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Global trends and implications

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Business reporting of Sustainable Development Goals: Global trends and implications

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Abstract

With a reported insufficient progress toward achieving the Sustainable Development Goals (SDGs), improving knowledge on the uptake and use of SDGs within the private sector is imperative. To address this need, we examine the SDG reporting characteristics of 8500 companies using a global business and governance database. Our results show no correlation in reporting specific goals, which could impede progress toward other goals. A disconnection between corporate sustainability performances and SDG reporting is also observed, meaning companies may select and report specific SDGs arbitrarily without rooting them with actual sustainability performances. These findings question the motivation and effectiveness of current SDG reporting and call for more guidance on SDG indicator selection and performance assessment. Looking ahead, SDG communication practices are anticipated to change due to the advent of new corporate sustainability reporting regulations. We therefore call for continuous monitoring of SDG adoption, uptake, and communication in businesses.

KEYWORDS

corporate sustainability performance, ESG performance, SDG linkages, SDG-washing, sustainability reporting, Sustainable Development Goals (SDGs)

1 | BACKGROUND ON SUSTAINABLE DEVELOPMENT GOALS (SDGS) REPORTING IN COMPANIES

The United Nations (UN) introduced the 17 SDGs to enhance worldwide endeavors toward sustainable development. Private sector participation in sustainable activities is crucial for achieving the UN's 17 SDGs, especially SDG17 (Partnership for Sustainable Development) and SDG12, with particular emphasis on SDG 12.6, which calls on large transnational corporations to adopt and report on sustainable practices (UN, 2015). However, knowledge about how companies engage with the SDGs and their progress toward achieving them is sparse (Heras-Saizarbitoria et al., 2022). Given the notably insufficient progress toward the SDGs globally (Sachs et al., 2023), a comprehensive investigation into the operationalization of SDGs within corporate spheres becomes imperative to bring valuable

Abbreviations: CSR, corporate social responsibility; CSRD, Corporate Sustainability Reporting Directive; EFRAG, European Financial Reporting Advisory Group; ESG, Environmental, Social, and Governance; ESRS, European Sustainability Reporting Standards; EU, European Union; GBR, Great Britain; GRI, Global Reporting Initiative; ILO, International Labour Organization; LAC, Latin America and the Caribbean; LSEG, Longdon Stock Exchange Group; NFRD, Non-Financial Reporting Directive; SDGs, Sustainable Development Goals; SEA, Southeast Asia; SMEs, small/medium enterprises; UN, United Nations; UNGC, United Nations Global Compact; USD, U.S. dollar.

insights to decision-makers at all levels (Silva, 2021). Recent research has utilized SDG reporting as a proxy for examining a company's overall SDG integration (e.g., Heras-Saizarbitoria et al., 2022).

Incorporating the SDGs into nonfinancial statements remains a voluntary disclosure exercise globally (Pizzi et al., 2022). Gaining insights into how companies engage with and report on the SDGs on a large scale has proven challenging. Several studies (e.g., Hummel & Schlick, 2016; Silva, 2021) have used multiple theories to describe SDG reporting at the company level. The most common motivation for reporting is to maintain legitimacy by informing stakeholders how well a company's business model supports sustainability progress (Dechow, 2023; Silva, 2021). Organizational legitimacy is closely linked to stakeholder perceptions (Deegan, 2018). Therefore, there is a potential risk of manipulating information rather than influencing actual changes in corporate management and performance to maintain a more favorable presence (Silva, 2021), and the SDGs can be used in this sense (Bebbington & Unerman, 2018). This aspect has led researchers to discuss a controversial issue surrounding reporting practices: substantive versus symbolic disclosure of nonfinancial information. This refers to disclosure practices that either lead to changes in management and processes or simply maintain the organization's reputation without actually implementing changes (Silva, 2021; van der Waal & Thijssens, 2020). Studying corporate reporting on the SDGs is crucial for understanding their operationalization and mitigating the risk of misusing nonfinancial reporting, particularly after substantiating nonfinancial disclosure through Directive 2014/95/EU (Pizzi et al., 2022).

Researchers and independent organizations have examined the reporting of SDGs in companies by analyzing corporate reports and the implementation of surveys using quantitative and qualitative approaches (e.g., Erin & Bamigboye, 2021; Heras-Saizarbitoria et al., 2022). Findings from those studies have suggested that companies prioritize certain SDGs over others, with SDGs 8, 13, 12, and 3 being the most emphasized (Erin & Bamigboye, 2021; Ghosh & Rajan, 2019; Haywood & Boihang, 2020; Heras-Saizarbitoria et al., 2022). This is in line with international standard setting organizations, such as GRI (GRI et al., 2015), and practitioners (KPMG, 2020), suggesting companies to engage with the SDGs that are relevant to their business activities. This common practice could contribute to the uneven progress against the SDG framework, as evidenced by the annual Sustainable Development reports (Sachs et al., 2023). This finding emphasizes the importance of understanding potential drivers behind corporate reporting on the individual SDGs and nuanced patterns of SDG reporting. According to an Oxfam's survey, it remains a challenge to determine whether the variation in SDG prioritization is based on companies' impact on them or other specific considerations (Mhlanga et al., 2018). Statistical analyses reveal that the disclosure of the specific contribution to the SDGs could possibly be influenced by jurisdiction and institutional setting, industry sector, company size, diversity of board members, and sustainability experience as suggested by inferential analyses of the relationship between company characteristics and corporate SDG reporting (Pizzi et al., 2021; Rosati & Faria, 2019b; van der Waal & Thijssens, 2020; Zampone et al., 2024).

The variation in SDG prioritization and limited understanding of corporate practices on SDG reporting prompts concerns about the potential symbolic use of the SDGs through selecting relevant ones superficially, without an in-depth examination of their relevance (e.g., van der Waal & Thijssens, 2020). Currently, most companies communicate their favorable influence on the SDGs rather than the negative one (KPMG, 2022). This approach may raise the likelihood of engaging in SDG-washing instead of implementing significant modifications in business operations (Heras-Saizarbitoria et al., 2022; Mhlanga et al., 2018; Mio et al., 2020). According to a qualitative analysis of corporate reports conducted by van der Waal and Thijssens (2020), it appears that companies' engagement with the SDGs is mostly symbolic and intentional, rather than substantive. This observation suggests that companies may perceive the SDGs as a mere strategic tool without real commitment, which has the potential to undermine stakeholder trust in sustainability reporting. A statistical analysis conducted by Emma and Jennifer (2021) suggests no effect of SDG reporting on firm market value. Regarding nonfinancial performance, a statistical analysis conducted by Ferrón Vílchez et al. (2022) suggests that companies with lower environmental performance tend to pursue environmental-related SDGs, while companies with higher process-oriented engagement tend to pursue both environmental- and social-related SDGs. The results of the qualitative analysis support the point that companies perceive the SDGs as a symbolic value in corporate disclosure. However, this phenomenon may not hold in some cases. Emma and Jennifer's (2021) study suggests a statistical association between SDG reporting and market value for companies that are either controversial or environmentally sensitive. Similarly, empirical findings by Nicolo' et al. (2023) suggest a positive correlation between SDG disclosure and sustainability performance, particularly among companies with superior sustainability performance and operating in sustainability-sensitive industries. However, as nation states mandate sustainability reporting, especially for the large and listed companies, the patterns of sustainability data in reports are likely to change.

The selective reporting on the SDGs among companies raises questions about their ability to contribute to achieving the SDGs. The 169 targets of the 17 SDGs are profoundly interconnected and indivisible (Nilsson, 2016; UN, 2015). This means that taking action to achieve one SDG without considering the potential interlinkages between them can unintentionally produce positive or negative impacts on other SDGs (Kostetckaia & Hametner, 2022). Ultimately, although SDG reporting may be substantive to corporate performance in specific circumstances, corporate performance against the SDGs can still be compromised. However, no evidence suggests companies' acknowledgment of the SDG interconnections. Therefore, it calls for investigating the potential interconnections between SDGs at the corporate level.

2 | LITERATURE REVIEW

There are two main categories of existing studies on trends and patterns in corporate reporting on the SDGs. The first category focuses

on providing an overview of the representation of the SDGs in corporate reporting through frequency counting. These studies reveal that corporate reporting on the SDGs is selective and context dependent. However, they have several limitations due to their narrow focus on SDG reporting in a single year or have a small or limited company sample size, such as specific geography, membership, and company size (e.g., Ghosh & Rajan, 2019; Mhlanga et al., 2018; Silva, 2021), which make it difficult to draw general conclusions about trends and patterns in SDG reporting. The most extensive survey to date comes from the grey literature and covers about 5200 companies in 58 countries, assessing their report's SDG coverage and information disclosure (KPMG, 2022). The results are limited to the top companies in the market and provide limited insights and comparability across countries, sectors, and so forth, which can support a scientific analysis on a global scale and thus provide a basis for later addressing effective SDG implementation in companies.

