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From outcomes to practices: Measuring the commitment to sustainability of organisations

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ABSTRACT

To achieve the Sustainable Development Goals (SDGs) outlined in the 2030 Agenda for Sustainable Development, organisations must transform their cultures and demonstrate high levels of commitment by developing sustainability-focused practices. However, existing measurement frameworks have often overlooked the concept of commitment or have used non-standardized approaches based on individual perceptions. Additionally, measurement approaches have tended to focus more on the final outcomes of sustainability initiatives rather than on the practices themselves, sometimes leading to behaviours that have undesired societal impacts, especially when short-term outcomes are emphasised.

This study conceptualises commitment to sustainability as the relationship between a company's resources and its implemented practices. The paper introduces a Data Envelopment Analysis (DEA)-based index designed to assess a company's environmental and social sustainability commitment. The approach was tested on a sample of 1411 Italian companies across six different industries.

The findings demonstrate that this innovative index effectively captures the theoretical concept of commitment to sustainability. Furthermore, assessing social and environmental commitment separately provides a clearer picture than using a single indicator encompassing both dimensions, thereby offering a nuanced understanding that aligns with the comprehensive targets set by the 2030 Agenda.

1. Introduction

The adoption of the United Nations SDGs in 2015 marked a significant milestone in global efforts to promote sustainability (DESA, U.N., 2018). The SDGs provide a universal framework for addressing critical issues such as poverty, inequality, climate change, and environmental degradation. Originally focused on guiding policy development, the 2030 Agenda has evolved to become a crucial tool for shaping corporate strategies and a reliable benchmark for communicating sustainability performance at the company level. Businesses play a pivotal role in achieving these goals by integrating sustainable practices into their operations and reporting their progress transparently, and the issue of corporate sustainability is increasingly capturing widespread attention across society (Pucheta-Martínez and Gallego-Álvarez, 2020).

This study aims to contribute to the literature on corporate sustainability measurement within the framework of the SDGs by developing a novel DEA-based measure that evaluates a company's commitment to environmental and social sustainability. Considering that commonly used frameworks for measuring corporate sustainability focus on the outcomes of sustainability-related processes, such as CO_2 emission reduction and societal benefits, the challenge lies in establishing robust pathways to sustainability that align with the overarching global goals while avoiding shortcuts and pursuit of quick wins.

The same SDGs present a comprehensive set of time-based targets and specific metrics (Alexander et al., 2022), supporting companies in defining their strategies and reporting their results. Nevertheless, focusing solely on outcomes at the company level may lead to opportunistic, easy-at-end behaviours that yield short-term results without requiring substantive organisational efforts and structural transformations (Consolandi et al., 2020). For example, a singular focus on achieving "Net Zero emissions" without defining specific preferred practices may lead companies to take two contrasting approaches, missing the overarching goal defined by the SDG 13 “Climate Action”. Some companies may enact transformations in industrial processes and

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organisational methods, investing in offsetting emissions only for the remaining share, while others may opt for business-as-usual practices, solely investing in carbon offsetting initiatives. Although both approaches may yield similar outcomes and immediate returns, the latter lacks a solid foundation for sustainable transition (ST) pathways, which would require tackling a broader set of SDGs, such as SDG 7 “Affordable and Clean Energy” and SDG 9 “Industry, Innovation, and Infrastructure”, ensuring a more solid approach, thus leading to questionable long-term outcomes.[1]

The SDGs framework is expected to facilitate the standardisation of approaches to consolidation measuring and disclosing sustainability-related information, currently scattered among various unstandardised schemes, thereby limiting comparability among firms and industrial sectors (Mura et al., 2018; O’Dwyer and Unerman, 2016). While this journey is still ongoing, the regulatory pressure is increasing at the international level (e.g. Corporate Sustainability Reporting Directive (CSRD) at the European level. Directive (EU) 2022/2464).

In order to develop effective policies and thoroughly analyse sustainability initiatives at the company level, which most of the literature treats as a “black box” (Lozano, 2015; Zhou et al., 2018; Gilbert et al., 2011), we propose breaking down the sustainability process into two sub-processes. The first sub-process involves the company’s commitment to sustainability, which refers to its level of engagement with social or environmental initiatives aimed at reducing its negative impact and promoting beneficial behaviours for society (Luzzini et al., 2015). This commitment is closely tied to the processes and actions that the company implements with the available resources (Schneider and Meins, 2012). The second sub-process assesses the effectiveness of these actions by comparing the actual sustainability outcomes to the company’s initiatives. This construct follows the dualisms between, on the one hand, policies and practices and, on the other hand, means and ends (Bromley and Powell, 2012; Wijen, 2014), namely the decoupling between strategy and processes actually implemented and between processes and their outcomes. Sustainability metrics can be categorised into processes (i.e., actions, practices, initiatives) and outcomes (i.e., final results) (Chen and Delmas, 2011; Ilinitch et al., 1998; Wood, 1991). While outcome-based measures are well-established, albeit not fully standardised, "process-based measures are often intangible and more difficult to measure" (Delmas et al., 2013, p. 258).

This presents a significant gap because corporate sustainability hinges on the specific processes that companies engage in, which must be carefully evaluated for effective management and improvement (Ahmadi-Gh and Bello-Pintado, 2022; Howard-Grenville, 2021; Marcus et al., 2015). It is important to use process-based measures to assess a company’s commitment to sustainability (Delmas et al., 2013), enriching and giving substance, in this sense, to the SDGs framework. While a company may be fully committed to developing processes to enhance sustainability, this may not always lead to immediate positive results if the processes are ineffective (Lankoski, 2008) or if insufficient resources are available (Labonne, 2006). However, the 2030 Agenda and ST require comprehensive and systemic changes, and they cannot depend solely on short-term actions (Marcus et al., 2015). Therefore, academia needs more robust measures of commitment to gain a deeper understanding of the phenomenon and provide clearer insights for managers and institutions to promote socially beneficial behaviours.

Furthermore, the field still lacks objective and standardised measures to assess a company’s commitment to sustainability (Schneider and Meins, 2012). This would allow building an integrated framework of the overall sustainability process, matching the commitment and effectiveness, namely processes and outcomes, to fully meet the Global Challenges defined by 2030 Agenda.

This study’s innovative approach lies in its focus on the commitment to sustainability practices rather than merely the outcomes, providing a more nuanced understanding of corporate sustainability.

In this study, we focus on the first sub-process, i.e. the company’s commitment to sustainability, which exemplifies an input (i.e., available resources) – output (i.e., sustainability practices implemented) relationship. Coherently with this approach, we apply DEA to a sample of 1411 Italian companies in order to develop our measure of commitment to sustainability. DEA is a well-known linear programming technique that compares inputs and outputs to measure the efficiency of specific items (Charnes et al., 1978). It has been widely used in various fields, including sustainability measurement (Zhou et al., 2018).

To our knowledge, this is the first study developing a standardised and objective metric for evaluating the relationship between a company’s resources and its sustainability practices (i.e. commitment). This novel metric allows for consistent cross-industry and cross-company comparisons, addressing a significant gap in the existing literature on sustainability measurement.

More in detail, our paper makes three main contributions to corporate sustainability measurement.

First, it adds to the literature on sustainability commitment within the framework of SDGs by developing a measure that assesses a company’s commitment to environmental and social sustainability. In particular, we offer a comprehensive measurement of sustainability practices, aligning with multiple SDGs through a holistic approach. This overcomes the established approaches to measurement and disclosure, typically based on industry-specific or opportunistic practices.

Secondly, the DEA-based measure allows for consistently evaluating companies of different sizes, making it possible to compare Small and Medium Enterprises (SMEs) with larger organisations. The DEA methodology generates dimensionless scores that are not influenced by a company’s size, enabling standardised measures to be developed. This is crucial, particularly as recent research has challenged the assumption that SMEs “do less” in Corporate Social Responsibility (CSR) due to resource constraints, lack of economies of scale, and less public pressure (Spence, 2016; Wickert et al., 2016). Evidence suggests that small firms are effectively engaged in CSR, which is related to their participation in supply chains that encourage and reward their efforts in this area (Sheng et al., 2023).

Finally, we contribute to the stream of literature using DEA to simultaneously assess social and environmental aspects (Chambers and Serra, 2018; Kapelko et al., 2021; Aparicio et al., 2023) by focusing on the concept of commitment, introducing a new set of process-based measures and developing a new dataset of measures collected on a large sample of Italian companies.

The remainder of the paper is organised as follows: Section 2 provides the literature background, while Section 3 presents the methodology applied to collect and analyse the data. Section 4 reports the study’s main findings. Finally, Section 5 discusses the results, and Section 6 presents the conclusions, limitations and potential avenues for future research.

2. Literature review

2.1. Sustainable development goals and corporate reporting

Firms’ contribution to achieving SDGs has sparked recent academic discussion (Suarez Giri and Sanchez Chaparro, 2023). Various authors have highlighted how companies can offer essential resources, including financing, managerial capacity, expertise, and competencies, and act as catalysts for technological innovation (Suarez Giri and Sanchez Chaparro, 2023; Berrone et al., 2019; Scheyvens et al., 2016). Companies have to contribute to the global goals (Suárez Giri and Sánchez Chaparro, 2023; Silva, 2021; Scheyvens et al., 2016), and they can, in turn, leverage the 2030 Agenda to inform their own strategy and communicate the company’s commitment toward sustainability through structured reporting (Ferrero-Ferrero et al., 2023).

[1] https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe

The literature highlights how companies extensively refer to the 2030 Agenda and the SDGs in their sustainability reports, while the level of action is significantly lower. (Ferrero-Ferrero et al., 2023; Heras-Saizarbitoria et al., 2022; Van Tulder et al., 2021; Diaz-Sarachaga, 2021). Several authors have argued that implementing the SDGs into measurable tools can be difficult, potentially hindering the achievement of global goals (Martinuzzi and Schönherr, 2019; Schönherr et al., 2019). This challenge may result in superficial or intentionally evasive reporting practices and even opportunistic behaviours, leading to selective disclosure of SDGs (Heras-Saizarbitoria et al., 2022; Van Tulder et al., 2021).

Still, the lack of a standardised framework or established theory for the evaluation of firms' impact on SDGs (Castro et al., 2021; Pizzi et al., 2020) has led to the development of various tools and indices tailored to specific sectors (among others, Vicente-Pascual et al., 2024; Dinçer et al., 2023; Giannetti et al., 2022; Jarosch et al., 2020; Suárez Giri and Sánchez Chaparro, 2023). The "cherry-picking" of a subset of SDGs has been recognised as a recurrent behaviour when investigating specific industry sectors (Vicente-Pascual et al., 2024; Borges et al., 2022; Hatayama, 2022; Wang et al., 2019; Stafford-Smith et al., 2017), and often correlated with the positive financial performance of the company, not necessarily under a negative lens, but rather signalling a focused sustainability strategy toward the relevant stakeholders (Mann et al., 2024).

In this context, one of the main issues is that the vast majority of sustainability measurement frameworks (and companies as a consequence) have focused on the final outcomes of the sustainability process (e.g., the level of GHG emissions), while neglecting the practices, processes or actions implemented to obtain such outcomes (e.g., the application of technologies aimed at limiting emissions) (Delmas et al., 2013; Howard-Grenville et al., 2021). Nevertheless, corporate sustainability is the natural consequence of companies' specific actions (Ahmadi-Gh and Bello-Pintado, 2022); thus, the lack of approaches to measure these practices constitutes a relevant gap in the field (Wood, 1991). Filling this gap requires carefully analysing both corporate actions and outcomes (Marcus et al., 2015) so that sustainability ratings can properly distinguish between those two levels (Chen and Delmas, 2011; Delmas et al., 2013; Wood, 1991) in this sense supporting the materialisation of the policy-practices and means-ends decoupling (Bromley and Powell, 2012; Wijen, 2014).

