efficiently	0.754	0.614	0.809	0.757
SCES_8	My organization is investing in engaging customers to achieve sustainable consumption (e.g., education, discouraging wasteful consumption practices)	0.577	0.588	0.806	0.692
SCES_9	My organization offers staff training for environmental sustainability	0.555	0.695	0.732	0.669
SCES_10	My organization is engaging with shareholders, investors and stakeholders for reaching environmental sustainability goals	0.741	0.648	0.750	0.730
SCES_11	My organization's efforts are oriented towards climate change mitigation	0.795	0.705	0.770	0.761
<i>Cumulative % of the variance explained</i>		52.224	44.834	59.242	51.831
<i>KMO</i>		0.771	0.724	0.888	0.870
<i>Bartlett's Test (p value)</i>		<0.001	<0.001	<0.001	<0.001
<i>Cronbach's Alpha</i>		0.900	0.864	0.929	0.904

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

may not have any impact on the other indicators, the items in the PLS-SEM measurement model are considered as composite indicators, and the measurement itself is formative [58, 59].

In scientific literature, it is commonly agreed that the reliability assessment for formative constructs is not meaningful because we do not aim to statistically prove the correlations among the indicators [54, 72, 73]. Formative measurement validity is assessed in three steps: assessment of convergent validity, investigation for collinearity issues, and assessment of the significance and relevance of formative indicators [54, 74].

Convergent validity assessment is conducted by using a formatively measured construct, in this case, by employing corporate environmental sustainability, as an exogenous latent variable in the PLS-SEM model to predict the construct operationalized by reflective indicators [54]. Since there is no established reflective scale to measure

corporate environmental sustainability or a commonly accepted global single item, an organizational sustainability-oriented purpose served as a measure that summarizes the essence of the construct intended to be measured by formative indicators [74]. The scale consisting of three statements is based on Bhattacharya et al. [75]; it is aimed to measure the perception of the employees on the organization's purpose in terms of its relation to environmental sustainability. This empirically tested scale was included in the research instrument, and thus the data was collected from all organizations included in this sample. The construct has a KMO value of 0.721, its Bartlett's measure is highly significant ( $p < 0.001$ ), and Cronbach's Alpha scores 0.833, thereby showing sampling adequacy, the normality of our data, and the reliability of this statement block in the instrument. Factor analysis based on Principal Axis Factoring with the Promax rotation method is administered for this reflectively measured construct. With the three item loadings scoring from 0.752 to 0.835, the construct explains close to 63% of the variance in the dataset and displays construct validity (see Table 5).

Two PLS-SEM models are analyzed, linking corporate environmental sustainability in manufacturing or service-based organizations as a formative measurement and a reflectively measured organizational sustainability-oriented purpose (See Figs. 1 and 2). In this redundancy analysis to assess convergent validity, the path coefficient linking the two constructs should be no less than 0.707, which means at least 50% of the explained variance in the target reflectively measured construct [54, 74]. The variance inflation factor (VIF) is used for the collinearity assessment in the formative measurement model, and it should not be above 5 [54]. It signals about collinearity issues in the formative measurement model when the correlations between independent variables are high, which can then affect the estimation of the indicator weights and their significance [54]. As a final step of the validity assessment, the significance of the outer weights and outer loadings of each indicator in the formative measurement are analyzed. The outer weight represents the relative contribution of an indicator to the construct, whereas the outer loading stands for an absolute contribution, and it should be more than 0.5 when evaluating the formative measurements [54].