The second category focused on exploring the potential drivers of corporate SDG reporting. Several studies shed light on the relationships between organization characteristics and external context and corporate SDG reporting using inferential statistics (Pizzi et al., 2021, 2022; Rosati & Faria, 2019b; van der Waal & Thijssens, 2020; Zampone et al., 2024). While these studies contribute valuable insights, the analyses have been limited to samples within a specific context. Furthermore, their focus has been on whether companies mention SDGs in their reports without indicating the range or types of SDGs they have prioritized and communicated. To provide a more comprehensive overview of corporate reporting on the SDGs, we recommend conducting a comprehensive analysis of a broader sample. An analysis should also focus on reporting on individual SDGs, as reporting on each of the SDGs could be driven by different factors.

Regarding the interconnections between the SDGs, a study by Kostetckaia and Hametner (2022) explored the linkages between the SDGs and their impact on the progress of EU member states toward achieving the SDGs. Their findings suggest that trade-offs between goals can slow progress toward the 2030 Agenda, while synergies can have a slightly accelerating effect. The importance of this aspect has led to a growing number of theoretical and empirical studies examining the interlinkages between the SDGs (Allen et al., 2019; Dawes, 2022; Nilsson, 2016). However, most previous studies have primarily focused on the natural science-based dynamics of interactions among the SDGs, and there is limited empirical analysis to understand the interactions' company-level dynamics. According to Nilsson et al. (2016), it is important to consider the context when interpreting the interactions between the SDGs. Therefore, it is necessary to examine the interactions between the SDGs at the company level separately.

Studies on the symbolic legitimation of SDG reporting in companies can be divided into two categories. The first category includes qualitative analyses that explore how the SDGs are used in corporate communications (Heras-Saizarbitoria et al., 2022; Lodhia et al., 2023; Silva, 2021; van der Waal & Thijssens, 2020). However, due to the intensive review required, these studies have limited sample sizes based on specific screening criteria, such as companies in the Forbes Global 2000 universe, FTSE 100, multinational companies, or large companies from specific countries. The second category consists of quantitative analyses that use inferential statistical techniques to examine the relationship between SDG reporting and firm performance (Emma & Jennifer, 2021; Ferrón Vílchez et al., 2022; Nicolo' et al., 2023). These quantitative analyses show an underlying relationship but focus on specific performance indicators, such as market value, ESG score, and GHG emissions. Most studies examine the relationship between performance and SDG reporting proxies, such as the SDG disclosure index, reporting on the SDGs as an overall framework, or specific to some SDGs. del Río et al. (2023) conducted a study to investigate whether the inconsistencies and limitations of different indicator approaches encourage companies to engage in washing processes. This research provides new insights into the potential origins of SDG-washing. However, it is important to note that this study primarily focused on companies implementing two specific types of indicators, rather than on overall company performance.

This study aims to fill these knowledge gaps about SDG corporate reporting. The study uses a large sample size that includes large and small-to-medium-sized companies to provide a comprehensive view of corporate SDG reporting. The study intends to achieve this by (i) identifying trends of corporate SDG reporting and SDG prioritization across three reporting years (2019–2021), (ii) analyzing corporate SDG reporting patterns based on correlations between company characteristics and reporting on individual SDGs, (iii) evaluating the potential correlations among the SDGs within corporate disclosures and compare them to the interconnections identified by the scientific community, and (iv) investigating the statistical relationships between corporate sustainability performance data on various indicators and SDG reporting. Furthermore, the study discusses the results in the context of the emerging CSR reporting mandates in some countries and their potential connections to the SDGs. This is due to the growing body of research analyzing the impact of reporting standards on companies' sustainability performance (Christensen et al., 2021; Luo & Tang, 2022). This study aims to contribute to accounting research and related fields such as management, sustainability studies, and policy considerations by examining factors that influence sustainability disclosure, exploring synergies among reported SDGs, and assessing the effectiveness of reporting on corporate sustainability efforts.

3 | METHOD

3.1 | Methodology overview

Figure 1 depicts the overview methodology utilized to achieve the objectives outlined in the paper. It is based on an empirical analysis, where the first step is to gather company data at global scale. The datasets were organized and transformed to make them suitable for the analysis of each of the objectives; the preprocessing of data from multiple sources is detailed in Section 3.2. Both descriptive and inferential statistics were then applied on the quantitative data. The

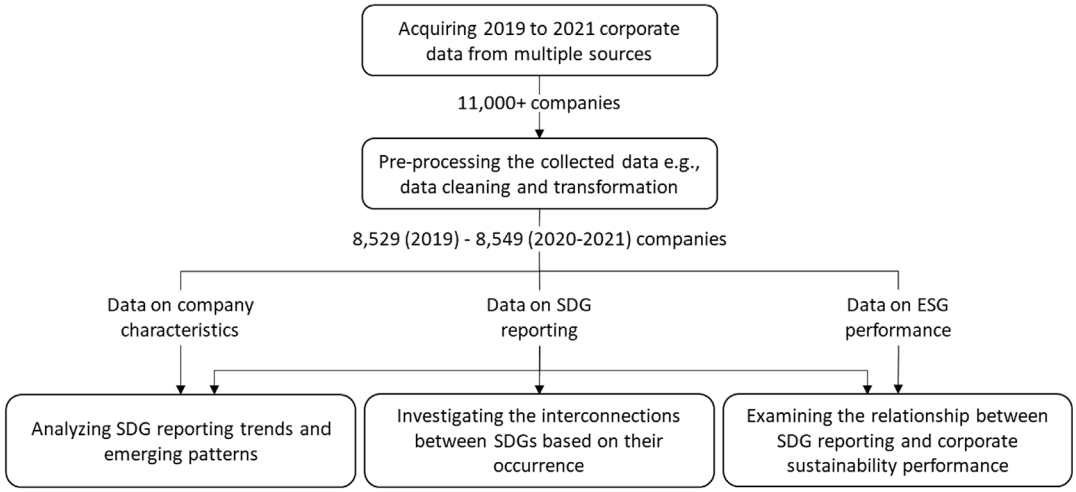

FIGURE 1 Methodological approach for analyzing corporate SDG reporting.

analyses were divided into three parts. First, descriptive and regression analyses were performed to discover the emerging trends of corporate SDG reporting (see Section 3.3). For the second objective, co-occurrence analysis technique was applied to identify associations between individual SDGs based on public disclosures of companies (see Section 3.4). Finally, the relationship between corporate sustainability performance and SDG reporting was examined using inferential statistics (see Section 3.5).

3.2 | Acquiring and curating data

Corporate data between 2019 and 2021 were gathered from the London Stock Exchange Group (LSEG) Data & Analytics (accessed on October 2022). This choice was made to ensure the representativeness of the data as it has been introduced as one of the largest and standardized corporate content collection operations in the world, covering over 85% of the global market cap (LSEG Data & Analytics, 2022). The universe of companies for which ESG data are maintained covers a wide range of public and private companies included in various indices worldwide (LSEG Data & Analytics, 2022). The distribution of the analyzed sample is presented in Table A1 of Appendix A. The original dataset was supplemented with additional UN and World Bank data to add more dimensions (see Section 1 in the Supporting Information S1 [SI-1]). The collected data can be categorized into three main types for analysis (i.e., the output from data preprocessing in Figure 1). Table 1 provides a summary description of each data category, while Table S1 in the Supporting Information S2 (SI-2) offers a comprehensive description, including data types, units of measurement, and missing values for each feature.

The first category refers to corporate features suggested by previous studies (e.g., Haywood & Boihang, 2020) as determinants for corporate SDG reporting. The second category is data of corporate reporting on 17 SDGs, collected by LSEG Data & Analytics from company disclosures (LSEG Data & Analytics, personal communication, October 22, 2021). Our analysis focused specifically on companies that publicly report on initiatives associated with the SDGs. Nondisclosing companies may not appear in the database. This distinction outlines our research scope and highlights potential limitations in capturing the entirety of corporate sustainability efforts. The third and final category is data on companies' Environmental, Social, and Governance (ESG) performances. ESG scores have been used extensively to measure corporate sustainability performance. ESG practices and disclosures represent a voluntary commitment to nonfinancial goals and the promotion of sustainable development (Khaled et al., 2021). Therefore, in this study, performance data from several ESG indicators are used as proxies to represent different dimensions of corporate sustainability performances.