2.2. The measurement of commitment to sustainability

To better understand the "black box" of a company's sustainability process (Lozano, 2015; Gilbert et al., 2011), we can delineate it into two sub-processes (Fig. 1). The first sub-process focuses on the company's ability to transform available resources (e.g., financial, human, and structural) into sustainability-related practices - in short, its commitment to sustainability (Jansson et al., 2017). The second sub-process concerns the relationship between the practices implemented and the sustainability outcomes obtained - in short, how effective the company is at translating actions into results.

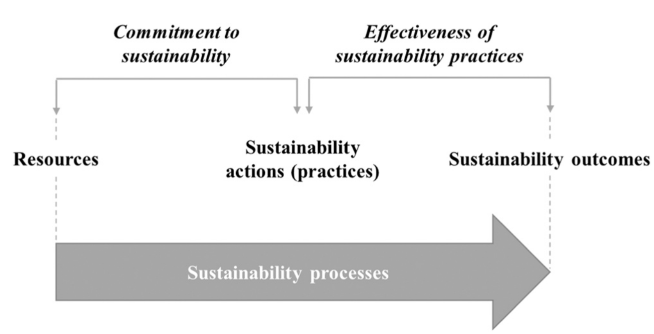

Fig. 1. The concepts of "commitment to sustainability" and "effectiveness" of the practices leading to sustainability outcomes.

The concept of commitment to sustainability is crucial because it guides companies to take long-term sustainable actions regardless of the short-term performance of those actions (Lankoski, 2008). This commitment is closely linked to achieving behaviours that benefit society. Focusing solely on outcome-based indicators can be misleading and result in incomplete results (Howard-Grenville et al., 2021; Wijen, 2014).

For example, the broader goal of addressing climate change through a systemic shift to sustainable production models is usually associated with specific targets set by policies developed from a command-and-control perspective (e.g., Industrial Emission Directives). Using outcome-based indicators, such as pollution control, often leads to short-term solutions that effectively achieve immediate goals but do not foster the development of an organisational culture capable of internalising such goals. As a result, they fail to prevent shortcuts like carbon leakage (Naegele and Zaklan, 2019).

Regulatory frameworks alone are insufficient for driving firms' commitment to sustainability (de Abreu et al., 2021). On the other hand, process-based indicators provide a better assessment of firms' commitment and effort toward sustainability, as the implemented processes involve significant changes to management and production methods. Process-based indicators can highlight enterprises' contributions to the systemic changes needed for a long-term sustainability transition (Delmas et al., 2013).

As shown in Fig. 1, the current study examines the concept of sustainability commitment as a relationship between input and output, comparing enacted processes with available organisational resources and aims to establish a standardised measure for evaluating a company's commitment to sustainability to compare the level of commitment among different companies.

Another important issue raised in the literature is the sustainability measurement in SMEs. While many studies have focused on large corporations (Jansson et al., 2017; Ormazabal et al., 2018), it's worth noting that SMEs account for approximately 95 % of companies in OECD countries (OECD, 2017). Therefore, it is important to explore the overall impact of SMEs on sustainability (Jansson et al., 2017; Mura et al., 2020).

Previous studies have shown that SMEs can play a significant role in improving overall company sustainability (Stubblefield Loucks et al., 2010) despite being less involved in sustainability-related activities (Cassells and Lewis, 2011) due to limited financial and human resources (Ortiz-Avram et al., 2018). Recent analyses indicate that SMEs can actively and experimentally develop sustainable business practices despite resource constraints (Soundararajan et al., 2018; Spence, 2016). This suggests that a lack of resources does not necessarily equate to a lack of commitment to sustainability (Brammer et al., 2012; Hoogendoorn et al., 2015). This is part of why we measure commitment to sustainability as an input-output relationship, comparing the adopted processes in relation to the available resources.

Finally, it is worth noting that several studies in the field have explored different aspects of sustainability - for instance, by highlighting the limited attention paid to social aspects in favour of environmental ones (Mallin et al., 2013; Smith and Bititci, 2017). For these reasons, there is a call for sustainability metrics that integrate both aspects with the same emphasis (Smith and Bititci, 2017; Abdul-Rashid et al., 2017).

2.3. Data envelopment analysis in sustainability measurement

After deciding to view commitment as an input-output relationship, we determined that DEA is the most suitable mathematical approach due to its well-known capabilities in measuring these types of relationships.

DEA is a widely used linear programming technique that assesses the relative efficiency of Decision Making Units (DMUs) such as companies and industries by comparing the inputs of a process with its outputs (Charnes et al., 1978). DEA is a non-parametric approach that does not require a specific pre-defined production function (Choi et al., 2012). It enables the evaluation of efficiency even in cases where the relationships between multiple and heterogeneous inputs and outputs are complex or unknown. As a result, DEA has been applied in various fields, including banking (Quaranta et al., 2018) and procurement (Visani and Boccali, 2020). DEA has been widely used in the area of sustainability performance measurement (Zhou et al., 2018). Various studies have explored different facets of sustainability, including developing sustainability indicators (de Castro Camioto et al., 2014) and evaluating how regulatory decisions affect the efficiency of waste collection services (Sarra et al., 2020).

In many DEA-based models used for analysing sustainability, the initial inputs are compared with the final outputs, often with little focus on the implemented practices. In some cases, outcomes and practice-related measures are considered outputs, but the different available resource levels are not considered inputs (Engida et al., 2018).

After conducting an extensive literature review on DEA-based sustainability assessment, Zhou et al. (2018) concluded that most DEA models still view the production process as a 'black box' when analysing overall efficiency impact factors. However, a production process may consist of multiple stages, so evaluating the efficiency of each stage separately could be necessary for diagnosing and improving overall production efficiency (p. 11). In line with this, we also aim to contribute to sustainability-related DEA models by dissecting the 'black box' and focusing on one of the stages mentioned by Zhou et al. (2018).

Further, it is worth noting that most of the existing literature has focused on the environmental dimension of sustainability, with only a few articles exploring the social dimension (Tian et al., 2020; Ait Sidhoum et al., 2020). A relatively recent body of literature on CSR uses DEA to comprehensively assess environmental and social sustainability. Chambers and Serra (2018) were the first to apply a DEA model to consider CSR activities as a whole. In 2019, Aparicio and Kapelko developed an approach that considers both positive and negative aspects of CSR, capable of identifying inefficiencies within industries and across industries. More recent applications have refined this approach by focusing on analysing dynamic social inefficiency (Kapelko et al., 2021; Aparicio et al., 2023). However, this body of literature is still relatively underdeveloped compared to research focusing solely on environmental efficiency (Ait Sidhoum et al., 2020; Kapelko et al., 2021) and has not specifically delved into the concept of societal and environmental commitment. Furthermore, all the analyses have been conducted on public datasets of medium and large-sized companies, with limited attention to the sustainability-related processes of SMEs.

As a result of the highlighted gaps in the literature, our goal is to develop a DEA-based approach to measure companies' commitment to environmental and social sustainability by considering available resources as inputs and activated processes as outputs.

3. Methodology

We frame the challenge of measuring commitment to sustainability within the context of Design Science Research Methodology (DSRM). DSRM, as introduced by Peffers et al. (2007), comprises a series of steps to be followed in creating an artefact and has proven to be an effective guide for DEA research (Tsolas et al., 2020). According to Geerts (2011) and Hevner et al. (2004), the primary characteristics of artefacts should be innovation and significance, and they can be defined as human-made objects primarily designed for practical use. In terms of innovation, our work represents the first attempt to measure commitment at the company level in the field of sustainability. In terms of significance, a company's commitment is vital for driving long-term sustainability.

The design problem can be stated as follows: to create a method (i.e., 12 output-oriented NIRS-DEA models) that can specifically address environmental and social commitment to sustainability at the company level. This is intended to assist policymakers in encouraging companies to achieve long-term sustainability. More specifically, Table 1 summarises the relevant research activities and highlights the resources related to their execution in the third column (Hevner et al., 2004).

The study was conducted in three consecutive stages: first, data were collected on a large set of sustainability-related practices implemented by Italian companies; second, an Exploratory Factor Analysis (EFA) was conducted to develop consistent sustainability metrics; and finally, several DEA-based models were developed to measure companies' commitment to sustainability.

3.1. Sample

In order to select the companies, we used a stratified sampling method based on the AIDA database (Bureau van Dijk Aida: Italian Company Information and Business Intelligence). We stratified the companies by revenue, using it as a reliable measure of organisational size. We focused on Italian regions with higher revenues, specifically Emilia-Romagna, Lombardy, Piedmont, Veneto, and Tuscany.

Table 1
Design Science Research Methodology (DSRM) applied to the current study.

DSRM activities	Activity description	Knowledge
Problem identification and motivation	The current focus on SDGs lacks attention to companies' sustainability commitment, specifically the implementation of practices aimed at improving sustainability. This lack of focus results in a lack of long-term sustainability outcomes. It is necessary to gain insight into a company's practices to measure its commitment and to assess the contributions of SMEs to global goals.	Literature review. Understanding of weaknesses of existing DEA models. Real-world problem.
Define the objectives of a solution	Providing a measure that can support the achievement of the global goals of the 2030 Agenda. This measure allows for: i) assessing a company's commitment to environmental and social sustainability, and ii) comparing companies of different sizes, thus providing consistent evaluations between SMEs and large organizations.	Literature review. Knowledge of existing tools.
Design and development	Design an approach (i.e., a NIRS output-oriented DEA model, using exploratory factor analysis as a preprocessor) that can help achieve long-term sustainability goals, separate environmental and social commitments, and encompass the diverse nature of the SDGs framework.	Exploratory factor analysis. NIRS output-oriented DEA models. Efficiency scores.
Demonstration	Case study demonstration: The proposed DEA models assess the overall, environmental, and social sustainability commitment of 1411 Italian companies across 6 industries (3 models per industry, 18 total).	Applying the proposed approach to 1411 companies.
Evaluation	Validation and comparative analysis.	Sargent's classification of operational validity. Understanding of current solution and its advantages.

The data were collected from companies' official websites or sustainability reports, focusing on 2019. The initial dataset comprised 1716 companies; however, after conducting a descriptive analysis that revealed missing or unreliable financial data for some companies, the dataset was reduced to 1411 companies. Table 2 presents the characteristics of the companies based on their industrial sector (according to NACE Rev.2 classification) and size (according to the European Commission (EC) definition).

3.2. Social and environmental related measures

To develop the DEA models, we needed to gather data on environmental and social sustainability practices. To do this, we created a set of metrics based on international sustainability standards such as GRI, Asset4, and existing literature in the field (Mura et al., 2018). This preliminary set consisted of 69 indicators from 11 different sustainability areas, which included environmental certifications, social certifications, energy management, water management, waste management, environmental impact, CSR, supply chain, consumption, product innovation, and business model.

We conducted two focus groups with 24 key informants from 20 different companies to validate the proposed sustainability indicators. These indicators were process-based and measured as binary variables to show whether an organisation followed specific sustainability practices. The metrics focus on management practices companies can use to enhance their sustainability performance, such as implementing equal opportunities policies or adopting eco-design tools. This allowed us to capture the efforts and commitment of firms towards sustainability.