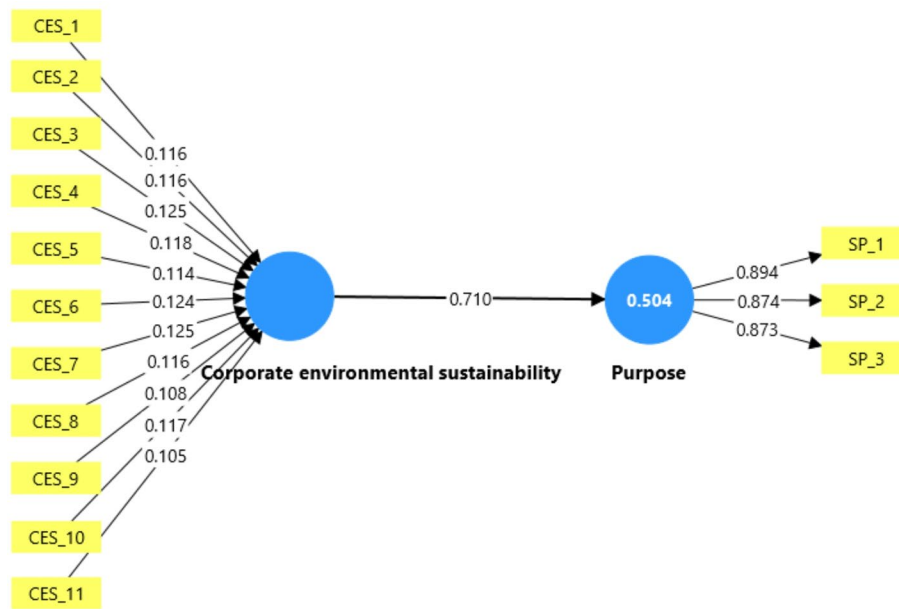
Table 6 reports on the statistics pertaining to the measurement model for the manufacturing organizations. The significance of the outer weights is considered by means of bootstrapping using 5,000 samples [54]. With VIF lower than 3 in all but one indicator, significant outer weights at  $p < 0.0001$  and outer loadings ranging from 0.697 to 0.834 (thus being higher than a threshold of 0.5), all of the indicators portray significance

**Table 5** Assessment of the measurement Organizational Sustainability-Oriented purpose

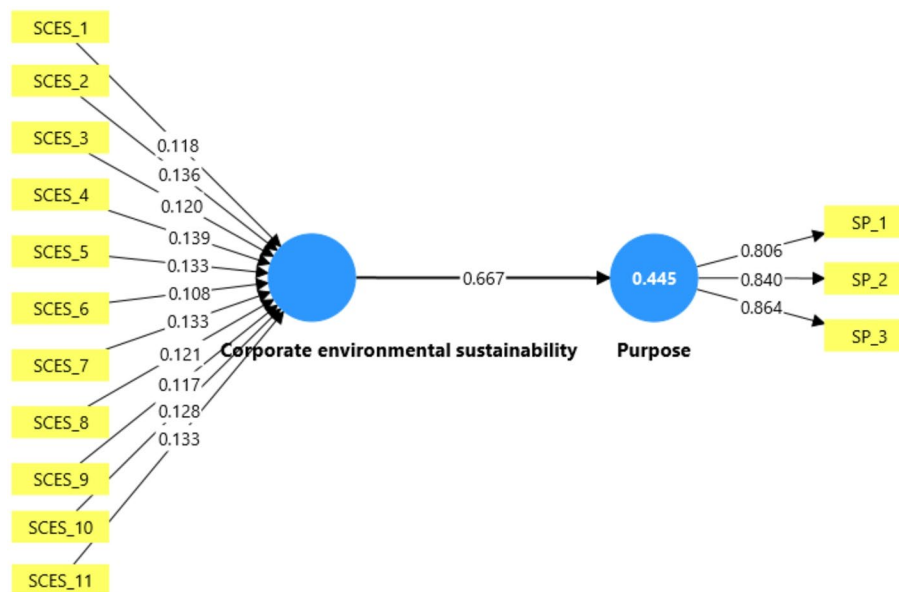
Item	Statements	Loadings	Cu- mula- tive %	KMO	Cron- bach's Alpha	Bartlett's test ( $p$ value)
SP_1	My Organization is acting on the environmental problems that our planet is facing	0.787	62.762	0.721	0.833	<0.001
SP_2	My Organization wants to make a difference in response to climate change beyond profit maximization	0.752				
SP_3	My Organization's purpose to a large extent is directed towards environmental issues	0.835				
<i>N</i>	369					

Extraction Method: Principal Axis Factoring.

Rotation Method: Promax.



**Fig. 1** Path model for corporate environmental sustainability measurement in manufacturing organizations



**Fig. 2** Path model for corporate environmental sustainability measurement in service-based organizations

and relevance attributes to the construct. The path coefficient between the constructs is 0.710 (see Table 8), and it indicates the validity of formative measurement to assess corporate environmental sustainability in manufacturing organizations. A relatively high number of indicators – as in this case – is known to reduce their weights or relative contribution to the constructs [54]. However, the assessment shows all of the indicators being significant and relevant to the final construct, with their weight variance ranging from 0.105 to 0.125.