After collecting the data, we examined the dataset for anomalies. We identified irrelevant data (e.g., data outside the period of interest), and missing values across the datasets for all 3 years. In the first two analyses, we refined our datasets by only including features related to corporate characteristics and SDG reporting. Then we eliminated missing values from the datasets. These preprocessing, data curation steps led to a reduction in the sample size from 11816 to 8549 companies, except for the 2019 dataset, which was reduced to 8529 observations. To analyze the potential relationship between ESG performance indicators and SDG reporting, we constructed a dataset for each SDG and its relevant ESG indicator(s), excluding missing values. The sample size varied depending on the ESG indicators included in each analysis. More details on these datasets and preprocessing steps are presented in Section S2 in SI-1 and Table S1 in SI-2.

3.3 | Analyzing trends and patterns of SDG reporting

Both descriptive and regression analysis were applied to assess the current state, progression, and patterns of corporate SDG reporting. To delineate the current profile and trends of corporate SDG reporting, we applied a statistical measure based on frequency distribution. This approach allowed us to identify various trends, including SDG

TABLE 1 Description of data categories used in this study and the data sources.

Data category	Description	Sources
Corporate characteristics	In this dataset, corporate characteristics consist of geographic representation (14 subregions), country economic level (4 income levels and parts of Great Britain [GBR]), sectoral representation (30 sectors) and 2 company sizes. The summary of sample properties of the analyzed datasets for each characteristic is provided in SI1-S3.	DataStream (Accessed on October, 2022) UN (Accessed on April, 2023) World Bank (Accessed on April, 2023)
Corporate SDG reporting	LSEG Data & Analytics' dataset includes 17 binary features that indicate whether a company has established a process to support the 17 SDGs, with a "Yes" value for companies with a process in place and a "No" value otherwise.	DataStream (Accessed on October, 2022)
Corporate ESG performance	A total of 81 corporate performance indicators on environmental, social, and governance dimensions, which are recognized as relevant to individual SDGs by LSEG Data & Analytics.	DataStream (Accessed on October, 2022)

uptake by companies, the number of SDGs covered by companies, and which SDGs are most/least prioritized.

Regression analysis was also used to examine the relationship between company characteristics and the likelihood to report on individual SDGs. This analysis consists of three steps as illustrated in Figure S3.1 in SI-1. Since all the features in the dataset used for this analysis are categorical variables (e.g., there are five categories in the income level characteristic as described in Table 1), the first step was to apply one-hot encoding (Hancock & Khoshgoftaar, 2020). This preprocessing step creates a new binary feature for each category of a categorical variable. For example, the application of this technique to a variable representing subregions (with 14 different categories) yields 14 binary variables.

In the next step, 17 regression models were fitted to cover all SDGs. The output of each regression model is a linear combination of corporate characteristics weighted by their respective coefficients and the intercept, as expressed in Equation (1).

$$y_{sdg} = \beta_0 + \sum_{sub=1}^{14} \beta_{sub} \cdot X_{sub} + \sum_{inc=1}^{5} \beta_{inc} \cdot X_{inc} + \sum_{sec=1}^{30} \beta_{sec} \cdot X_{sec} + \sum_{size=1}^{2} \beta_{size} \cdot X_{size} \quad (1)$$

where

- y_{sdg} represents the odds of the reporting on a given Sustainable Development Goal *sdg*,
- X represents binary variables of the one-hot encoded company characteristics, including 14 subregions (X_{sub}), 5 income levels (X_{inc}), 30 sectors (X_{sec}), and 2 sizes (X_{size}), (see a full list of company features in Table S4 in SI-2) and
- β represents the coefficients associated with each characteristic X while β_0 represents the intercept.

The explanatory variables in Equation (1) are binary, which we obtained by performing one-hot encoding on four company characteristics: subregion, income level, sector, and size. Notice that the categories in each characteristic are mutually exclusive, a company can only belong to one category for a given characteristic. For instance, a company with an income level $inc = 3$ yields the variable assignments $X_{inc1} = 0, X_{inc2} = 0, X_{inc3} = 1, X_{inc4} = 0, X_{inc5} = 0$. Furthermore, the four company characteristics are collectively exhaustive, that is, a company should be described by these four characteristics in this analysis. While it is possible to analyze the relationship between a single characteristic (e.g., income level) and the reporting likelihood on a given SDG, including more company characteristics paints a more comprehensive picture.

As it is easier to interpret probabilities than odds, we convert the odds in Equation (1) into probability using the formula in Equation (2) (Morgan & Teachman, 1988):

$$P(sgd \mid X) = \frac{\exp(y_{sdg})}{1 + \exp(y_{sdg})} = \frac{1}{1 + \exp(-y_{sdg})} \quad (2)$$

where

- $P(sgd \mid X)$ is the probability of a company reporting on a Sustainable Development Goal *sdg* given the company characteristics X, and
- y_{sdg} is the odds defined in Equation (1).

The final step in our methodology involves computing the probabilities of nearly all combinations of the categories in the four company characteristics. We excluded combinations resulting in datasets with fewer than 20 observations. Finally, we visualized the probabilities in a heatmap to highlight the nuanced patterns of the correlations between corporate characteristics and reporting on individual SDGs. This approach allows us to gain valuable insights into the dynamics between these factors and the propensity of companies to report on specific SDGs.

3.4 | Analyzing the interrelationships between the SDGs

A co-occurrence analysis was employed to identify associations between SDGs based on their occurrences in companies' public disclosures. We followed a two-step approach (see Figure S3 in SI-1). In

the first step, we computed a co-occurrence matrix for pairs of SDGs where (i,j)-th element denoted $C_{SDG_{i,j}}$ is the number of companies reporting on SDG_i and SDG_j simultaneously. In the second step, we normalized the co-occurrence counts by their corresponding diagonal values using the formula in Equation (3).

$$N_{SDG_{i,j}} = \frac{C_{SDG_{i,j}}}{C_{SDG_{i,j}}},\ i \neq j \tag{3}$$

Normalization ensures that all values are on a uniform scale. This technique is useful for creating consistent and interpretable values, especially when dealing with values of varying magnitudes. For example, the co-occurrence count of $SDG_{8,13}$ is 2641, while the co-occurrence count of $SDG_{1,2}$ is 669. Without normalization, the co-occurrence count will be skewed toward the first pair because more companies mentioned SDG 8 than SDG 1. By normalizing the first and second pair with $SDG_{8,8}$ and $SDG_{1,1}$ (the number of companies reporting on SDG 8 and SDG 1), respectively, we obtained normalized values in relation to reporting on SDG 8 and SDG 1. The normalized matrix exhibits asymmetry because of inherent differences in the frequency of reported SDGs. Each asymmetric pair $SDG_i \rightarrow SDG_j$ and $SDG_j \rightarrow SDG_i$ conveys unique information and gives an overview of how each SDG interacts with the others. Considering a pair of SDG 1 and SDG 8 reported in 2021 as an example (see Figure 5), the values indicate that 93% of companies that reported on SDG 1 (1130 companies) also reported on SDG 8 ($SDG_{8,1}$), whereas only 35% of companies that reported SDG 8 (2988 companies) reported on SDG 1 ($SDG_{1,8}$).

Our primary focus is on identifying correlations between SDGs based on their occurrence in corporate disclosures. Our aim is not to determine the reasons for these relationships but to uncover potential connections between pairs of SDGs that companies may have overlooked compared to the SDG interlinkages identified by the science community.

3.5 | Analyzing the relationship between ESG performance and SDG reporting

Regression analysis was conducted to investigate the potential relationships between ESG performance and reporting on individual SDGs using relevant ESG performance indicators as explanatory variables (see Figure S3.3 in SI-1). The ESG indicators provided by LSEG Data & Analytics include both process- and result-oriented indicators. Corporate ESG indicators were examined and screened based on specific selection criteria to ensure that they are relevant to the SDGs and reflect companies' impact on sustainability issues. The criteria included (1) relevance to SDG, (2) measurable, (3) data availability, (4) distribution of population, and (5) result orientation. The full description of the criteria is presented in Table S3.1 in SI-1. The selection criteria are a modification of a comprehensive list of criteria for selecting SDG indicators proposed by (Gebara et al., 2024) to fit with the objective of the screening.

The screening process for indicators produced 24 relevant ESG indicators from a pool of 81 indicators. More than 90% of the metrics conform with the corporate sustainability indicators outlined by the Global Reporting Initiative (GRI) (KPMG, 2022). Nevertheless, it should be emphasized that the short-list indicators do not encompass all aspects of the SDGs. Based on the selected criteria (see Table S3 in SI-2), this selection of indicators allowed for assessing the correlation between these indicators and the reporting on SDG 1, 3, 5, 6, 7, 8, 9, 10, 12, 13, and 16. Tables S7 and S8 in SI-2 contain details about the ESG performance variables utilized for statistical analysis of each SDG and the results.