In order to understand the underlying structure of the phenomenon, we conducted an EFA on the proposed metrics. This analysis resulted in a set of 28 indicators across eight areas: environmental certification, social certification, energy, CSR, emissions, supply chain, waste management and circular economy, and water. We then extracted factors with eigenvalues over 1.0 (Bollen, 1989) and applied a promax rotation to interpret better the factor structure (Kim and Mueller, 1978). Since the variables processed were dichotomous and we assumed a latent distribution for each pair of variables, we computed the correlation matrix using tetrachoric correlation, based on Edwards and Edwards (1984), with a maximum likelihood estimator.

We assessed the convergent and discriminant validity of the model constructs as per Muthen and Christoffersson (1981). Each item, which represents different sustainability practices, had a loading of more than 0.50 on its respective factor, supporting the convergent validity of the construct. We confirmed discriminant validity by comparing the loadings on the respective factor with the cross-loadings on other factors. The Cronbach's Alpha coefficients for all the constructs, except social certifications and energy, were higher than 0.6, which is considered an acceptable threshold (Van Griethuijsen et al., 2015). Given the novelty of the scale applied and the limited number of items in these two factors, the construct reliability seems to be supported (Van Griethuijsen et al., 2015; Taber, 2018).

The analysis revealed six factors with strong psychometric properties. Using the results from the EFA, we calculated the factor scores and included them as variables in the DEA model. Table 3 displays the findings of the EFA, showcasing the factor loadings, reliability coefficients, and descriptive statistics for all identified factors.

These six factors align with several SDGs. For "CSR," they support SDG 8 (Decent Work and Economic Growth) by promoting inclusive and equitable employment practices and SDG 3 (Good Health and Wellbeing) by ensuring a safe and healthy working environment. In terms of "Production," they align with SDG 12 (Responsible Consumption and Production) by promoting sustainable production and consumption patterns and SDG 9 (Industry, Innovation, and Infrastructure) by fostering innovation in sustainable manufacturing practices.

Regarding "Water," they support SDG 6 (Clean Water and Sanitation) by ensuring access to clean water and sanitation facilities, and also SDG 14 (Life Below Water) and SDG 15 (Life on Land) by promoting responsible water use and waste reduction. For "Environmental certifications," they are linked to multiple SDGs, including SDG 12, SDG 13 (Climate Action), and SDG 15. Regarding "Social certifications," they contribute to SDG 2 (Zero Hunger) by ensuring food security and promoting sustainable agriculture practices. Lastly, for "Energy," they support SDG 7 (Affordable and Clean Energy) by promoting renewable energy sources and energy efficiency.

3.3. The DEA model

The initial DEA model, proposed by Charnes et al. (1978), (1981) and known as CCR, yields dependable outcomes when dealing with constant returns to scale. Among the numerous adaptations of DEA, the BCC model (Banker et al., 1984) is the most widely used, as it can handle variable returns to scale that arise due to the impact of input and output vector sizes on their relationship.

As regards this point, in the context of this study, all the models presented are Non-Increasing Returns to Scale (NIRS) because all the outputs are upper-bounded process-based indicators measured as dummy variables that capture whether an organisation applies the specific sustainability-related practice.[2]

It is important to consider the orientation of the DEA model when determining the most appropriate one. In this research context, where a decision-making unit (DMU) is represented by a single company, all the presented models are Output-oriented, focusing on the sustainability processes that have been implemented.

More specifically, the Output-oriented NIRS DEA models can be formulated as follows (formula 1):

$$
\begin{aligned}
&\max\ \theta_0 + \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right) \\
&\text{s.t.} \sum_{j=1}^{N} \lambda_j x_{ij} + s_i^- = x_{i0} \qquad i = 1, 2, \ldots, m \\
&\sum_{j=1}^{N} \lambda_j y_{rj} - s_r^+ = \theta_0 y_{r0} \qquad r = 1, 2, \ldots, s \\
&\sum_{j=1}^{N} \lambda_j \le 1 \\
&s_i^- \ge 0;\ s_r^+ \ge 0;\ \lambda_j \ge 0 \qquad j = 1, 2, \ldots, N
\end{aligned}
\tag{1}
$$

where x_{ij} indicates the ith input (out of a total of m inputs) and y_{rj} the rth output (out of a total of s outputs) for DMU j; θ_0 is the efficiency score of the DMU_0 under evaluation, λ_j are the weights,

ε represents a non-Archimedean value whose purpose is to enforce strict positivity among the variables, and s_i^- and s_r^+ are the ith input and rth output slacks, respectively.

The higher the DEA score of a DMU, the more efficient it is compared to others. The DMUs with the highest scores can be identified as 'best in class' and represent the efficiency frontier. "Efficient" DMUs have a DEA score of 1.00. To develop the overall DEA model (OA DEA model), we considered four input variables (total assets, operating cost,

[2] There is no literature regarding return to scale and commitment to sustainability, thus we analyzed the robustness of the proposed indicator benchmarking the efficiency scores provided alternatively by a NIRS and VRS DEA model.According to Avkiran (2015), we performed a Spearman's rank correlation test with reference to all the models developed in the context of this research. The results lie in the range 0.782–0.990 (0.000), showing a statistically significant correlation and confirming that the models proposed are robust to assumptions regarding returns-to-scale.

Table 2
Description of the sample of companies included in the analysis. Industrial sector based on NACE Rev.2 classification; companies' size based on EC definition.

Nace Rev.2 Code	Nace Rev.2 Description	Short reference	No. companies by size			No. companies (total)	%
			Micro and Small	Medium	Large		
28	Manufacture of machinery and equipment nec	Machinery and equipment nec	7	129	233	**369**	**26.2 %**
10	Manufacture of food products	Food products	2	131	187	**320**	**22.7 %**
25	Manufacture of fabricated metal products, except machinery and equipment	Metal products	2	158	120	**280**	**19.8 %**
29	Manufacture of motor vehicles, trailers and semi-trailers	Motor vehicles and trailers	88	63	36	**187**	**13.3 %**
24	Manufacture of basic metals	Basic metals	12	63	73	**148**	**10.5 %**
20	Manufacture of chemicals and chemical products	Chemical	2	40	65	**107**	**7.6 %**
Total			**113**	**584**	**714**	**1411**	**100.0 %**

environmental certifications, and social certifications) and four output variables (CSR, PRODUCTION, WATER, and ENERGY).

When considering the inputs, it's important to note that a review of the sustainability literature initially revealed that the financial strength of companies is an important factor in the sustainability process (Schrettle et al., 2014). As a result, we chose revenues, total assets, and total operating costs as potential inputs for our models. The data were obtained from the AIDA database. Upon initial data analysis, we found a strong correlation between revenues and total assets (Pearson's correlation coefficient >.88; p-value <.01). Therefore, we only included total assets and operating costs in the model.

We applied the natural logarithm to both measures in order to minimise data variance and the influence of outliers. In addition, we included the environmental and social certifications of the companies as inputs for our models, identified through the EFA. These certifications help promote adopting specific sustainability practices (Prieto-Sandoval et al., 2018). As for outputs, we utilised the variables gathered specifically for this study, incorporating CSR, production, water, and energy measures identified through the EFA analysis.

In addition, as one of the paper's objectives is to address social and environmental sustainability specifically, we created two additional DEA models with distinct inputs and outputs. For the social sustainability model (SOC DEA), we chose total assets, operating costs, and social certifications as inputs and CSR as the sole output. For the environmental sustainability model (ENV DEA), we selected total assets, operating costs, and environmental certifications as inputs and PRODUCTION, WATER, and ENERGY as outputs. To prevent issues with negative data, we standardised the six variables obtained through the EFA.

Before applying the various standard NIRS models, we conducted a Super Efficiency DEA model (Banker et al., 2017) to remove outliers from the analysis. Consistent with previous studies (Banker and Chang, 2006), any DMUs with a score exceeding 1.2/1 were excluded from the analysis.

We conducted separated DEA analyses for different industries. This is important because the industry type affects the production model, legal requirements, and the perception of sustainability issues. We used DEA analyses for six manufacturing industries (NACE Rev.2 codes): food products industry, chemical industry, basic metals industry, metal products industry, machinery and equipment NEC (Not Elsewhere Classified) industry, and motor vehicles and trailers industry. In total, we analysed 1411 companies (refer to Table 1).

We chose to focus on manufacturing companies for several reasons. The first reason is the ongoing discussion about sustainability issues in the manufacturing sector (Buallay, 2020). Second, manufacturing companies have a higher impact on environmental sustainability (Abdul-Rashid et al., 2017). Third, sustainability reporting is more developed for manufacturing organisations due to the more stringent environmental regulations they face (Mura et al., 2019). After conducting the Super-Efficiency DEA test, the sample was reduced to 1372 companies.

4. Findings

We conducted three different DEA models to assess overall sustainability commitment (OA DEA model), social sustainability commitment (SOC DEA model), and environmental sustainability commitment (ENV DEA model). We ran 18 models in total: one for each of the three categories across the six industries analysed.

4.1. Validation of the overall, social and environmental DEA-based commitment indicators

After running the models, we confirmed that the measures we obtained accurately represent the companies' overall social and environmental commitment. To verify the validity of our findings, we used Sargent's (2013) classification of operational validity and identified the most appropriate validation approach for this study, as shown in Table 4.

Since operational data regarding the commitment to sustainability is unavailable in this study, we must categorise it as a "non-observable system." Additionally, no alternative models are available to measure the commitment to sustainability. As a result, the validation of our model falls within the "non-observable system" and "subjective approach" category (top-right corner in Table 4).

To elaborate, we evaluated the effectiveness of the proposed DEA-based indicator in representing companies' social and environmental commitment by examining how the model behaves with different combinations of inputs and outputs. Specifically, we evaluated the ability of the three models to properly account for the different inputs-outputs combinations summarised in Table 5.

The OA, SOC, and ENV DEA scores can be reliable indicators of commitment under the following conditions:

1. If the input levels of two companies are very similar, the company with higher outputs should have a greater DEA commitment score (1.a), while the company with lower outputs should have a lower score (1.b).
2. If a company (2.a) has both lower inputs and outputs compared to another company (2.b), the DEA commitment score should not be greater for the higher-outputs company or for the lower-inputs company, regardless of the specific distances among inputs and outputs.
3. When a company can obtain a greater output level with a lower level of inputs (3.a), the DEA score must be greater than that of the competitor (3.b).
4. Finally, given the same output level, the DEA score for the company with lower inputs (4.a) must be greater than that of the competitor (4.b).

Table 3
Results of the exploratory factor analysis and descriptive statistics.