Table 7 reports on the assessment of the measurement model for the service-based organizations. None of the indicators shows collinearity issues with VIF being lower

**Table 6** Formative measurement model assessment for manufacturing organizations

	VIF	Standard deviation	T statistics	p values (bootstrap)	Outer Weights	Outer Loadings
<i>Corporate Environmental Sustainability</i>						
CES_1 -> CES	2.395	0.006	19.785	0.0001	0.116	0.770
CES_2 -> CES	2.303	0.005	24.509	0.0001	0.116	0.773
CES_3 -> CES	3.196	0.006	21.817	0.0001	0.125	0.833
CES_4 -> CES	2.467	0.006	19.407	0.0001	0.118	0.782
CES_5 -> CES	2.252	0.005	22.562	0.0001	0.114	0.757
CES_6 -> CES	2.953	0.005	23.389	0.0001	0.124	0.824
CES_7 -> CES	3.162	0.006	20.093	0.0001	0.125	0.834
CES_8 -> CES	2.344	0.005	23.648	0.0001	0.116	0.774
CES_9 -> CES	1.932	0.006	19.464	0.0001	0.108	0.721
CES_10 -> CES	2.498	0.005	22.995	0.0001	0.117	0.776
CES_11 -> CES	2.101	0.004	23.344	0.0001	0.105	0.697
<i>Organizational Sustainability-Oriented Purpose</i>						
SP_1		0.011	34.673	0.0001		0.894
SP_2		0.010	39.511	0.0001		0.874
SP_3		0.009	40.028	0.0001		0.873
Average variance extracted (AVE)	0.775					
Composite reliability ( $\rho_c$ )	0.912					

Bootstrapping based on  $n=5000$  subsamples.

**Table 7** Formative measurement model assessment for service-based organizations

	VIF	Standard deviation	T statistics	p values (bootstrap)	Outer Weights	Outer Loadings
<i>Corporate Environmental Sustainability</i>						
SCES_1 -> SCES	1.940	0.010	11.875	0.0001	0.118	0.674
SCES_2 -> SCES	2.868	0.008	17.125	0.0001	0.136	0.773
SCES_3 -> SCES	1.938	0.008	14.138	0.0001	0.120	0.682
SCES_4 -> SCES	2.526	0.008	17.274	0.0001	0.139	0.791
SCES_5 -> SCES	2.101	0.010	13.242	0.0001	0.133	0.757
SCES_6 -> SCES	1.759	0.009	11.326	0.0001	0.108	0.613
SCES_7 -> SCES	2.592	0.007	19.051	0.0001	0.133	0.757
SCES_8 -> SCES	2.191	0.008	15.299	0.0001	0.121	0.692
SCES_9 -> SCES	1.778	0.008	17.125	0.0001	0.117	0.669
SCES_10 -> SCES	2.223	0.007	18.459	0.0001	0.128	0.730
SCES_11 -> SCES	2.701	0.009	15.288	0.0001	0.133	0.761
<i>Organizational Sustainability-Oriented Purpose</i>						
SP_1		0.015	25.698	0.0001		0.806
SP_2		0.015	26.030	0.0001		0.840
SP_3		0.018	22.912	0.0001		0.864
Average variance extracted (AVE)	0.701					
Composite reliability ( $\rho_c$ )	0.875					

Bootstrapping based on  $n=5000$  subsamples.

than 3 in all of the cases. With significant outer weights and outer loadings above 0.5 and ranging from 0.613 to 0.791, all of the indicators are significant and relevant for the construct. Their relative contribution to the construct varies from 0.108 to 0.136 with the weights in this case being different compared with the previous model for manufacturing organizations. However, the measurement for service-based organizations narrowly misses the validity benchmark again as its path coefficient linking the formatively

**Table 8** Measurement validation

Organizational Sustainability-Oriented Purpose	Path coefficient	R-square
Model 1: CES -> SP	0.710	0.504
Model 2: SCES -> SP	0.667	0.445

measured construct to the organizational sustainability-oriented purpose is 0.667 (see Table 8).