The relationship between ESG performance and SDG reporting was examined in two aspects. First, we analyzed the impact of ESG performance changes ($\Delta ESG\,performance$) by focusing on the change in performance from 2019/2020 to 2020/2021. Subsequently, the performance data were transformed by classifying the interannual change of performance to either "Improvement" (coded as "1") and "Stagnation/Deterioration" (coded as "0"), allowing us to evaluate the influence of changing ESG performance on the SDG reporting. Second, we examined the impact of ESG performance scores on SDG reporting.

Collinearity issues were mitigated by excluding highly correlated variables within each set of exploratory variables used to describe reporting on each SDG (e.g., injury rate and total accidents). To allow comparability across companies, several indicators that could be varied depending on business size were normalized by company revenue (e.g., the normalized water discharged is water discharged per USD of revenue). When examining changes in performance, emphasizing normalized metrics was less critical, as the magnitude of change was not a primary consideration. This allowed us to choose between absolute or relative metrics and select metrics that included more data. However, in the context of ESG performance scores, we emphasized normalized metrics and opted for relative performance variables.

Although the absolute performance metrics were normalized, the explanatory variables still had different value ranges (e.g., 0 to 99 or 0 to 16,000). To simplify the value comparisons and ensure unbiased comparisons, we applied standardization (see Equation 4) to rescale the values (Raju et al., 2020):

$$Z_{scaled} = \frac{(X - \mu)}{\sigma} \tag{4}$$

where Z_{scaled} is standardized variables, X is the original data value, μ is mean, and σ is standard deviation.

4 | RESULTS AND DISCUSSION

4.1 | SDG reporting status and patterns

The descriptive findings in Figure 2 reveal a notable increase in corporate SDG reporting from 8.9% in 2019 to 41.3% in 2021 (out of 8529/8549 observations). The increasing trend could be attributed to

a desire to meet stakeholder expectations, driven by self-regulatory initiatives, regional/national plans, and the potential for financial gain in the marketplace (Heras-Saizarbitoria et al., 2022; Pizzi et al., 2022). The COVID-19 pandemic may have also played a role in the increasing trend, as it has served as a driving force for transformation, bringing attention to the sustainability matters integrated into the SDGs (Shulla et al., 2021). However, more effort is required to encourage greater engagement from the private sector as over 50% of the companies in the considered dataset have yet to report on their progress toward the SDGs.

Companies typically align themselves with six to 10 SDGs. Companies began to cover a more extensive range of SDGs, as evidenced by the increasing number of companies aligning with more than 10 goals. Although the results exhibited a positive development from the private sector, it is essential to question the quality of the disclosure (Silva, 2021). Previous studies (e.g., Heras-Saizarbitoria et al., 2022) have raised concerns about selective reporting on the SDGs, which can lead to suspicions of SDG-washing, where companies may report certain SDGs they are comfortable with (Mhlanga et al., 2018). Increasing the number of reported goals does not necessarily reduce the risk of SDG-washing if done arbitrarily. There is skepticism about the effectiveness of companies' contribution to the SDGs, considering how challenging it is for them to allocate resources efficiently and prioritize impactful initiatives toward the complex indicator framework with 231 indicators (GRI et al., 2015; KPMG, 2020).

As illustrated in Figure 3, between 2019 and 2021, companies most frequently reported on five of the SDGs: SDG 8 (economic growth and decent employment), SDG 13 (climate actions), SDG 12 (sustainable consumption and production), SDG 3 (healthy lives and well-being), and SDG 5 (gender equality). The least prioritized SDGs were SDG 2 (zero hunger and sustainable agriculture), SDG 14 (oceans and marine resources), SDG 1 (no poverty and resource mobilization), SDG 15 (terrestrial ecosystem), and SDG 6 (water availability and sanitation).

A potential reason why companies report more on the top five SDGs could be their alignment with operational activities of businesses, regulatory requirements, and global initiatives related to them (e.g., International Labour Organization [ILO] and the Paris Agreement) (Khaled et al., 2021; Mhlanga et al., 2018). Conversely, the least prioritized SDGs may seem complex and disconnected from mainstream CSR practices (van der Waal & Thijssens, 2020), which could explain the less attention they have received from companies.

This study's revelation on the unequal prioritization of the SDGs mirrors other research with smaller/narrower sample sizes (e.g., Ghosh & Rajan, 2019; Mhlanga et al., 2018; Silva, 2021), which may explain the significant disparities in SDG progress highlighted by the annual Sustainable Development Report (Sachs et al., 2023). The unequal emphasis on the SDGs highlights the importance of understanding companies' motivations and operational approaches toward the SDGs. However, the information on these practices is limited (Mhlanga et al., 2018). Although some patterns of SDG reporting are uncovered, additional data features, qualitative analyses of corporate disclosure, or company surveys at a macro scale are necessary to comprehend the motivation and internal approaches toward SDGs.

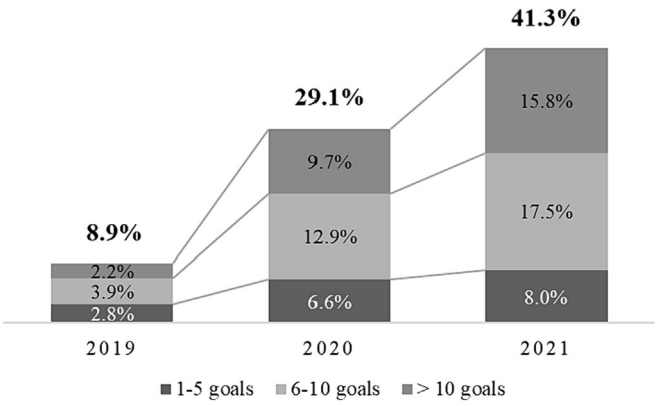

FIGURE 2 Trends in SDG reporting rates and the percentage of companies reporting specific ranges of SDGs from 2019 to 2021.

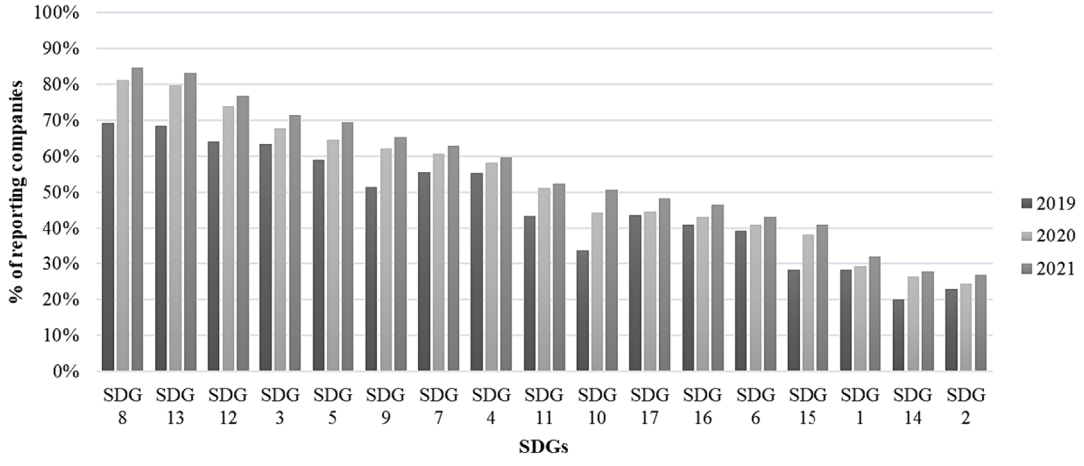

FIGURE 3 The percentage of reports referencing the respective SDG for each reporting year.

4.1.1 | Geographical patterns

According to Table S4 in SI-2, the analysis of 17 regression models shows that geographic regions such as Southeast Asia (SEA), Latin America and the Caribbean (LAC), and sub-Saharan Africa are significantly associated with reporting on most SDGs. Conversely, the regions of Northern America, Northern Europe, and Australia and New Zealand show significant correlations with no reporting on most SDGs. Although companies in Northern America and Northern Europe have the highest number of reporting companies, the proportion of reporting companies in these subregions is lower than in SEA and LAC. In particular, Northern America has the lowest proportion of reporting companies at 20.4% (see Table S3.1 in SI-1). According to a study conducted by van der Waal and Thijssens (2020), Asian companies in East Asia and Thailand are leading the way in reporting on SDG activities. This may be due to the presence of active sustainability networks, such as the United Nations Global Compact (UNGC) that support and promote SDG-related initiatives (Luo & Tang, 2022; van der Waal & Thijssens, 2020). Meanwhile, the same study shows that companies from the United States (US) tend to score lower on SDG disclosure, possibly due to fear of criticism, lower sustainability disclosure requirements, and lack of interest from some companies (EY, 2021; van der Waal & Thijssens, 2020).