	Factor Loadings					
Factors, Cronbach's α, mean, and std deviation	I	II	III	IV	V	VI
Corporate Social Responsibility (α=.8369; mean=.2045; sd=.2955)						
The company has implemented a policy for equal opportunities of employees	**.9277**	.1883	.0964	.0677	.0151	.0597
The company has implemented an ethical code of conduct	**.9130**	.1827	.1394	.0386	.0191	.0382
The company develops training policies for employees beyond mandatory regulation	**.7638**	.2596	.2738	.0581	.0852	.1142
The company has developed a risk analysis policy for employees' protection in the working environment	**.8587**	.2212	.2532	.0320	.0012	.0634
The company applies environmental and social criteria to select suppliers	**.5929**	.4014	.2752	.0747	.0396	.2041
Production (α=.6897; mean=.0794; sd=.16725)						
The company applies policies of social communication about the sustainability of the products to inform consumers	.1916	**.8227**	.1143	.1487	.0029	.0546
The company provides information about the initiatives in place to reduce the energy footprint of products'	.2869	**.7758**	.2527	.0957	.0417	.0773
The company adopts Environmental product innovation policy/initiative on eco-design	.1249	**.7548**	.0716	.0417	.1280	.2420
The company adopts Environmental product innovation policy/initiative on life-cycle assessment	.2258	**.7114**	.3490	.0615	.0529	.0684
The company adopts Environmental product innovation policy/initiative on dematerialization	.2952	**.6613**	.2592	.0103	.0144	.1652
The company reports new production techniques to improve the global environmental impact during the production process	.1940	**.7221**	.2207	.0353	.1133	.1459
Water *(α=.7492; mean=.04268; sd=.1421)*						
The company applies wastewater treatment and purification plant	.1805	.2482	**.8883**	.0509	.1269	.1065
The company applies rainwater treatment and purification plan	.1073	.1619	**.7644**	.1214	.0571	.2039
The company reports the percentage of water use	.2889	.3311	**.8162**	.0673	.0662	.0096
The company reports quantitative information (such as graphics, tables) that supports the declarations made on WATER management	.3827	.2547	**.8006**	.0819	.0862	.1035
The company reports quantitative information (such as graphics, tables) that supports the declarations made on WASTE management	.4347	.3710	**.6366**	.0828	.0210	.1944
Environmental certification (α=.6065; mean=.1079; sd=.1707)						
Certification ISO14001	.0254	.0138	.1465	**.8633**	.0821	.1625
Certification EMAS	.0305	.1307	.0177	**.7556**	.2655	.0303
Certification ISO50001	.0870	.0160	.0428	**.7686**	.0261	.1405
Certification Ecolabels	.1212	.0646	.0258	**.5966**	.2461	.0024
Certification LEED	.2867	.1534	.2099	**.6817**	.2457	.3170
Certification OHSAS18001	.0301	.0346	.0823	**.8394**	.0436	.0757
Social certification (α=.5301; mean=.05225; sd=.1583)						
Certification IFS	.0513	.0363	.0192	.0209	**.9012**	.0634
Certification ISO22005	.0105	.0402	.1066	.0947	**.8787**	.0929
Certification ISO22000	.0026	.0242	.0813	.2672	**.7934**	.0159
Energy (α=.3726; mean=.0725; sd=.1701)						
The company uses solar panels	.1597	.3836	.1748	.1025	.0108	**.6774**
The company uses energy-saving light bulbs	.3119	.3212	.3496	.0563	.0947	**.5903**
The company has built an outer coat	.0518	.0936	.1621	.1522	.3513	**.7949**

Table 4
Sargent (2013), *Operational validity classification.*

Decision approach	*Observable system*	*Non-observable system*
Subjective approach	- Comparison using graphical displays - Explore model behaviour	- Explore model behaviour - Comparison to other models
Objective approach	- Comparison using statistical tests and procedures	- Comparison to other models using statistical tests

Table 5
Different combinations of inputs and outputs.

		Outputs level		
		Lower	Equal	Higher
Inputs level	Lower	2.a	4.a	3.a
	Equal	1.b		1.a
	Higher	3.b	4.b	2.b

We thoroughly analysed the results from the OA, SOC, and ENV DEA models for each industry. We compared the DEA commitment scores and input and output levels of different companies. Our assessment of the six industries found no examples that could discredit the four previously discussed conditions. On the contrary, we found several examples that confirm the models' ability to account for such situations at the industry level properly.

Regarding the ENV DEA model, Table 6 presents examples from various industries, showcasing the four input/output combinations outlined in Table 5.

In situation 1, companies A and B have very similar inputs, but company A has significantly higher output levels, resulting in a DEA commitment score of 80.1 compared to 55.6 for company B. In situation 2, company D has higher input levels than company C, but it also generates greater output levels, resulting in a DEA commitment score of 73.4 versus 69.5 for company C. However, company D's DEA commitment score is lower than company E's, despite company E having lower inputs and outputs (73.4 vs. 84.4).

The examples show that when a company has higher inputs and outputs than a competitor, the DEA commitment score can be either lower or higher, depending on the differences among the various inputs and outputs. For instance, in situation 3, companies F and G demonstrate that when a company has lower levels of inputs and higher levels of outputs (F), the DEA commitment score is greater than the competitor's score (83.3 vs 57.6 in the given example). In situation 4, two companies (H and I) are able to generate very similar output levels using different input levels. As expected, the company with lower input levels (H) obtains a higher DEA commitment score (67.7 vs 54.8). Similar results were obtained from the OA and SOC DEA analyses.

The second aspect we investigated to validate our models was the percentage of fully efficient DMUs for each model. A percentage of efficient DMUs greater than 15–20 % is usually associated with a poorly developed model or a very small sample. As seen in Table 7, the percentage of efficient DMUs ranges from 0.5 % to 12 % in the ENV and SOC DEA models, while the percentages are much higher for the OA DEA model, reaching 46 % for the chemical industry.

The high percentage of efficient DMUs for the OA DEA models warrants further investigation. While focusing on an overall score may seem appealing, especially from a practitioner's perspective, a more thorough analysis of the results exposes the risk of being misled. This is because achieving the same efficient overall score could result from vastly different behaviours in terms of environmental and social commitment.

This is highlighted by Fig. 2, which reports the *ENV* and *SOC DEA* scores separately for all the 240 DMUs highlighted as efficient by the six *OA DEA* models.

It is evident that companies with high environmental and low social scores and companies with high social and environmental scores can be considered fully efficient according to the OA models. Additionally, some underperforming DMUs may appear fully efficient, such as the orange-coloured DMU in Fig. 2, which has relatively low ENV DEA and SOC DEA scores compared to the other efficient units.

Considering all this, measuring the overall commitment to sustainability could be restrictive and misleading. A more reliable understanding of companies' real commitment can only be gained by using separate DEA models for social and environmental sustainability.

4.2. *The results of the social and environmental DEA models*

Fig. 3 reports the distribution of ENV and SOC DEA commitment scores, calculated separately for each industry through 12 NIRS models.

The scores for environmental and social commitment display different distributions. In the case of ENV DEA (Fig. 3.a), 10.3 % of the DMUs have a score higher than 95. The minimum and mean values are 34.4 and 74.4, respectively, with a standard deviation 13. The distribution is negatively skewed.

In contrast, regarding SOC DEA (Fig. 3.b), 63.2 % of the DMUs exhibit a commitment score below 30.1. The lowest and average values are 2.1 and 36, respectively, with a standard deviation of 23.4, and a positive distribution.

To provide more information, we illustrate the ENV and SOC DEA using a 2×2 matrix that displays the social commitment score on the vertical axis and the environmental commitment score on the horizontal axis (see Fig. 4). With both axes having a maximum value of 100 and requiring a unique value, we have designated 50 as the threshold between low and high values. This allows for the identification of four quadrants representing different sustainability commitment levels.

- The "High" quadrant, where both the scores are high;
- The "Environmental" quadrant, characterised by companies with high environmental commitment but low social commitment;
- The "Social" quadrant, where companies' environmental commitment is low, but the social one is high;
- The "Low" quadrant, where both the environmental and social commitment scores are low.

The descriptive statistics by quadrant are reported in Table 8.

In the analysis, we found that 19.2 % of the companies fall into the "High" quadrant, while the majority, accounting for 77.5 % of the companies, belong to the "Environmental" quadrant. Only 3.3 % of the companies are in the "Social" quadrant, and none are in the "Low" quadrant. Hence, within the sample, we found no companies that exhibit low social and environmental aptitude simultaneously.

4.3. *Analysis by size*

The ENV and SOC DEA commitment scores were analysed in relation to the size of the companies. As mentioned in Section 2, the new index is expected to be more effective in representing the commitment of small companies to sustainability. It considers the limited resources available

Table 6
Examples of comparisons between different companies to validate the ENV DEA commitment score.

Industry short reference	Situation	DMU	Total assets (Log)	Operating cost (Log)	Environmental certifications (standardized)	Production (standardized)	Water (standardized)	Energy (standardized)	DEA commitment score
Chemical	**1.a**	A	17.36	17.66	0.19	0.24	0.33	0.37	**80.1**
	1.b	B	17.34	17.60	0.23	0.14	0.19	0.29	**55.6**
Metal products	**2.a**	C	18.90	18.88	0.15	0.17	0.25	0.31	**69.5**
	2.b	D	19.24	19.44	0.19	0.24	0.33	0.37	**73.4**
Metal products	**2.a**	E	18.41	17.66	0.11	0.14	0.22	0.30	**84.4**
	2.b	D	19.24	19.44	0.19	0.24	0.33	0.37	**73.4**
Food products	**3.a**	F	18.90	18.64	0.47	0.28	0.58	0.17	**83.3**
	3.b	G	19.57	19.69	0.61	0.11	0.48	0.15	**57.6**
Machinery and equipment nec	**4.a**	H	18.25	17.68	0.09	0.13	0.26	0.26	**67.7**
	4.b	I	18.74	18.44	0.13	0.13	0.26	0.28	**54.8**

Table 7
Percentage of fully efficient DMUs by industry and sustainability dimension (social and environmental).

	Nace Rev. 2 Code and short reference					
	10 - Food products	20 - Chemical	24 - Basic metals	25 - Metal products	28 - Machinery and equipment nec	29 - Motor vehicles and trailers
Overall DEA	12.6 %	46.4 %	12.9 %	13.9 %	14.1 %	16.9 %
Environmental DEA	4.1 %	9.8 %	7.7 %	6.9 %	6.0 %	12.0 %
Social DEA	1.3 %	2.9 %	3.5 %	0.7 %	1.4 %	0.5 %

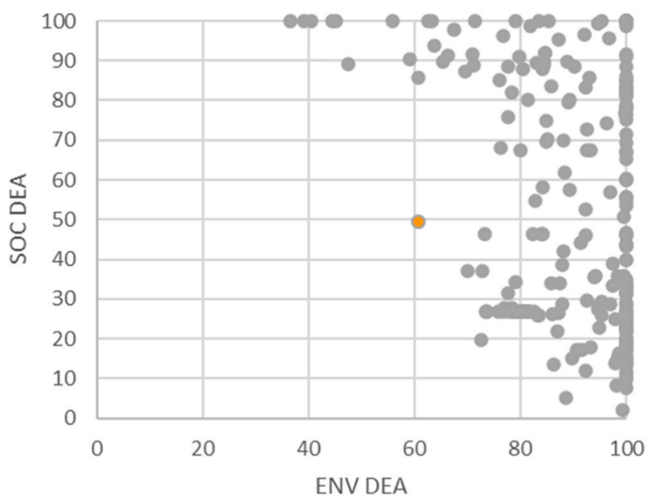

Fig. 2. Benchmarking of the 240 efficient DMUs as measured through the OA DEA models.

to promote sustainability-related processes in these companies.

We divided the dataset into three subsets: "Micro and Small", "Medium", and "Large" Enterprises, according to the current European definition. Table 9 presents a descriptive summary of ENV and SOC DEA, along with the mean aptitude score, standard deviation, and minimum score based on company size.

When comparing environmental and social commitments, we observe different results and patterns. The average ENV DEA commitment scores for medium and large companies are below 80 (76.3 and 72.8, respectively), while the micro and small companies exhibit a higher average score of 91.2. On the other hand, the SOC DEA scores show an opposite pattern: the average score increases from 26.9 for micro and small companies to 42.0 for large companies. Additionally, the standard deviation of SOC DEA is greater than ENV DEA's (11.7 compared to 7.7 for micro and small companies, 19.2 compared to 9.9 for medium companies, and 26.2 compared to 14.0 for large companies).