Indicator weights for the formative measurement, loadings for the reflective measurement and path coefficient linking the two constructs are portrayed in Fig. 1 for the manufacturing firms and Fig. 2 for the service-based organizations investigated in this research. Tables 6 and 7 confirm the reliability and validity of the reflective measurement, i.e., organizational sustainability-oriented purpose, separately for each model. Internal consistency reliability is reported by a composite reliability above 0.8 required for an established construct [54]. In both models, the outer loadings were above a threshold of 0.707 for indicator communality [54]. The average variance extracted (AVE) above 0.5 indicates construct communality. Discriminant validity is observed by using the Heterotrait-monotrait ratio (HTMT), with none of the correlations scoring higher than 0.9 [76, 77].

Even though this construct does not summarize the corporate environmental sustainability in its entirety, it aims to measure a construct that shares a high similarity. Thus, it helps to validate the formative measurement for corporate environmental sustainability assessment in manufacturing firms, and reveals the potential shortcomings of the measurement for service-based organizations. By not reaching the threshold of 0.707, the path coefficient shows that the formative construct does not explain 50% of the variance in the target construct [54, 74], thereby reiterating the PCA result. Combining the results of both analyses, it is observed that the indicators for the service-based organizations do not yet explain a sufficient variance of the data on these organizations, and thus the indicators need to be improved. However, the use of PLS-SEM as a confirmatory test strengthened the validation process and demonstrated that the measurement overall accurately captures employees' perceptions of corporate environmental sustainability across different organizational settings [55].

## 5 Discussion

Positioned at the intersection of sustainable development and organizational sustainability, this paper develops and validates an instrument for corporate environmental sustainability measurement based on cross-SDGs integration. In doing so, it responds to several significant research gaps voiced by the scholars regarding a need for robust constructs and indicator systems as measurements for: (1) corporate environmental sustainability [24], and organization-level SDGs implementation and contribution to SDGs [15, 16]; (2) an interdisciplinary solution-oriented approach to sustainability development and SDGs [7, 12]; and (3) a stakeholder-oriented approach and methodological innovation to study sustainability [20]. By exploring corporate sustainability and SDG implementation, research areas known for their complexity [4, 7, 23], this study considers their interconnectedness and employs a systems approach that regards sustainable development as a system composed by economic, social and environmental systems [19]. It then focuses on the environmental dimension [27] and its relation to SDGs. There are several notable studies exploring the adoption of SDGs in companies and its assessment [11, 13, 15, 16,

18], but empirical studies linking corporate environmental sustainability and SDGs have so far remained scarce [25].

Despite its strategic focus, conceptually, this paper adapted a framework developed by Naidoo and Gasparatos [46] due to its emphasis on the corporate environmental activities related to internal operations, supply chain management and stakeholder engagement. This study extends their work by operationalizing an empirically testable, perception-based measurement instrument that evaluates corporate environmental sustainability across the UN SDG framework. The instrument integrates the UN SDGs as a comprehensive set of indicators, enabling to capture corporate environmental sustainability and SDG implementation in organizations. The study addresses the main limitations which were noted with regards to the existing literature on environmental sustainability [23, 24] and SDGs implementation in firms [15, 16]. First, it provides a clear construct to measure the perceived corporate environmental sustainability and validates it by following a rigorous two-step process that includes additional validation tests with PLS-SEM. Second, its indicators do not rely on the environmental strategy, but are rather focused on the integration across SDGs. Cross-SDG measurement is formative, given that some aspects in corporate environmental sustainability and SDGs implementation – and thus indicators in the measurement – might be related negatively, some positively, or might be not related at all; there also might be trade-offs in achieving SDGs and fragmented implementation [11, 13, 19, 59]. Third, it does not rely on sustainability reports or other sustainability-related disclosure data, nor is it based on self-assessment. Methodologically, the measurement instrument follows a stakeholder-approach [20] in relying on employees' assessment as an internal stakeholder group [32].