Bose and Khan (2022) examined other influential factors and found that companies in countries with national sustainability regulations and higher UN SDG performance scores tend to have different SDG reporting practices. However, our findings contradict Bose & Khan's notion that SDG reporting is higher for companies in countries with common law practices (shareholder-oriented countries such as the United States, the United Kingdom, or Australia) compared to those in code law practices (stakeholder-oriented countries such as France, Sweden, Norway, and others). It is possible that this discrepancy is due to differences in reporting timeframes or other unexplored factors that require further investigation. These factors may include a country's susceptibility to climate change, governmental policies, and education spending (Rosati & Faria, 2019a). Interestingly, our findings align with Bose & Khan's research, which suggest that SDG reporting is more prevalent among companies in developing countries than developed ones (see Figure 4).

To better understand reporting outcomes, it is important to examine how different characteristics interact and affect reporting, rather than looking at individual characteristics in isolation. The reporting likelihood heatmap in Figure 4 considers all corporate characteristics and shows that the likelihood of reporting varies according to the size of the company and the income level of the country. For example, Northern European companies are more likely to report if they are larger, while North American companies are less likely to report on the SDGs, regardless of company size and economic conditions.

It is important to acknowledge that companies' geographical scope in this study is determined by the location of their corporate headquarters. Therefore, the observed patterns may be influenced by the company's internationalization across its entire value chain (Dasgupta et al., 2022; Ordonez-Ponce & Talbot, 2022), which was not included in the analysis.

4.1.2 | Economic status

Income levels help classify jurisdictions and improve understanding of SDG reporting across subregions. Economic status determines overall SDG reporting in the same subregion, as confirmed by the heatmap of five subregions in Figure 4. Companies headquartered in high-income countries tend to report on a larger number of SDGs. As suggested by Rosati and Faria (2019a), companies in countries with higher economic prosperity have more capacity to report on their CSR and SDG activities. However, this pattern deviates globally, where Northern America is less likely to report compared to other middle-income regions, implying that other variables may exert greater influence on SDG reporting in this region.

4.1.3 | Business size

Drawing conclusions based on business size presents challenges, as SMEs represent only 14% of the analyzed companies in the dataset. Therefore, instead of comparing the total number of reports across different business sizes, we looked at the percentage of companies reporting on SDGs within the same business size. Our findings indicate that only about 16% of SMEs report on SDGs, while larger companies report at a rate of 45% (see Table S3.1 in SI-1). This trend is also reflected in Figure 4. Additionally, our regression analyses suggested the statistical significance of business size in reporting on all SDGs ($p < .05$; see Table S4 in SI-2).

Active reporting on the SDGs among large companies could be due to social legitimacy (van der Waal & Thijssens, 2020), resources and capabilities (Heras-Saizarbitoria et al., 2022), and mandatory nonfinancial disclosure requirements targeting larger companies (e.g., Directive 2014/95/EU). Meanwhile, Baumann-Pauly et al. (2013) found that limited resource allocation makes SMEs less likely to report nonfinancial information, which could include SDG-related information. The low likelihood of reporting may also derive from SMEs' inclination to support sustainable development without external commitment (Perrini et al., 2007). However, according to Figure 4, there are deviations, where SMEs in countries with higher income levels were more likely to report on the SDGs.

Researchers have acknowledged that SMEs have limited participation in sustainability initiatives, including this study. Despite the considerable public attention that large companies have received, it is important to emphasize that SMEs also need to adopt sustainable practices, and stakeholders such as higher authorities, investors, and larger companies need to support SMEs in their efforts, such as the Corporate Sustainability Reporting Directive (CSRD), which is discussed in Section 4.4.

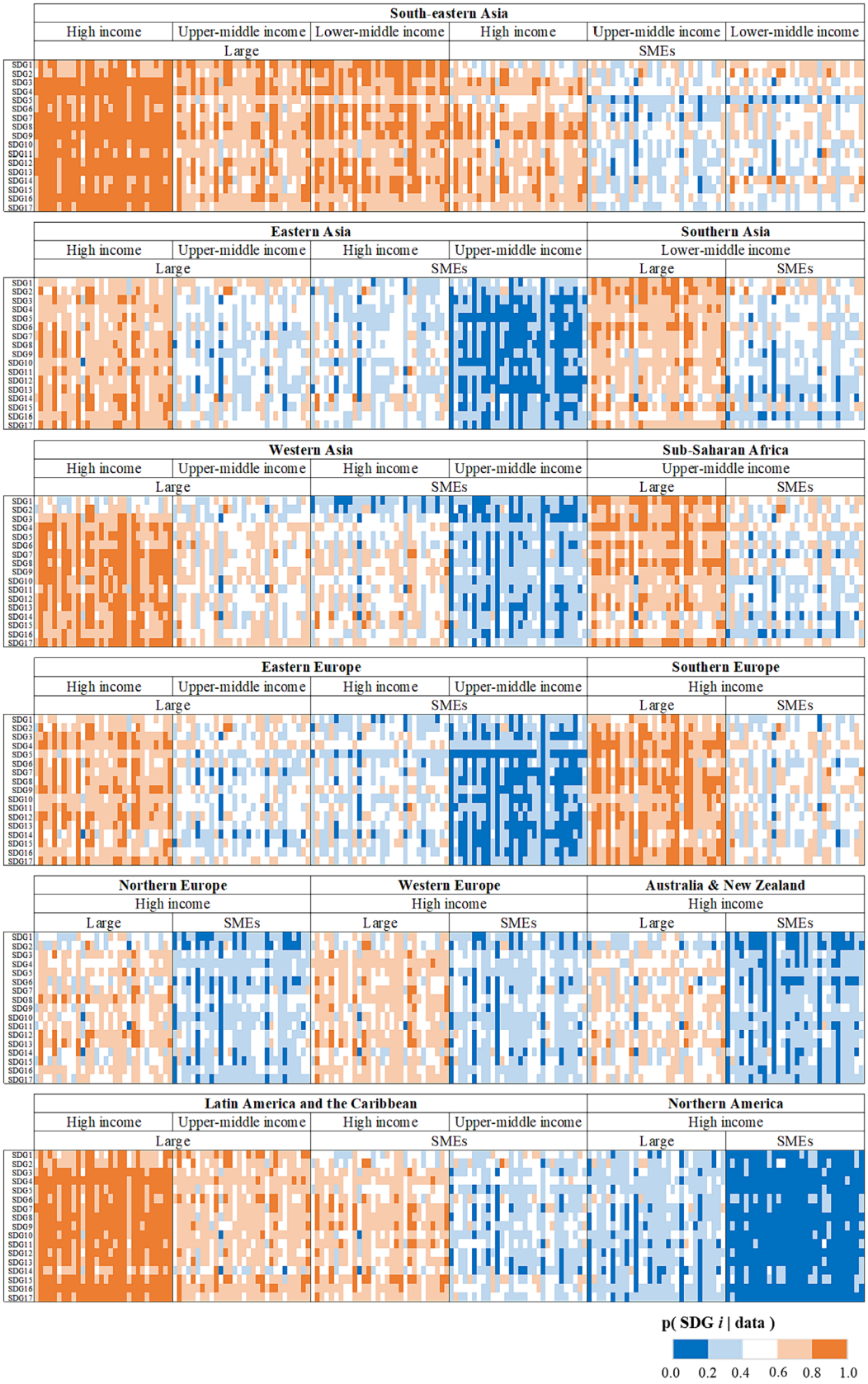

FIGURE 4 Heatmap of reporting probability of each SDG in response to corporate characteristics of headquarters' locations (12 subregions), sector (30 sectors), company size (large, SMEs) and levels of income (lower middle, middle, upper-middle, high). Each row represents individual SDGs. The permutations of specific subregions (e.g., Central Asia) and income level (e.g., low income) are disregarded because of too low data sample to generate statistically meaningful results (see details in Table S4 in SI-2). The full heatmap with probability values (gradient reflecting probability) is provided in Table S5 in SI-2.

4.1.4 | Business sectors

According to the descriptive findings (see Table S3.1 in SI-1), companies from the primary sectors (such as forestry and wood products, fishery and agriculture, mineral extraction, and fossil fuel extraction) and secondary sectors (such as chemicals, utilities, automotive, industrial products, and consumer discretionary) have been playing an active role in overall SDG reporting since 2019 (see Section 1 in SI-1 for sector classification). Companies in these sectors are inherently more exposed to social controversies and environmental issues. The potential benefits of SDG reporting on companies' reputation and market value (Emma & Jennifer, 2021) may motivate companies from these sectors to report on the SDGs. However, its benefits on corporate sustainability performance have yet to be confirmed. Sections 3.5 and 4.3 provide the investigation and presentation of such relationships.