The adapted Li test (Simar and Zelenyuk, 2006) is significant for both the *ENV DEA* and the *SOC DEA,* as summarised in Table 10.

5. Discussion

This study offers valuable insights into incorporating sustainability measurement into the SDGs framework using a DEA-based approach. In terms of novelty, this study is pioneering in using DEA to measure sustainability commitment by evaluating the inputs and processes rather than merely the outcomes. This approach provides a more comprehensive and actionable understanding of how resources are translated into sustainability practices, a significant advancement over traditional outcome-focused metrics. Moreover, developing a standardised metric facilitates cross-company and cross-industry comparisons, which has been a notable gap in sustainability research. The aim is to align corporate sustainability practices with global sustainability objectives.

When striving to develop a measure for assessing a company's commitment to environmental and social sustainability, we applied Sargent's (2013) validation approach and realised that trying to create a single measure for overall sustainability commitment can be inappropriate. The results suggest that the environmental and social aspects of sustainability should be assessed separately to highlight their relative contributions, but they can still be jointly represented in a matrix to capture the complexities of a firm's sustainability-oriented behaviour.

This aligns with the multifaceted nature of sustainability framed by the SDGs, encompassing a wide range of sustainability aspects from environmental conservation to social equity, thus requiring a more complex approach, able to overcome sector-specific tools and indices (Suárez Giri and Sánchez Chaparro, 2023).

The need to separate environmental and social sustainability stems from the fact that their implementation processes at the firm level are inherently different. Environmental sustainability often involves technological solutions aligned with goals such as SDG 7, "Affordable and Clean Energy", and SDG 9 "Industry, Innovation, and Infrastructure". On the other hand, the social aspect is more closely linked to management practices, illustrated by SDG 3 "Good Health and Well-being" and SDG 8 "Decent Work and Economic Growth." Examining this framework to understand sustainability processes shows that the two dimensions result in different sub-processes to measure their outcomes. Additionally, regulatory pressures have impacted the two dimensions differently, with varied timing and reflecting distinct stakeholder expectations, leading to uneven responses.

The second contribution concerns the consistent evaluations between SMEs and large organisations, an extremely important topic considering recent literature focused on CSR engagement of SMEs (Spence, 2016; Wickert et al., 2016) and the ongoing academic conversation about the role of businesses in sustainable development.

Innovatively, the commitment of SMEs to sustainability-related issues is evaluated by considering available resources as relevant inputs of the processes rather than focusing solely on outputs (Engida et al., 2018). This sheds new light on the commitment of SMEs to sustainability-related issues. Previous research largely excluded SMEs from analysing sustainability-related behaviours (Ormazabal et al., 2018). When SMEs were included, they exhibited lower involvement and outcomes (Brammer et al., 2012). Our findings support more recent research, which suggests a more complex and fragmented view of the topic. Some SMEs demonstrate relatively higher attention to sustainability-related issues (Ortiz-Avram et al., 2018; Soundararajan et al., 2018). This challenges the traditional view that smaller firms are less engaged in sustainability due to resource constraints and highlights their potential to contribute meaningfully to the SDGs (Surman and Bőcskei, 2023).

The presence of stricter regulations, institutional conformity, and the need for legitimacy seems to push all companies to develop a strong commitment to environmental sustainability, regardless of size. However, SMEs are more committed to environmental sustainability than large companies. In fact, micro and small companies exhibit the highest environmental commitment despite having fewer resources. They take various actions driven by internal motivators such as organisational culture, reputation, competitive advantage, and strategic intent (Del Río Gonzàles, 2005). On the other hand, the social aspect of sustainability has only recently gained attention (Sroufe and Gopalakrishna-Remani, 2019), which is likely why the largest companies show the highest levels of social commitment. It is reasonable to assume that the conformity process has not yet occurred in this aspect.

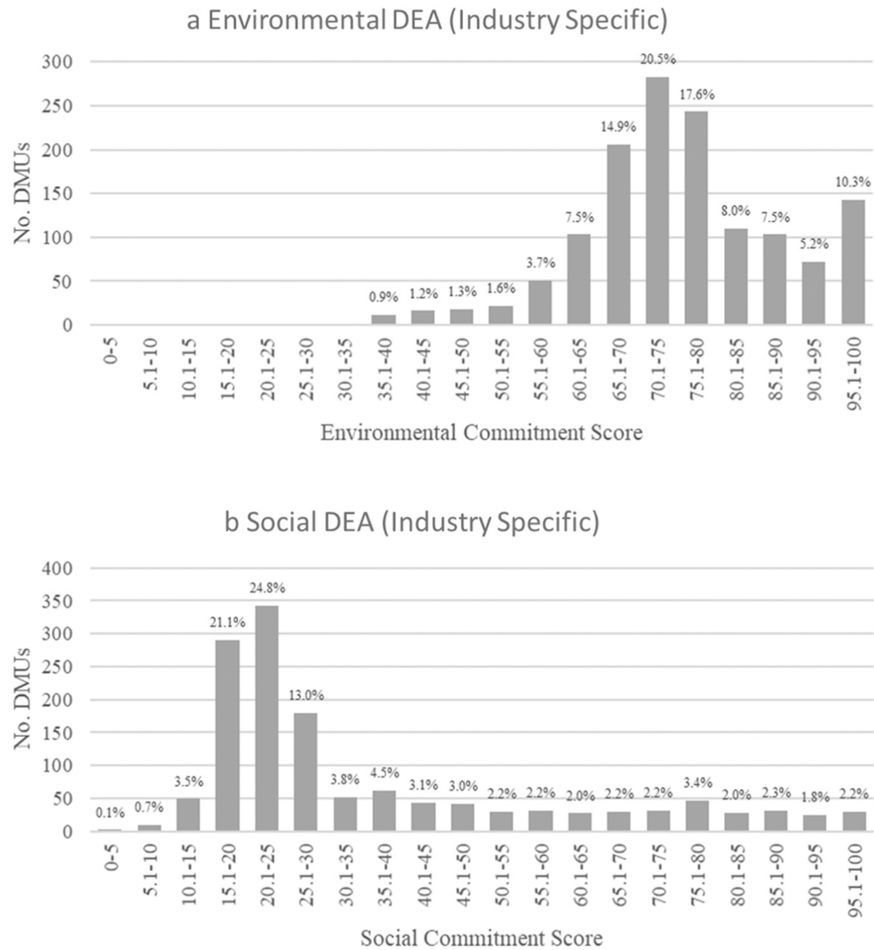

Fig. 3. Summary of the ENV (3.a) and SOC (3.b) DEA Commitment Score distribution obtained by the NIRS DEA models.

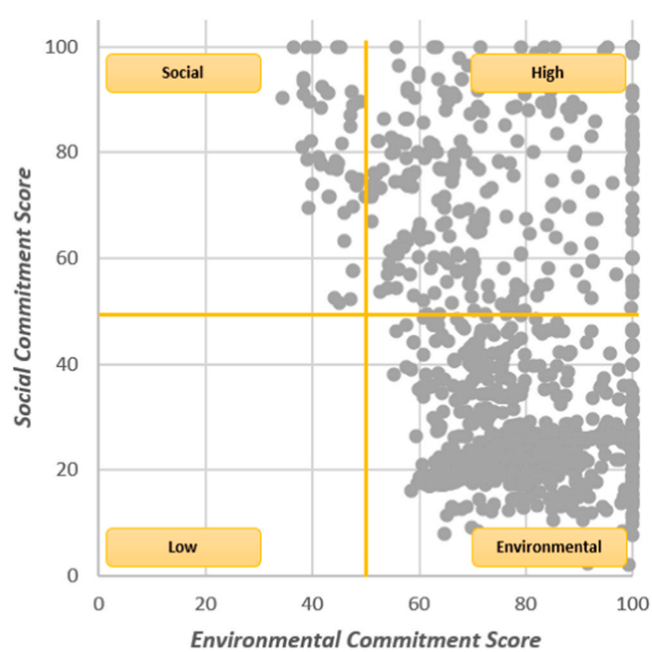

Fig. 4. The matrix reporting the ENV and SOC DEA Commitment Score for each DMU.

Table 8
Descriptive statistics by quadrant.

Quadrant	No. DMU	DMU %	ENV DEA (mean)	SOC DEA (mean)
High	265	19.2 %	**74.4**	**74.4**
Environmental	1071	77.5 %	**77.5**	**24.6**
Social	46	3.3 %	**43.4**	**80.2**
Low	0	0.0 %		

Table 9
Descriptive statistics related to the ENV and SOC DEA Commitment Score by company size.

		Environmental DEA			Social DEA		
Company size	No. DMUs	mean	st. dev.	min	mean	st. dev.	min
Micro and Small	**111**	91.2	7.7	62.6	26.9	11.7	10.4
Medium	**580**	76.3	9.9	39.4	30.6	19.2	7.1
Large	**691**	72.8	14.0	34.4	42.0	26.2	2.1

Our findings confirm what Surman and Bőcskei (2023) reported for Hungarian companies. In a relatively new context with a lack of specific regulations, companies with greater resources are more likely to be more committed to developing social initiatives (Bansal, 2005). However, this should not be taken as evidence that SMEs have little interest in social practices. While large companies seek social legitimacy by meeting expectations, standards, and guidelines (e.g., from sustainability rating agencies; Chatterji and Toffel, 2010), small companies tend to be more

Table 10
The adapted Li test for equality of distributions of ENV and SOC DEA efficiency scores by company size.

	DEA Model	The Li test statistics	Bootstrap p-value	Decision (at 5 % level of significance)
Large *vs* Medium	ENV DEA	31.72	0.000	Reject H_0
Large *vs* Micro and Small	ENV DEA	39.02	0.000	Reject H_0
Medium *vs* Micro and Small	ENV DEA	48.66	0.000	Reject H_0
Large *vs* Medium	SOC DEA	38.05	0.000	Reject H_0
Large *vs* Micro and Small	SOC DEA	45.84	0.000	Reject H_0
Medium *vs* Micro and Small	SOC DEA	41.78	0.000	Reject H_0

Note - H_o: The densities of estimated efficiency scores of the two cluster of companies are equal.

involved in actions that benefit their local communities (Wickert et al., 2016). These actions are not easily captured by a measurement framework (Lawrence et al., 2006). This study contributes to the literature by highlighting that SMEs, despite their resource constraints, can exhibit significant sustainability commitment, particularly in environmental practices. This challenges the prevailing notion that sustainability is primarily a concern for larger firms and underscores the potential of SMEs to play a crucial role in achieving the SDGs. Our findings provide empirical support for more inclusive sustainability policies that consider the unique contributions of SMEs.