Cowan et al. [42] state that every organization, whether selling products or services, should be able to analyze the environmental sustainability of its operations and supply chain. Supporting this statement and acknowledging that adoption might depend on the nature of the company's activities [11, 28, 29], the measurement is adapted and validated on independent samples so that it could be used for both, manufacturing and service-based organizations. The results show that the proposed measurement instrument maintains a consistent factor structure across independent samples as well as across manufacturing and service organizations. This confirms that the measure captures a shared organizational-level construct of environmental sustainability. It also suggests that employees from different sectors interpret the main aspects of corporate environmental sustainability in a similar way, despite contextual variations in operational practices. Therefore, the instrument can be viewed as a first iteration of a cross-sector measure for assessing perceived environmental sustainability, and a tool for benchmarking how organizations align their practices with the UN SDGs. Future research may extend this approach by adding sector-specific items that capture unique environmental challenges in particular industries. The instrument retains conceptual coherence when applied in different organizational contexts supporting its broader adaptability for use in diverse industries.

## 6 Contributions, limitations, and areas for future research

This study relies on the agency theory to conceptualize organizations as accountable agents, and more firmly on stakeholder and institutional theories as it shows how organizations manage environmental sustainability – whether as an obligation to their

stakeholders or in response to institutional pressures. Corporate environmental sustainability measurement presented in this study is primarily aimed at management and sustainability scholars as a construct and a validated instrument which could be used in statistical modelling to inform institutional and stakeholder theories on environmental sustainability in organizations (see Annex A). For example, by using this measurement as a variable in their models, scholars can investigate how well companies exercise environmental sustainability, driven by pressures, intent to comply with the relevant regulations or when aiming to create value for their stakeholders, and test interconnections with various other factors. This could also be applied in research building on the agency theory perspective, and while exploring governance for corporate environmental sustainability [24], but with a caution though, since it was not intended or created to serve as a guideline on how to implement SDGs in the company. In addition, this study contributes to the field of research by creating an indicator system that is oriented towards promoting good practice in the private sector to accelerate progress towards SDGs [5]. All companies participating in the present study showed a great interest in the results and used this as an instrument for self-evaluation on their contribution to environmental sustainability. This could also be used as a tool for sustainability officers in organizations. In this case, the authors of this paper would like to advise against changing the measurement's Likert scale and including the 'I do not know' option, as it might produce unreliable results. If certain indicators are not relatable to the employees of an organization, the Likert scale accommodates them with other options to respond with.

The authors further acknowledge that, despite the measurement being validated on five independent samples, their sizes and the size of a combined dataset are insufficient to call this measurement a fully validated index. The effect of this undertaking could be seen in the dimension reduction results for case Company D, where the item loadings might have been affected as compared to the other samples due to its smallest sample size. Therefore, future research might further validate the instrument on large(r) sample sizes of manufacturing and service-based organizations. Related to this, the statistical analysis indicates the need for reviewing the indicators for service-based organizations, as the explained variance is insufficient, and as it likely misses some important aspects to environmental sustainability adoption in this kind of companies. Rather than aiming for a generalizable cross-sectorial measurement, future research may refine this instrument by incorporating sector-specific extensions that capture the unique environmental dynamics of particular sectors.

The operationalization of measurements for organizations based on the nature of their activities might face criticism due to their minimal differentiation from one another. However, since this instrument is meant to be operationalized through the employees to gather their perceptions, the correct wording and examples that they can relate with proved to be of top importance. In relation to this, the authors of this paper advise against changing the examples from general to exact practices or examples from the organization they are employed at due to a risk of being too suggestive and because of the possibility of biasing the respondent by, for example, influencing their response based on a single practice.

## **Annex A: Questionnaire to determine corporate environmental sustainability**

1. Filter question:

What best describes your current employment status?

- a. Working at the company that produces or supplies goods;
- b. Working at the company that offers services;
- c. Unemployed.

2. Organizational sustainability-oriented purpose [if NOT Unemployed in Filter Q] (adapted from Bhattacharya et al. [75]):

Please indicate the degree to which you agree with the following statements (Likert: 1 strongly disagree; 2 Disagree, 3 Somewhat disagree, 4 Neither agree nor disagree, 5 Somewhat agree, 6 Agree, 7 strongly agree).

- i. My Organization is acting on the environmental problems that our planet is facing.
- ii. My Organization wants to make a difference in response to climate change beyond profit maximization.
- iii. My Organization's purpose to a large extent is directed towards environmental issues.