A detailed analysis of the top and the least reported SDGs by sectors (see Table S3.2 in SI-1), and the statistical relationship between reporting on individual SDGs and sectors (see Table S4 in SI-2) suggest the presence of sectoral patterns in SDG reporting. However, it may be challenging to distinguish this effect based on the visualization in Figure 4, where high and low reporting probabilities cluster densely in several variations, such as large companies in SEA and SMEs in Northern America. Nonetheless, we observed a consistently high reporting likelihood of specific SDGs among companies in particular sectors, provided they share the same jurisdiction, income level, and business size (see Table 2). For example, companies in the Food & Beverage and Food & Drug Retailing sectors generally prioritized SDG 2 (food and nutrition and sustainable agriculture) as one of the most reported goals. Companies in the Applied Resources sector, which focuses on the forestry industry, typically disclose SDG 15 (sustainable management and use of terrestrial ecosystems) more often than other sectors.

According to Heras-Saizarbitoria et al.'s (2022) research, certain companies' SDGs are selected based on sector-specific factors. Demonstrating their commitment to aligning the SDGs based on their core competencies is a positive indication. However, failing to make a meaningful contribution to their core SDGs and overlooking the impact of other business activities on the SDGs could lead to engaging in SDG-washing.

4.1.5 | Patterns of corporate SDG reporting and implications

Based on the analysis presented in Sections 4.1.1–4.1.4, a distinct pattern can be observed in the reporting of SDGs by companies based on their profiles (i.e., headquarters' locations, economic status, sector, and size). Generally, large companies located in high-income countries tend to report the same top five SDGs, that is, SDG 8, 13, 12, 3, and 5, regardless of their sector or location. However, other SDGs may be relevant for companies depending on their specific activities or environment. According to our analysis of the dataset, business sectors and regional differences may influence the selection of SDGs to report on. The empirical findings in earlier subsections hence raise the following concerns/challenges regarding corporate practices toward the SDG framework:

i. Extensive reporting on the SDGs by companies without careful consideration can result in SDG-washing. Arbitrarily reporting on all the goals without proper consideration could lead to an "icon-picking" approach and ultimately undermine progress toward meeting the SDGs.
ii. Contextual dependence of several SDGs, notably the least reported SDGs, suggests that specific stakeholder groups bear a disproportionate burden of the impacts despite a larger number of stakeholders across the value chain affecting these SDGs globally (Sachs et al., 2023).

To overcome the challenges and address concerns, businesses need a robust process to identify the relevant SDGs for their activities and reflect on their impacts on the SDGs across the entire value chain, extending beyond national borders. Furthermore, directed interventions to strengthen sustainability initiatives are necessary, especially

TABLE 2 The sectors most likely to report on the specific SDGs, regardless of jurisdiction, income level, or business size.

SDG	Sectoral pattern
SDG 1: Ending poverty and ensuring mobilization of resources	Banking & investment services and basic services (i.e., basic materials, energy, food & beverage, personal & household products and services, and utilities)
SDG 2: Ending hunger and promoting sustainable agriculture	Food & beverage and food & drug retailing
SDG 3: Ensuring healthy lives and well-being	Chemical, real estate, consumer-related products and service, insurance, healthcare, and mineral resources
SDG 4: Ensuring quality education and lifelong learning opportunities	Telecommunication services
SDG 6: Ensuring water availability and sanitation	Applied resources, chemical, food & beverage, mineral resources, real estate, and energy
SDG 7: Ensuring access to affordable and sustainable energy	Real estate, renewable energy, and utilities
SDG 11: Ensuring sustainable urbanization	Real estate
SDG 14: Conserving oceans and marine resources	Energy—fossil fuel, applied resources, chemical, utilities, and food & beverage
SDG 15: Ensuring sustainable use of and conserving terrestrial ecosystem	Applied resources, food & beverage, mineral resources, and utilities

for the most urgent goals and the least prioritized goals across diverse locations, sectors, and business scales. By enacting regulatory and incentive measures and fostering collaboration among various industries and stakeholders across the system, the SDGs can be effectively addressed and unintended consequences of SDG trade-offs can be avoided (Sachs et al., 2023; Schaltegger et al., 2018).

4.2 | Potential relationship between the SDGs

Figure 5 presents the matrix displaying the average normalized co-occurrence of SDG pairs from 2019 to 2021. Generally, the co-occurrence rate ranges between 50% and 70%, except in cases where there is involvement of the SDGs with the highest and lowest reporting frequency. Therefore, our results and discussion focus on the possible correlations between SDGs when particular SDGs are highly engaged or minimally involved.

An analysis of the top five SDGs: SDG 8 (economic growth and decent employment), SDG 13 (climate actions), SDG 12 (sustainable consumption and production), SDG 3 (healthy lives and well-being), and SDG 5 (gender equality), using co-occurrence matrix, indicates that over 69% of companies that report on other SDGs also tend to address these top reported SDGs (as shown in the corresponding rows in Figure 5). Although actions taken toward SDG 6 (water availability and sanitation), 14 (oceans and marine resources), and 15 (terrestrial ecosystem) might have negative impacts on SDG 8 (Dawes, 2022), a vast majority of reporting on SDG 6, 14, and 15—83%, 91%, and 92%, respectively—indicated their alignment with SDG 8. However, when looking at companies that report on the top five SDGs (as depicted in the corresponding columns in Figure 5), there is limited co-occurrence (ranging from 26% to 44%) between the top SDGs and the least reported SDGs: SDG 2 (zero hunger and sustainable agriculture), SDG 14, SDG 1 (no poverty and resource mobilization), SDG 15, and SDG 6. The high rates of co-occurrence among the most frequently reported SDGs and others could possibly be explained by the frequent appearance of the top five SDGs, rather than a thorough understanding of their interconnections, as evidenced by the lack of symmetry in the depicted relationships.

In the case of the least reported goals (SDG 1, 2, 6, 14, and 15), their infrequent occurrence is anticipated to limit their co-occurrence with other SDGs. Although this pattern holds true in most cases, exceptions are evident in our analysis. Moderate co-occurrence rates between them are present when both SDGs focus on social well-being ($SDG\,1 \leftrightarrow SDG\,2$) or environmental preservation (e.g., $SDG\,14 \leftrightarrow SDG\,15$), which potentially co-benefit each other (International Council for Science, 2017; Pham-Truffert et al., 2019). Figure 5 shows several pairs of SDGs with limited co-occurrences, such as $SDG\,8 \rightarrow SDG\,14$, $SDG\,8 \rightarrow SDG\,6$, $SDG\,11 \rightarrow SDG\,2$, and $SDG\,7 \rightarrow SDG\,14$. The scientific community has identified potential trade-off relationships between these pairs (International Council for Science, 2017; Nilsson, 2016; Pham-Truffert et al., 2019), in which advancing one SDG may impede the achievement of another (Kostetckaia & Hametner, 2022). On the other hand, another group of limited co-occurrences, such as $SDG\,8 \rightarrow SDG\,1$, $SDG\,8 \rightarrow SDG\,2$, and $SDG\,14 \rightarrow SDG\,12$, may not pose a threat to the SDGs achievement due to their beneficial impact on each other (e.g., Dawes, 2022; Pham-Truffert et al., 2019). Although academic research has identified trade-offs in the SDGs that receive less attention, the limited co-occurrences in the matrix suggest that the least reported SDGs are often not linked to others, suggesting a possible weakness in corporate sustainability governance (Nilsson et al., 2016).

Companies are encouraged to use the SDG interactions identified in prior research to assess the balance of trade-offs and co-benefits in their SDG-related pursuits. While it is concerning that some interconnections between trade-off SDGs may go unreported, Kühnen et al. (2019) argue that it is important to consider both the positive and negative aspects of sustainability narratives and their interdependencies. Simply focusing on mitigating negative impacts when assessing trade-offs is not sufficient to drive sustainable transitions for companies (Kühnen et al., 2019). Research conducted by Nilsson et al. in 2016 and 2018 concluded that various contextual aspects, such as resource endowment, geographic setting, governance, and time

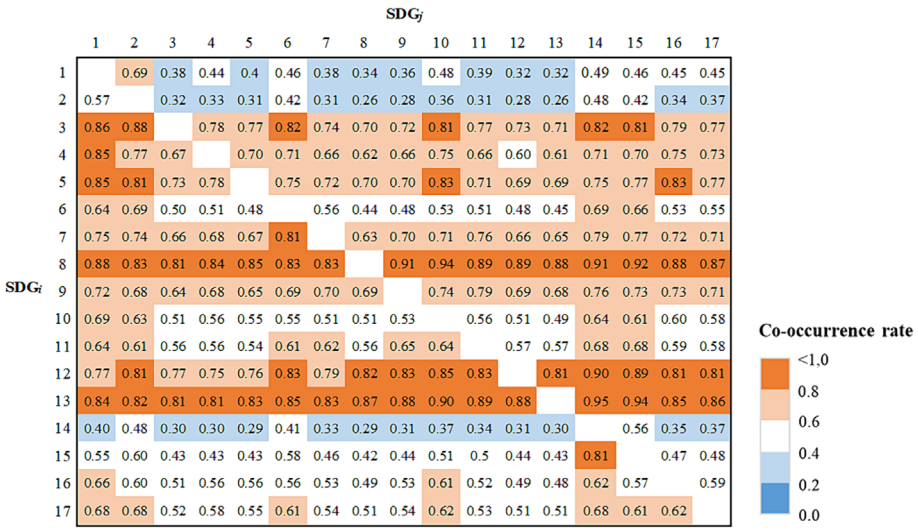

FIGURE 5 Average of normalized co-occurrence between each pair of SDGs from 2019 to 2021. The co-occurrence rates of each year are provided in Table S6 in SI-2.

horizon, significantly impact interactions. Therefore, creating a mapping of SDG interactions in a specific context, whether for individual companies or industries, can be highly beneficial for gaining comprehensive and accurate knowledge of SDG interactions in the private sector (Nilsson et al., 2016; Nilsson et al., 2018).