Thirdly, while the vast majority of previous DEA applications focused only on environmental sustainability (Ait Sidhoum et al., 2020; Kapelko et al., 2021), we provide a contribution to the relatively recent stream of research on CSR aimed at jointly evaluating environmental and social sustainability (Chambers and Serra, 2018; Aparicio and Kapelko, 2019). Unlike previous models, our research focuses on the concept of commitment, develops innovative measures for evaluating sustainability practices instead of outcomes and shows the potential of decoupling the indicators instead of including environmental and social indicators in a single DEA model. The ENV DEA and SOC DEA model results support the proposed indexes' effectiveness and are consistent with the main literature on environmental and social sustainability. In general, all the companies showed a significant commitment to at least one of the two dimensions, but there was a much higher and more consistent level of environmental commitment compared to the social aspect. These results are partly due to the differing levels of regulations related to these two dimensions. On the one hand, advances in environmental policies have gained a foothold in companies' awareness and have triggered institutional isomorphism among enterprises (Di Maggio and Powell, 1983), even though explicit sanctions are required to overcome possible opportunistic behaviour and boost sustainability performance (King and Lenox, 2000). As regulations are expected to become more stringent, companies are encouraged to be proactive in order to avoid falling behind in the near future, both in terms of regulations and stakeholders (Aguilera et al., 2006; Bansal, 2005). Alongside these considerations, a strong motivation for a company's commitment (Thomas and Lamm, 2012) is the pursuit of legitimacy (Suchman, 1995), which is essential for reputation and the company's identity (Rao, 1994). Our findings indicate that social pressures (following the institutional approach; Wright and Rwabizambuga, 2006) and strategic approaches (according to the strategic approach; Esty and Winston, 2009) lead to a greater focus on the environmental aspect of sustainability rather than the social aspect. This shift in practice is reflected in the literature, which has also shown a much higher focus on the environmental side of sustainability (Antolín-López et al., 2016; Delmas and Blass, 2010).

5.1. Policy implications

The study we developed has several implications for policy-makers, especially within the context of the 2030 Agenda Framework. Using a DEA-based measure to assess sustainability commitments, the study promotes the incorporation of SDGs into corporate strategies and reporting. This encourages businesses to play an active role in advancing global sustainability goals.

First, our study adds to the growing need for standardised sustainability metrics that can be used across different industries and company sizes. From a policymaker's point of view, this standardisation is essential for comparing and evaluating sustainability commitment in terms of applied practices, making it easier to create consistent incentivising mechanisms geared toward addressing global challenges. Our findings can help policymakers understand the effectiveness of current sustainability policies and identify areas that need more attention. The data-driven approach of DEA provides empirical evidence that can steer policy adjustments and the creation of new regulations to support corporate sustainability initiatives better.

The proposed DEA-based measure aligns with reporting requirements from a company's perspective, especially in relation to upcoming regulations like the recently implemented CSRD at the European level (Directive (EU) 2022/2464 3). This measure offers a structured approach to assess and report on sustainability practices, which can help companies more effectively meet the CSRD requirements.

Second, the study highlights the significant role of SMEs in achieving SDGs. Given that SMEs represent a large portion of the global economy, mapping the efficiency of the translation of resources into sustainability practices may support the development of targeted policies to leverage their contribution towards global goals.

Third, the proposed measure aims to address the issue of companies selectively disclosing information favouring their public image. It seeks to provide a more holistic and accurate assessment of sustainability commitments, preventing the "cherry-picking" of SDGs and ensuring transparent reporting. Under the CSRD framework and general sustainability reporting regulations, operationalising commitment can help develop assurance mechanisms to support policy-makers. This is particularly relevant as regulations become more stringent, pushing companies towards greater transparency and accountability in their sustainability reporting.

6. Conclusion, limitations and future avenues of research

The main goal of this study was to create a way to measure companies' dedication to sustainability within the framework of the 2030 Agenda. This was achieved by examining the sustainability-driven activities carried out by 1411 Italian companies. To do this, we used a DEA-based approach and conducted an EFA to develop a set of indicators for evaluating the processes implemented by the companies. These processes were linked to a subset of SDGs and considered inputs and outputs in the DEA model, along with financial data related to the available resources.

Finally, we have developed three different models (OA DEA model, ENV DEA, and SOC DEA) applied to six different industries. These models respond to the need for approaches that can measure sustainability using limited indicators (Roca and Searcy, 2012) across various industrial sectors and different company sizes while still accounting for their specificities. To sum up, assessing the dedication of Italian SMEs to sustainability within the SDG framework offers a comprehensive and practical method for promoting sustainable business practices and bolstering the vital role of businesses in tackling the global challenges outlined in the 2030 Agenda.

Our study has some limitations related to the input data type, the indicators' composition, and the ratio between the inputs and outputs in the DEA model. The dataset is based on information companies provide, which could be influenced by strategic or selective disclosure (Haffar and Searcy, 2018) and organisational facades (Abrahamson and Baumard, 2008) that are used to meet the expectations of different stakeholder groups. In future studies, different data sources or collection methods could be evaluated, and regions with lower revenues analysed. Indeed, the developed model and the obtained results might not be generalizable to companies operating in lower-income contexts, where the operational, social, and political environment is significantly different (Mura et al., 2023). Furthermore, future research could expand on our findings by focusing on the effectiveness of sustainability practices, exploring the concept of mean-ends decoupling (Bromley and Powell, 2012; Wijen, 2014), and considering the SDGs framework as it becomes more established, including among SMEs. Also, the original measurement framework focuses more on environment-related KPIs rather than social ones. It's suggested that future research could develop an equal number of indicators for both aspects of sustainability.

Finally, it should be remembered that this is the first paper analysing the commitment to sustainability, adopting a traditional DEA model, the most commonly applied in sustainability literature according to Zhou et al. (2018). Regarding this aspect, it is important to note that the DEA model has an inherent inconsistency as it applies an unusual set of weights to a range of inputs and outputs, potentially overvaluing the efficiency score of a single DMU. Future studies could consider using a common set of weights to address this technical issue. Furthermore, future studies could focus on technical advances in line with the evolution of other sustainability-related performance metrics. For example, intertemporal DEA using the Malmquist Index could be employed to handle time series data (Graham, 2009) to separate the general variation in commitment due to increased awareness and adherence to the SDGs from the specific extra commitment of each individual company. Additionally, a two-stage framework for evaluating contextual factors could be considered to explore the main drivers of commitment. First, it obtains efficiency scores through DEA analysis and then correlates these scores with various contextual factors through a series of statistical regression analyses.

CRediT authorship contribution statement

Sara Zanni: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Filippo Boccali:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Formal analysis. **Franco Visani:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Matteo Mura:** Writing – original draft, Supervision, Project administration, Methodology, Data curation, Conceptualization. **Mariolina Longo:** Writing – original draft, Supervision, Project administration, Data curation, Conceptualization.

Declaration of Competing 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.

Data Availability

Data will be made available on request.

References

Abdul-Rashid, S.H., Sakundarini, N., Ghazilla, R.A.R., Thurasamy, R., 2017. The impact of sustainable manufacturing practices on sustainability performance: empirical evidence from Malaysia. Int. J. Oper. Prod. Manag. https://doi.org/10.1108/IJOPM-04-2015-0223.

Abrahamson, E., Baumard, P., 2008. What lies behind organizational façades and how organizational façades lie: An untold story of organizational decision making. Oxf. Handb. Organ. Decis. Mak. *437-452* https://doi.org/10.1093/oxfordhb/9780199290468.003.0023.

Aguilera, R.V., Williams, C.A., Conley, J.M., Rupp, D.E., 2006. Corporate governance and social responsibility: a comparative analysis of the UK and the US. Corp. Gov.: Int. Rev. *14* (*3*), 147–158. https://doi.org/10.1111/j.1467-8683.2006.00495.x.

Ahmadi-Gh, Z., Bello-Pintado, A., 2022. Why is manufacturing not more sustainable? The effects of different sustainability practices on sustainability outcomes and competitive advantage. J. Clean. Prod. *337*, 130392 https://doi.org/10.1016/j.jclepro.2022.130392.

Ait Sidhoum, A., Serra, T., Latruffe, L., 2020. Measuring sustainability efficiency at farm level: a data envelopment analysis approach. Eur. Rev. Agric. Econ. *47* (*1*), *200–225*. https://doi.org/10.1093/erae/jbz015.

Alexander, A., Blome, C., Schleper, M.C., Roscoe, S., 2022. Managing the "new normal": the future of operations and supply chain management in unprecedented times. Int. J. Oper. Prod. Manag. *42* (*8*), 1061–1076. https://doi.org/10.1108/IJOPM-06-2022-0367.

Antolín-López, R., Delgado-Ceballos, J., Montiel, I., 2016. Deconstructing corporate sustainability: a comparison of different stakeholder metrics. J. Clean. Prod. *136*, 5–17. https://doi.org/10.1016/j.jclepro.2016.01.111.

Aparicio, J., Kapelko, M., 2019. Enhancing the measurement of composite indicators of corporate social performance. Soc. Indic. Res. *144*, 807–826. https://doi.org/10.1007/s11205-018-02052-1.

Aparicio, J., Kapelko, M., Ortiz, L., 2023. Enhancing the measurement of firm inefficiency accounting for corporate social responsibility: a dynamic data envelopment analysis fuzzy approach. Eur. J. Oper. Res. *306* (*2*), 986–997. https://doi.org/10.1016/j.ejor.2022.09.003.

Avkiran, N.K., 2015. An illustration of dynamic network DEA in commercial banking including robustness tests. Omega *55*, 141–150. https://doi.org/10.1016/j.omega.2014.07.002.

Banker, R.D., Chang, H., 2006. The super-efficiency procedure for outlier identification, not for ranking efficient units. Eur. J. Oper. Res. *175* (*2*), 1311–1320. https://doi.org/10.1016/j.ejor.2005.06.028.

Banker, R.D., Chang, H., Zheng, Z., 2017. On the use of super-efficiency procedures for ranking efficient units and identifying outliers. Ann. Oper. Res. *250* (*1*), 21–35. https://doi.org/10.1007/s10479-015-1980-8.

Banker, R.D., Charnes, A., Cooper, W.W., 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. Manag. Sci. *30* (*9*), 1078–1092. https://doi.org/10.1287/mnsc.30.9.1078.

Bansal, P., 2005. Evolving sustainably: A longitudinal study of corporate sustainable development. Strateg. Manag. J. *26* (*3*), 197–218. https://doi.org/10.1002/smj.441.

Berrone, P., Ricart, J.E., Duch, A.I., Bernardo, V., Salvador, J., Piedra Peña, J., Rodríguez Planas, M., 2019. EASIER: An evaluation model for public–private partnerships contributing to the sustainable development goals. Sustainability *11* (*8*), 2339. https://doi.org/10.3390/su11082339.

Bollen, K.A., 1989. A new incremental fit index for general structural equation models. Sociol. Methods Res. *17* (*3*), 303–316. https://doi.org/10.1177/0049124189017003004.

Borges, F.M.M.G., Rampasso, I.S., Quelhas, O.L.G., Filho, W.L., Anholon, R., 2022. Addressing the UN SDGs in sustainability reports: an analysis of latin American oil and gas companies. Environ. Chall. *7*, 100515 https://doi.org/10.1016/j.envc.2022.100515.

Brammer, S., Hoejmose, S., Marchant, K., 2012. Environmental management in SME s in the UK: practices, pressures and perceived benefits. Bus. Strategy Environ. *21* (*7*), 423–434. https://doi.org/10.1002/bse.717.

Bromley, P., Powell, W., 2012. From smoke and mirrors to walking the talk: decoupling in the temporary world. Acad. Manag. Ann. *6*, 483–530. https://doi.org/10.5465/19416520.2012.684462.

Buallay, A., 2020. Sustainability reporting and firm's performance: comparative study between manufacturing and banking sectors. Int. J. Product. Perform. Manag. *69* (*3*), 431–445. https://doi.org/10.1108/IJPPM-10-2018-0371.

Cassells, S., Lewis, K., 2011. SMEs and environmental responsibility: do actions reflect attitudes? Corp. Soc. Responsib. Environ. Manag. *18* (*3*), 186–199. https://doi.org/10.1002/csr.269.