3A. Corporate environmental sustainability [if "Working at the company that produces or supplies goods" in Filter Q] (adapted from UN [45] and Naidoo and Gasparatos [46]):

Please indicate the degree to which you agree with the following statements (Likert: 1 strongly disagree; 2 Disagree, 3 Somewhat disagree, 4 Neither agree nor disagree, 5 Somewhat agree, 6 Agree, 7 strongly agree).

- i. My organization's internal operations focus on energy management and greenhouse gas emissions reduction.
- ii. My organization's internal operations are focused on waste reduction, such as packaging (e.g., prevention, reduction, recycling, reuse).
- iii. My organization's internal operations ensure efficient use of water and natural resources.
- iv. My organization's supply chain management applies sustainable sourcing (e.g., mostly sourcing certified raw materials, choosing local suppliers).
- v. My organization's supply chain is focused on circularity (e.g., by offering takeback mechanisms to clients and customers for broken or not functioning components, packaging return/refund).
- vi. My organization ensures sustainable transportation efficiency in its supply chain (e.g., by choosing the best transportation mode for products).
- vii. My organization collaborates with suppliers that are using water and natural resources efficiently.
- viii. My organization is investing in engaging customers for achieving sustainable consumption (e.g., by recycling, return/refund, buying the more environmentally friendly product with the lowest CO2 impact or free from plastic, discouraging wasteful consumption practices).
- ix. My organization offers staff training for environmental sustainability.
- x. My organization is engaging with shareholders and investors for reaching environmental sustainability goals.
- xi. My organization's efforts are oriented towards climate change mitigation.

3B. Corporate environmental sustainability [if “Working at the company that offers services” in Filter Q] (adapted from UN [45] and Naidoo and Gasparatos [46]): Please indicate the degree to which you agree with the following statements (Likert: 1 strongly disagree; 2 Disagree, 3 Somewhat disagree, 4 Neither agree nor disagree, 5 Somewhat agree, 6 Agree, 7 strongly agree).

- i. My organization’s internal operations focus on energy management and greenhouse gas emissions reduction (e.g., our buildings).
- ii. My organization’s internal operations are focused on waste reduction, such as printouts (e.g., prevention, reduction, recycling, reuse).
- iii. My organization’s internal operations ensure efficient use of water (e.g., beneficial water reuse, practices to minimize water use for irrigation).
- iv. My organization’s service supply chain management applies sustainable sourcing (e.g., mostly sourcing from certified suppliers or products with environmental certifications).
- v. My organization’s service supply chain is focused on circularity (e.g., by applying reuse, sharing, 2<sup>nd</sup> life strategies).
- vi. My organization ensures sustainable transportation efficiency in its service supply chain (e.g., by choosing the best transportation mode for service delivery, by rethink strategies, by using digital technologies instead of travel).
- vii. My organization collaborates with suppliers that are using water and natural resources efficiently.
- viii. My organization is investing in engaging customers to achieve sustainable consumption (e.g., education, discouraging wasteful consumption practices).
- ix. My organization offers staff training for environmental sustainability.
- x. My organization is engaging with shareholders, investors and stakeholders for reaching environmental sustainability goals.
- xi. My organization’s efforts are oriented towards climate change mitigation.

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#### **Author contributions**

Funding acquisition, VD; Investigation, VD and SD; Methodology, VD and SD; Supervision, VD; Data collection, VD and SD; Data analysis, VD; Validation, VD and SD; Writing—original draft, VD; Writing—review and editing, VD and SD. All authors have read and agreed to the submitted version of the manuscript.

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#### **Data availability**

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### **Declarations**

##### **Ethical approval**

The study was approved by the institutional review board of ISM University of Management and Economics (2024/29-02-19), and informed consent was obtained from all individual participants included in the study. All procedures performed in studies involving human participants were in accordance with the Helsinki declaration as revised in 2013 and its later amendments.

##### **Consent to participate**

Informed consent was obtained for each participant. They were reassured that their participation was voluntary and that they were free to withdraw at any time. In addition, all information was gathered anonymously and handled

confidentially. The study design assured adequate protection of study participants and neither included clinical data about patients nor configured itself as a clinical trial.

#### Consent for publication

not applicable.

#### Competing interests

The authors declare no competing interests.

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