Since progress toward the SDGs have been advancing at an inadequate rate (Sachs et al., 2023), disregarding these linkages could result in considerable setbacks in achieving the goals with the least progress. To promote the implementation of SDG interlinkages in business practices, guidelines, and standards must specifically include this element. Additionally, supplementary tools should be developed to assist companies in achieving this pursuit. Managing trade-offs and co-benefits related to the SDGs can also be effectively accomplished by establishing partnerships between companies and other players in the global system (Pham-Truffert et al., 2020).

The SDG reporting features were categorized as binary, which means they were either reported or not reported, represented by "1" and "0." However, the specific SDG-related activities that resulted in such categorization were not considered at this point of the study. Therefore, the results do not encapsulate the interlinkages of SDGs based on their activities. Instead, they should be considered as indications of potential associations among the reported topics. Consequently, it cannot be assumed that companies are fully aware of the interrelatedness between them, nor can it be assumed that actions related to them may or may not produce genuine co-benefits or trade-offs. Analyzing detailed reporting activities extracted from corporate disclosures, indicating positive or negative actions and performance is essential to characterize the co-occurrences for their additive, synergistic, or antagonistic effects. This will enable us to gain a more comprehensive understanding of the significant interlinkages reported by these companies.

4.3 | Relationship between SDG reporting and ESG performance

As a preliminary step toward gaining empirical insight into potential SDG-washing, we analyzed the correlation between corporate ESG performance and SDG reporting. This section addresses (i) the relationship between SDG reporting and ESG performance changes, to study how sustainability performances may influence SDG reporting (Section 4.3.1); and (ii) the relationship between SDG reporting and ESG performance relative to the average ESG performance of the analyzed sample, to investigate how the positioning of the sustainability performances of a company may influence SDG reporting (Section 4.3.2).

4.3.1 | SDG reporting and changes in ESG performance

Table S7 in SI-2 reveals that approximately four out of the 41 potential relationships (9%) between SDG reporting and individual company ESG performance, as compared to their interannual progress/change ($\Delta ESG\,performance$), demonstrate statistical significance. In instances where ESG variables were statistically significant, improved performances in specific ESG metrics corresponded with a greater likelihood of reporting relevant SDGs (see Table 3). For example, the improvement in the ESG indicator "Gender Pay Gap" could increase the likelihood of reporting on SDG 10, addressing inequality.

Due to the limited number of significant relationships, it is uncertain whether these results are coincidental. Indeed, 37 potential relationships (91%), which are not found to be statistically significant, indicate insufficient evidence to substantiate that a genuine relationship exists between ESG performance improvement and reporting of related SDGs. Furthermore, two of the significant relationships are determined by two composite ESG performance indicators (i.e., environmental innovation and emission scores), which offer a limited view of environmental performances and economic opportunities. Although this analysis bears limitation due to its sample size and warrants for more investigation, including a critical review of corporate sustainability reports, these empirical findings suggest that the progress of companies regarding sustainability may not translate into reporting using the SDG framework. Future research should

TABLE 3 Likelihood of reporting on SDGs with a statistically significant relationship to an ESG metric. The results consist of two sections: the likelihood of reporting when there is an improvement in ESG performance (Part A), and the likelihood of reporting when ESG performance is above average by one standard deviation (Part B).

SDG reporting	Significant ESG metric[a,b]	Reporting likelihood[c]
Part A: ESG performance improvement and SDG reporting		
SDG 9	Environmental innovation score	⇧
SDG 10	Gender pay gap	⇧
SDG 13	Emission score	⇧
SDG 16	Business ethics controversies	⇧
Part B: ESG performance and SDG reporting		
SDG 3	Total injury rate	⇩
SDG 3	Emission score	⇧
SDG 6	Emission score	⇧
SDG 8	Environmental innovation score	⇧
SDG 10	Percentage of women managers	⇧
SDG 12	Waste recycling ratio	⇧
SDG 12	Water pollutant emissions to revenues USD in million	⇧
SDG 12	Environmental innovation score	⇧
SDG 13	Emission score	⇧

[a]Environmental innovation score includes metrics related to product innovation and green revenues, research development, and capital expenditure (LSEG Data & Analytics, 2022).
[b]Emission score includes metrics related to on total CO_2 equivalent per million USD of revenue, and total waste per million USD of revenue (LSEG Data & Analytics, 2022).
[c]Increased reporting likelihood is represented by ⇧ or ⇩ otherwise.

investigate the temporal sequence of relationships between ESG progress and SDG reporting since SDG reporting may be carried out before or after progress observation.

4.3.2 | SDG reporting and ESG performance

To go beyond the analysis of an individual company's progress toward sustainability (Section 4.3.1), the relative sustainability performances of a company within the analyzed sample (i.e., companies with available data regardless of companies' features) can be examined. Table S8 in SI-2 shows the probability of reporting on each SDG relative to the average performance of the analyzed sample (*N*). Out of the 39 potential relationships between SDG reporting and ESG performance relative to the average of the included sample, nine potential relationships (23%) show statistical significance. The results indicate that companies with ESG performances exceeding the sample average by one standard deviation tend to report more on the relevant SDGs. For instance, a higher waste recycling ratio than average may increase the likelihood of reporting on SDG 12 (sustainable production and consumption). However, such practice was only observed if a higher performance than the average was deemed a positive development. Businesses with higher-than-average injury rates are less likely to report on SDG 3, which pertains to human health and well-being (Table 3).

However, it is observed that 30 relationships (70%) between ESG performance indicators and SDG reporting do not show any significant correlation. Furthermore, five out of nine relationships with statistical significance are determined by two composite ESG performance indicators, which is similar to the findings in Section 4.3.1. The general lack of statistical significance suggests insufficient evidence to assert a true relationship between a company's sustainability performances, compared to the average company performance, and SDG reporting. Any correlation observed in the sample is likely due to random chance.

Although uncertainties are present in this analysis and calls for further investigation, the findings align with those in Section 4.3.1 and, except for a few instances (Table 3), generally indicate a lack of causality between a company's sustainability performances and its SDG reporting.

4.3.3 | Potential causes of symbolic use of the SDGs

Previous analyses (Shayan et al., 2022; Silva, 2021) have regarded the SDGs as an additional feature of CSR activities. Qualitative results from Heras-Saizarbitoria et al.'s (2022) study suggest that companies could integrate the SDGs into their reports through indicators, actions, or results. However, our quantitative analysis (Sections 4.3.1 and 4.3.2), limited to our set of ESG indicators, shows that companies' ESG performances generally do not correlate with their disclosure of the corresponding SDGs, or to a minimal extent. The rare instances of correlation observed in Table 3 suggest that companies tend to emphasize their favorable performances while underreporting negative impacts that could be related to the SDGs (one case found only with SDG 3; cf. Table 3). This is consistent with previous studies (e.g., KPMG, 2020; van der Waal & Thijssens, 2020) indicating a strong emphasis on positive impacts over negative impacts related to the SDGs.

Our empirical findings are aligned with previous qualitative (e.g., Silva, 2021) and quantitative (Emma & Jennifer, 2021; Nicolo' et al., 2023) studies suggesting that businesses prioritize the strategic nature of SDG reporting within the context of legitimacy perspective. This raises concerns about "SDG-washing" where companies communicate SDG-related measures without assessing their effectiveness. This is consistent with previous studies highlighting a lack of reporting on measurable indicators (PwC, 2019; Silva, 2021). Insufficient resources and support for companies, particularly the lack of methodology and tools to evaluate their progress and performance toward SDGs, could be the underlying cause for the disconnect between corporate sustainability indicators and SDG reporting. According to a study by del Río et al. (2023), there are concerns about the possibility of SDG-washing due to discrepancies between guiding indicators (SDG Compass) and expert-based indicators (external agency assessment). To avoid SDG-washing, it is essential to establish a comprehensive and standardized framework for corporate SDG indicators.