Castro, G.D.R., Fernández, M.C.G., Colsa, Á.U., 2021. Unleashing the convergence amid digitalization and sustainability towards pursuing the Sustainable Development Goals (SDGs): a holistic review. J. Clean. Prod. *280* https://doi.org/10.1016/j.jclepro.2020.122204.

Chambers, R.G., Serra, T., 2018. The social dimension of firm performance: a data envelopment approach. Empir. Econ. *54*, 189–206. https://doi.org/10.1007/s00181-016-1135-z.

Charnes, A., Cooper, W.W., Rhodes, E., 1978. Measuring the efficiency of decision making units. Eur. J. Oper. Res. *2* (*6*), 429–444. https://doi.org/10.1016/0377-2217(78)90138-8.

Charnes, A., Cooper, W.W., Rhodes, E., 1981. Evaluating program and managerial efficiency: an application of data envelopment analysis to program follow through. Manag. Sci. *27* (*6*), 668–697. https://doi.org/10.1287/mnsc.27.6.668.

Chatterji, A.K., Toffel, M.W., 2010. How firms respond to being rated. Strateg. Manag. J. *31* (*9*), 917–945. https://doi.org/10.1002/smj.840.

Chen, C.M., Delmas, M., 2011. Measuring corporate social performance: an efficiency perspective. Prod. Oper. Manag. *20* (*6*), 789–804. https://doi.org/10.1111/j.1937-5956.2010.01202.x.

Choi, Y., Zhang, N., Zhou, P., 2012. Efficiency and abatement costs of energy-related CO2 emissions in China: A slacks-based efficiency measure. Appl. Energy *98*, 198–208. https://doi.org/10.1016/j.apenergy.2012.03.024.

Consolandi, C., Phadke, H., Hawley, J., Eccles, R.G., 2020. Material ESG outcomes and SDG externalities: evaluating the health care sector's contribution to the SDGs. Organ. Environ. *33* (*4*), 511–533. https://doi.org/10.1177/1086026619899795.

de Abreu, M.C.S., Webb, K., Araújo, F.S.M., Cavalcante, J.P.L., 2021. From "business as usual" to tackling climate change: exploring factors affecting low-carbon decision-making in the canadian oil and gas sector. Energy Policy 148, 111932. https://doi.org/10.1016/j.enpol.2020.111932.

de Castro Camioto, F., Mariano, E.B., do Nascimento Rebelatto, D.A., 2014. Efficiency in Brazil's industrial sectors in terms of energy and sustainable development. Environ. Sci. Policy *37*, 50–60. https://doi.org/10.1016/j.envsci.2013.08.007.

Del Río González, P., 2005. Analysing the factors influencing clean technology adoption: a study of the Spanish pulp and paper industry. Bus. Strategy Environ. *14* (*1*), 20–37. https://doi.org/10.1002/bse.426.

Delmas, M., Blass, V.D., 2010. Measuring corporate environmental performance: the trade-offs of sustainability ratings. Bus. Strategy Environ. *19* (*4*), 245–260. https://doi.org/10.1002/bse.676.

Delmas, M.A., Etzion, D., Nairn-Birch, N., 2013. Triangulating environmental performance: What do corporate social responsibility ratings really capture? Acad. Manag. Perspect. *27* (*3*), 255–267. https://doi.org/10.5465/amp.2012.0123.

Desa, U.N., 2018. The sustainable development goals report 2018. United Nations.

Di Maggio, P.J., Powell, W.W., 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. Am. Sociol. Rev. 147–160. https://doi.org/10.2307/2095101.

Diaz-Sarachaga, J.M., 2021. Shortcomings in reporting contributions towards the sustainable development goals. Corp. Soc. Responsib. Environ. Manag. *28*, 1299–1312. https://doi.org/10.1002/csr.2129.

Dinçer, H., Yüksel, S., Hacioglu, U., Yilmaz, M., Delen, D., 2023. Development of a sustainable corporate social responsibility index for performance evaluation of the energy industry: a hybrid decision-making methodology. Resour. Policy *85*, 103940. https://doi.org/10.1016/j.resourpol.2023.103940.

Edwards, J.H., Edwards, A.W.F., 1984. Approximating the tetrachoric correlation coefficient. Biometrics *40*, 563.

Engida, T.G., Rao, X., Berentsen, P.B., Lansink, A.G.O., 2018. Measuring corporate sustainability performance-the case of European food and beverage companies. J. Clean. Prod. *195*, 734–743. https://doi.org/10.1016/j.jclepro.2018.05.095.

Esty, D.C., & Winston, A. (2009). Green to gold: How smart companies use environmental strategy to innovate, create value, and build competitive advantage. *John Wiley & Sons.*

Ferrero-Ferrero, I., Muñoz-Torres, M.J., Rivera-Lirio, J.M., Escrig-Olmedo, E., Fernández-Izquierdo, M.Á., 2023. SDG reporting: an analysis of corporate sustainability leaders. Mark. Intell. Plan. *41* (*4*), 457–472. https://doi.org/10.1108/MIP-07-2022-0332.

Geerts, G.L., 2011. A design science research methodology and its application to accounting information systems research. Int. J. Account. Inf. Syst. *12* (*2*), 142–151. https://doi.org/10.1016/j.accinf.2011.02.004.

Giannetti, B.F., Sevegnani, F., García, R.R.M., Agostinho, F., Almeida, C.M.V.B., Coscieme, L., Liu, G., Lombardi, G.V., 2022. Enhancing the assessment of cleaner production practices for sustainable development: the five-sector sustainability model applied to water and wastewater treatment companies. Sustainability *14* (*7*), 4126. https://doi.org/10.3390/su14074126.

Gilbert, D.U., Rasche, A., Waddock, S., 2011. Accountability in a global economy: the emergence of international accountability standards. Bus. Ethics Q. *21* (*1*), 23–44. https://doi.org/10.5840/beq20112112.

Graham, M., 2009. Developing a social perspective to farm performance analysis. Ecol. Econ. *68* (*8-9*), *2390–2398*. https://doi.org/10.1016/j.ecolecon.2009.03.013.

Haffar, M., Searcy, C., 2018. Target-setting for ecological resilience: Are companies setting environmental sustainability targets in line with planetary thresholds? Bus. Strategy Environ. *27* (*7*), 1079–1092. https://doi.org/10.1002/bse.2053.

Hatayama, H., 2022. The metals industry and the sustainable development goals: the relationship explored based on SDG reporting. Resour., Conserv. Recycl. *178*, 106081 https://doi.org/10.1016/j.resconrec.2021.106081.

Heras-Saizarbitoria, I., Urbieta, L., Boiral, O., 2022. 'Organizations' engagement with sustainable development goals: From cherry-picking to SDGwashing? Corp. Soc. Responsib. Environ. Manag. *29* (*2*), 316–328. https://doi.org/10.1002/csr.2202.

Hevner, A.R., March, S.T., Park, J., Ram, S., 2004. Design science in information systems research. MIS Q. 75–105. https://doi.org/10.2307/25148625.

Hoogendoorn, B., Guerra, D., van der Zwan, P., 2015. What drives environmental practices of SMEs? Small Bus. Econ. *44*, 759–781. https://doi.org/10.1007/s11187-014-9618-9.

Howard-Grenville, J., Nelson, A., Vough, H., Zilber, T.B., 2021. From the editors-Achieving fit and avoiding misfit in qualitative research. Academy of Management Journal 64 (5), 1313–1323.

Ilinitch, A.Y., Soderstrom, N.S., Thomas, T.E., 1998. Measuring corporate environmental performance. J. Account. Public Policy *17* (*4-5*), 383–408. https://doi.org/10.1016/S0278-4254(98)10012-1.

Jansson, J., Nilsson, J., Modig, F., Hed Vall, G., 2017. Commitment to sustainability in small and medium-sized enterprises: The influence of strategic orientations and management values. Bus. Strategy Environ. *26* (*1*), 69–83. https://doi.org/10.1002/bse.1901.

Jarosch, L., Zeung, W., Bezama, A., Finkbeiner, M., Thrän, D., 2020. A regional socio-economic life cycle assessment of a bioeconomy value chain. Sustainability *12* (*3*), 1259. https://doi.org/10.3390/su12031259.

Kapelko, M., Lansink, A.O., Stefanou, S.E., 2021. Measuring dynamic inefficiency in the presence of corporate social responsibility and input indivisibilities. Expert Syst. Appl. *176*, 114849 https://doi.org/10.1016/j.eswa.2021.114849.

Kim, J.O., & Mueller, C.W. (1978). *Factor analysis: Statistical methods and practical issues* (Vol. 14). sage. https://doi.org/10.4135/9781412984256.

King, A.A., Lenox, M.J., 2000. Industry self-regulation without sanctions: the chemical industry's responsible care program. Acad. Manag. J. *43* (*4*), 698–716. https://doi.org/10.5465/1556362.

Labonne, J., 2006. A comparative analysis of the environmental management, performance and innovation of SMEs and larger firms. Eur. Comm., Dir. -Gen. Environ., CL Cons., St. Michel Sur Orge 1–44.

Lankoski, L., 2008. Corporate responsibility activities and economic performance: a theory of why and how they are connected. Bus. Strategy Environ. *17* (*8*), 536–547. https://doi.org/10.1002/bse.582.

Lawrence, S.R., Collins, E., Pavlovich, K., Arunachalam, M., 2006. Sustainability practices of SMEs: the case of NZ. Bus. Strategy Environ. *15* (*4*), 242–257. https://doi.org/10.1002/bse.533.

Lozano, R., 2015. A holistic perspective on corporate sustainability drivers. Corp. Soc. Responsib. Environ. Manag. *22* (*1*), 32–44. https://doi.org/10.1002/csr.1325.

Luzzini, D., Brandon-Jones, E., Brandon-Jones, A., Spina, G., 2015. From sustainability commitment to performance: the role of intra-and inter-firm collaborative capabilities in the upstream supply chain. Int. J. Prod. Econ. *165*, 51–63. https://doi.org/10.1016/j.ijpe.2015.03.004.

Mallin, C., Michelon, G., & Raggi, D. (2013). Monitoring intensity and stakeholders' orientation: how does governance affect social and environmental disclosure?. *Journal of business ethics, 114(1),* 29-43. https://doi.org/10.1007/s10551-012-1324-4.

Mann, E.C., Safari, N., Oetzel, J., Dillon, S., & Williamson, A.J., (2024). Less is more? Communicating SDG orientation and enterprises' economic performance. *Journal of Business Venturing Insights, 22,* e00470. https://doi.org/10.1016/j.jbvi.2024.e00470.

Marcus, J., MacDonald, H.A., & Sulsky, L.M. (2015). Do personal values influence the propensity for sustainability actions? A policy-capturing study. Journal of Business Ethics, 127(2), 459-478. https://doi.org/10.1007/s10551-013-2032-4.

Martinuzzi, A., & Schönherr, N., (2019). Introduction: The sustainable development goals and the future of corporate sustainability. Business and the sustainable development goals, 11–17. Cham: Palgrave Pivot. https://doi.org/10.1007/978-3-030-16810-0_1.

Mura, M., Longo, M., Zanni, S., 2020. Circular economy in Italian SMEs: a multi-method study. J. Clean. Prod. *245*, 118821 https://doi.org/10.1016/j.jclepro.2019.118821.

Mura, M., Longo, M., Domingues, A.R., Zanni, S., 2019. An exploration of content and drivers of online sustainability disclosure: a study of Italian organisations. Sustainability *11* (*12*), 3422. https://doi.org/10.3390/su11123422.

Mura, M., Longo, M., Micheli, P., Bolzani, D., 2018. The evolution of sustainability measurement research. Int. J. Manag. Rev. *20* (*3*), 661–695. https://doi.org/10.1111/ijmr.12179.

Mura, M., Longo, M., Zanni, S., Toschi, L., 2023. Exploring socio-economic externalities of development scenarios. An analysis of EU regions from 2008 to 2016. J. Environ. Manag. *332*, 117327 https://doi.org/10.1016/j.jenvman.2023.117327.

Muthen, B., Christoffersson, A., 1981. Simultaneous factor analysis of dichotomous variables in several groups. Psychometrika *46* (4), 407–419. https://doi.org/10.1007/BF02293798.

Naegele, H., Zaklan, A., 2019. Does the EU ETS cause carbon leakage in European manufacturing? J. Environ. Econ. Manag. *93*, 125–147. https://doi.org/10.1016/j.jeem.2018.11.004.

O'Dwyer, B., Unerman, J., 2016. Fostering rigour in accounting for social sustainability. Account., *Organ. Soc. 49*, 32–40. 〈https://doi.org/10.1016/j.aos.2015.11.003〉.

OECD, P., 2017. Enhancing the contributions of SMEs in a global and digitalised economy. Paris. Retrieved Aug *28*, *2020*.

Ormazabal, M., Prieto-Sandoval, V., Puga-Leal, R., Jaca, C., 2018. Circular economy in Spanish SMEs: challenges and opportunities. J. Clean. Prod. *185*, 157–167. https://doi.org/10.1016/j.jclepro.2018.03.031.

Ortiz-Avram, D., Domnanovich, J., Kronenberg, C., Scholz, M., 2018. Exploring the integration of corporate social responsibility into the strategies of small-and medium-sized enterprises: a systematic literature review. J. Clean. Prod. *201*, 254–271. https://doi.org/10.1016/j.jclepro.2018.08.011.

Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S., 2007. A design science research methodology for information systems research. J. Manag. Inf. Syst. *24* (*3*), 45–77. https://doi.org/10.2753/MIS0742-1222240302.

Pizzi, S., Caputo, A., Corvino, A., Venturelli, A., 2020. Management research and the UN sustainable development goals (SDGs): a bibliometric investigation and systematic review. J. Clean. Prod. *276*, 124033 https://doi.org/10.1016/j.jclepro.2020.124033.

Prieto-Sandoval, V., Ormazabal, M., Jaca, C., Viles, E., 2018. Key elements in assessing circular economy implementation in small and medium-sized enterprises. Bus. Strategy Environ. *27* (*8*), 1525–1534. https://doi.org/10.1002/bse.2210.

Pucheta-Martínez, M.C., Gallego-Álvarez, I., 2020. Corporate environmental disclosure practices in different national contexts: the influence of cultural dimensions. Organ. Environ. *33* (4), 597–623. https://doi.org/10.1177/1086026619860263.

Quaranta, A.G., Raffoni, A., Visani, F., 2018. A multidimensional approach to measuring bank branch efficiency. Eur. J. Oper. Res. *266* (*2*), 746–760. https://doi.org/10.1016/j.ejor.2017.10.009.

Rao, H., 1994. The social construction of reputation: certification contests, legitimation, and the survival of organizations in the American automobile industry: 1895–1912. Strateg. Manag. J. *15* (*S1*), 29–44. https://doi.org/10.1002/smj.4250150904.

Roca, L.C., Searcy, C., 2012. An analysis of indicators disclosed in corporate sustainability reports. J. Clean. Prod. *20* (*1*), 103–118. https://doi.org/10.1016/j.jclepro.2011.08.002.

Sargent, R.G., 2013. Verification and validation of simulation models. J. Simul. *7* (1), 12–24. https://doi.org/10.1057/jos.2012.20.

Sarra, A., Mazzocchitti, M., Nissi, E., 2020. Optimal regulatory choices in the organization of solid waste management systems: empirical evidence and policy implications. Environ. Sci. Policy *114*, 436–444. https://doi.org/10.1016/j.envsci.2020.09.004.

Scheyvens, R., Banks, G., Hughes, E., 2016. The private sector and the SDGs: The need to move beyond "Business as Usual": The private sector and the SDGs: Moving beyond "Business-as-Usual"'. Sustain. Dev. 24 (6), 371–382. https://doi.org/10.1002/sd.1623.

Schneider, A., Meins, E., 2012. Two dimensions of corporate sustainability assessment: towards a comprehensive framework. Bus. Strategy Environ. *21* (*4*), 211–222 https://doi.org/10.1002/bse.726.

Schönherr, N., Reisch, L., Farsang, A., Martinuzzi, A., Temmes, A., & Tharani, A. (2019). Implementing Impact Measurement and Management. *Business and the sustainable development goals, pp. 113–128*. Cham: Palgrave Pivot.

Schrettle, S., Hinz, A., Scherrer-Rathje, M., Friedli, T., 2014. Turning sustainability into action: explaining firms' sustainability efforts and their impact on firm performance. Int. J. Prod. Econ. *147*, 73–84. https://doi.org/10.1016/j.ijpe.2013.02.030.

Sheng, X., Chen, L., Yuan, X., Tang, Y., Yuan, Q., Chen, R., Liu, H., 2023. Green supply chain management for a more sustainable manufacturing industry in China: a critical review. Environ., Dev. Sustain. *25* (*2*), 1151–1183. https://doi.org/10.1007/s10668-022-02109-9.

Silva, S., 2021. Corporate contributions to the sustainable development goals: an empirical analysis informed by legitimacy theory. J. Clean. Prod. *292*, 125962 https://doi.org/10.1016/j.jclepro.2021.125962.

Simar, L., Zelenyuk, V., 2006. On testing equality of distributions of technical efficiency scores. Econom. Rev. *25* (*4*), 497–522. https://doi.org/10.1080/07474930600972582.

Smith, M., Bititci, U.S., 2017. Interplay between performance measurement and management, employee engagement and performance. Int. J. Oper. Prod. Manag. https://doi.org/10.1108/IJOPM-06-2015-0313.

Soundararajan, V., Jamali, D., Spence, L.J., 2018. Small business social responsibility: a critical multilevel review, synthesis and research agenda. Int. J. Manag. Rev. *20* (*4*), 934–956. https://doi.org/10.1111/ijmr.12171.

Spence, L.J., 2016. Small business social responsibility: expanding core CSR theory. Bus. Soc. *55* (*1*), 23–55. https://doi.org/10.1177/0007650314523256.

Sroufe, R., Gopalakrishna-Remani, V., 2019. Management, social sustainability, reputation, and financial performance relationships: an empirical examination of US firms. Organ. Environ. *32* (3), 331–362. https://doi.org/10.1177/1086026618756611.

Stafford-Smith, M., Griggs, D., Gaffney, O., Ullah, F., Reyers, B., Kanie, N., O'Connell, D., 2017. Integration: the key to implementing the sustainable development goals. Sustain. Sci. *12*, 911–919. https://doi.org/10.1007/s11625-016-0383-3.

Stubblefield Loucks, E., Martens, M.L., Cho, C.H., 2010. Engaging small-and medium-sized businesses in sustainability. Sustain. Account., Manag. Policy J. *1* (*2*), 178–200. https://doi.org/10.1108/20408021011089239.

Suárez Giri, F., Sánchez Chaparro, T., 2023. Measuring business impacts on the SDGs: a systematic literature review. Sustain. Technol. Entrep. *2*, 100044 https://doi.org/10.1016/j.stae.2023.100044.

Suchman, M.C., 1995. Managing legitimacy: strategic and institutional approaches. Acad. Manag. Rev. *20* (*3*), 571–610. https://doi.org/10.5465/amr.1995.9508080331.

Surman, V., Bőcskei, E., 2023. The SDG relevance-presence map of Hungarian SMEs - The relationship between the SDGs and the three pillar model. Clean. Environ. Syst. *11*, 100144 https://doi.org/10.1016/j.cesys.2023.100144.

Taber, K.S., 2018. The use of cronbach's alpha when developing and reporting research instruments in science education. Res. Sci. Educ. *48*, 1273–1296. https://doi.org/10.1007/s11165-016-9602-2.

Thomas, T.E., Lamm, E., 2012. Legitimacy and organizational sustainability. J. Bus. Ethics 110 (2), 191–203. https://doi.org/10.1007/s10551-012-1421-4.

Tian, N., Tang, S., Che, A., Wu, P., 2020. Measuring regional transport sustainability using super-efficiency SBM-DEA with weighting preference. J. Clean. Prod. *242*, 118474 https://doi.org/10.1016/j.jclepro.2019.118474.

Tsolas, I.E., Charles, V., Gherman, T., 2020. Supporting better practice benchmarking: a DEA-ANN approach to bank branch performance assessment. Expert Syst. Appl. *160*, 113599 https://doi.org/10.1016/j.eswa.2020.113599.

Van Griethuijsen, R.A.L.F., Van Eijck, M.W., Haste, H., et al., 2015. Global patterns in students' views of science and interest in science. Res. Sci. Educ. *45*, 581–603. https://doi.org/10.1007/s11165-014-9438-6.

Van Tulder, R., Rodrigues, S.B., Mirza, H., Sexsmith, K., 2021. The UN's sustainable development goals: can multinational enterprises lead the decade of action? J. Int. Bus. Policy *4* (*1*), 1–21. https://doi.org/10.1057/s42214-020-00095-1.

Vicente-Pascual, J.A., Paradinas Márquez, M. d C., Gonzáles-Rodrigo, E., 2024. Key elements for achieving high impact and their relationship to the SDGs: analysis of BCorp-certified companies in the primary sector. Technol. Forecast. Soc. Change *201*, 123176. https://doi.org/10.1016/j.techfore.2023.123176.

Visani, F., Boccali, F., 2020. Purchasing price assessment of leverage items: a data envelopment analysis approach. Int. J. Prod. Econ. *223*, 107521 https://doi.org/10.1016/j.ijpe.2019.107521.

Wang, X., Yuen, K.F., Wong, Y.D., Li, K.X., 2019. How can the maritime industry meet Sustainable Development Goals? An analysis of sustainability reports from the social entrepreneurship perspective. Transp. Res. Part D: Transp. Environ. *78*, 102173 https://doi.org/10.1016/j.trd.2019.11.002.

Wickert, C., Scherer, A.G., Spence, L.J., 2016. Walking and talking corporate social responsibility: Implications of firm size and organizational cost. J. Manag. Stud. *53* (*7*), 1169–1196. https://doi.org/10.1111/joms.12209.

Wijen, F., 2014. Means versus ends in opaque institutional fields: trading off compliance and achievement in sustainability standard adoption. Acad. Manag. Rev. *39* (*3*), 302–323. https://doi.org/10.5465/amr.2012.0218.

Wood, D.J., 1991. Corporate social performance revisited. Acad. Manag. Rev. *16* (*4*), 691–718. https://doi.org/10.5465/amr.1991.4279616.

Wright, C., Rwabizambuga, A., 2006. Institutional pressures, corporate reputation, and voluntary codes of conduct: an examination of the equator principles. Bus. Soc. Rev. *111* (*1*), 89–117. https://doi.org/10.1111/j.1467-8594.2006.00263.x.

Zhou, H., Yang, Y., Chen, Y., Zhu, J., 2018. Data envelopment analysis application in sustainability: the origins, development and future directions. Eur. J. Oper. Res. *264* (*1*), 1–16. https://doi.org/10.1016/j.ejor.2017.06.023.