The lack of comprehensive and conclusive indicators indeed hinders effective monitoring and evaluation of the private sector's progress toward achieving the SDGs (Rashed & Shah, 2021). Composite indicators have been increasingly utilized to capture the multi-faceted nature of the SDGs (Khaled et al., 2021; Sachs et al., 2023; Schmidt-Traub et al., 2017) due to their well-known strengths (Olsthoorn et al., 2001). However, the results demonstrated that composite indicators exhibited correlations with the reporting of multiple SDGs, complicating the interpretation of their correlations to SDG reporting. Improving these metrics could lead companies and stakeholders to misinterpret the company's performance on the SDGs. Our research emphasizes the necessity for a harmonized set of corporate sustainability indicators that comprehensively capture the SDGs, while reflecting the specific aspects within them.

Our analysis of the relationship between SDG reporting and ESG performance was based on limited indicators. The United Nations Conference on Trade and Development proposed 34 core indicators explicitly focusing on SDG indicators relevant to businesses (UN, 2022). This work could serve as a starting point for improving the list of indicators for future analyses. However, it is essential to include indicators beyond this current list and the guidance indicators in the next study, as they were not collectively exhaustive. Including process-oriented indicators, such as implementation of policies and activities, in the quantitative and qualitative analysis is essential to determine whether SDG reporting depends on policies, activities, or actual performance.

4.4 | Corporate sustainability reporting requirements and SDGs

While mandatory climate-related reporting is the most advanced area (Luo & Tang, 2022), we observe the emergence of more comprehensive disclosure requirements for companies in some countries in response to the SDGs and their 2030 Agenda (Christensen et al., 2021). For example, in Europe, the Corporate Sustainability Reporting Directive (CSRD) was introduced in 2020 as part of the European Green Deal, amending the Non-Financial Reporting Directive (NFRD) and making fundamental changes to mandatory ESG reporting (European Union, 2022). It includes uniform reporting standards and policy measures to combat the climate crisis and advance the 2030 Agenda. Under the CSRD, reporting requirements have now extended to small listed companies. In Section 4.1, a small number of SMEs were found to have reported on their activities in relation to the SDGs. The implementation of this regulation can be anticipated to be a significant driver for SMEs in the EU, changing the outlook for nonfinancial disclosure among them from 2026 onwards (European Commission, 2023). Companies subject to the CSRD must follow the European Sustainability Reporting Standards (ESRS), which facilitates cohesiveness with other initiatives and regulations (e.g., Regulation [EU] 2020/852—Sustainable Finance Taxonomy) (EFRAG, 2022). The ESRS requires comprehensive disclosure in the areas of environmental (E), social (S), and governance (G), embedded with the SDGs suitable for corporate engagement and reporting (EFRAG, 2022). Under that standard, audit and assurance of reported information will become mandatory, making the CSRD an important step in the fight against greenwashing.

Outside of the EU, the United States (US) Securities and Exchange Commission has proposed a climate disclosure rule in 2022 (U.S. Securities and Exchange Commission, 2022). While this rule may increase reported information on SDG 13 and other related SDGs (e.g., SDGs 3 on well-being and human health and SDG 7 on affordable and clean energy), reporting on other sustainability issues still requires attention as other SDGs may be impacted by the advancement of SDG 13 (Pham-Truffert et al., 2019).

The establishment of regulatory requirements for corporate sustainability practices could affect how companies integrate and communicate the SDGs (Christensen et al., 2021). To ensure the effective implementation of the SDGs, scientifically sound guidance or methodology for assessing the progress toward the SDGs in corporations is crucial. Such an approach should consider the complexity of the SDGs and the business value chain. Additionally, it is essential to continuously monitor how businesses operate and communicate their efforts toward the SDGs.

5 | CONCLUSIONS AND RECOMMENDATIONS

In this study, extensive company datasets focusing on SDG reporting were analyzed to identify trends and patterns worldwide. Data from 8529/49 companies worldwide were analyzed to provide an overview of SDG reporting trends from 2019 to 2021 and shed light on the broader business community's engagement with the SDGs through three analyses. Our research carries several implications from a theoretical standpoint. From a legitimacy perspective, the growing trend of extensive coverage of the SDGs suggests that companies recognize the importance of aligning with socially constructed norms. However, there is insufficient evidence to establish any relationships between ESG performance metrics (i.e., year-over-year changes in each company's performance and ESG performance relative to the average ESG performance of the sample analyzed) and SDG reporting, as most relationships are not statistically significant. Nonetheless, the few significant relationships suggest that companies with positive performance on specific ESG metrics are more inclined to communicate their commitment to relevant SDGs, indicating the strategic nature of SDG reporting within the broader context of legitimacy. This finding adds to current research by considering changes in corporate sustainability performance. The factors influencing companies' SDG reporting were explored. The findings suggest that regional differences, industry-specific challenges, income level, and business size have shaped the emphasis on specific SDGs, highlighting contextual dependencies across multiple SDGs. They also suggest that a disproportionate burden is placed on certain subregions or sectors.

Given the indivisibility of the SDGs, the potential relationships among the reported SDGs were investigated. The co-occurrence matrix reveals both high and limited co-occurrence rates between multiple SDGs. The limited co-occurrence rates occur when the pairing SDGs are the least reported, raising questions about the broader implications for achieving sustainability goals. The progress of the reported SDGs could be affected by their limited co-occurrence with another, depending on whether the scientific community identified them as trade-offs or co-benefits. While the co-occurrence analysis reveals possible links between the reported SDGs, mere co-occurrence does not necessarily imply that companies are aware of SDG linkages.

In light of these results, this study raises potential research and policy implications. Researchers, decision-makers, and policymakers should work together to develop targeted interventions to effectively integrate the SDGs into businesses. An essential measure of SDG engagement is the establishment of a standardized framework to assess companies' integration and contributions to the SDGs. SDG guides (e.g., SDG Compass) and consultants have advised companies to identify SDGs that are relevant to their core business. While this approach has been seen as pragmatic, it could hinder progress toward the SDGs if companies do not think more scientifically about their relevant SDGs. To ensure a more systematic, effective, and objective engagement with the SDGs, any future framework should include, but not be limited to, the following:

i. A process for identifying relevant SDGs based on their contribution to the global value chain and the dynamics between the three systems: biosphere, technosphere, and sociosphere.

ii. A standardized SDG progress assessment framework that can be adapted to the company level, and broader guidance on how to select relevant SDG indicators, accounting for interlinkages.

These elements are expected to prevent companies from simply "icon-picking" SDGs without addressing the real issues that need to be addressed in their context. It is thus expected to strengthen the link between corporate sustainability performances and actual progress toward the SDGs.

In addition, the regulatory context can be of great help to reinforce the implementation of SDG in businesses. Indeed, new reporting regulations, for example in Europe and the United States, have emerged to increase nonfinancial disclosure and combat corporate greenwashing. The impact of these regulations on how companies address SDGs in their operations and, ultimately, how they communicate about them in their reporting, is potentially significant. Therefore, regulatory bodies should carefully consider the process of integrating the SDGs into business operations. This includes understanding the interlinkages of the SDGs and developing a coherent indicator framework that promotes transparency and accountability in sustainability reporting. The emerging reporting requirements also call for renewed efforts to monitor how companies take up the SDGs as part of their operations and how they manage their communications. Apart from the reporting, policymakers can also address uneven SDG progress by establishing regulatory and incentive measures and fostering collaboration across industries and stakeholders in global value chains.

In addition to our major recommendations, it is important to note that our study carries some limitations calling for further research. First, the sample we used primarily consisted of large companies and entities included in existing indices, which makes it difficult to generalize the results to other types of companies. Second, the dataset we used relied on dichotomous values for SDG reporting, and there was a lack of detailed information on SDG-related activities, which can make it challenging to explore interconnections at the company level. To make the analysis more robust, future research should prioritize large-scale analysis of reported SDG activities extracted from corporate disclosures. Furthermore, our analysis of the relationships between SDG reporting and ESG performance was limited to a subset of outcome-oriented indicators. Therefore, future studies should prioritize including a more extensive set of indicators, including process-oriented indicators. Finally, it is essential to investigate the potential temporal sequence of relationships between ESG progress and SDG reporting for comprehensively understanding the dependencies between SDG reporting and corporate performances. Last but not least, conducting additional empirical research on SDG implementation within the public sector could offer a holistic assessment of progress toward the SDGs. This research would enable a deeper understanding of the various entities involved and their impact on achieving the SDGs.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A

TABLE A1 Distribution of analyzed observations across dataset categories.

Breakdown by subregion		Business sector	
Australia and New Zealand	2%	Academic & educational services	0%
Central Asia	0%	Applied resources	1%
Eastern Asia	19%	Automobiles & auto parts	2%
Eastern Europe	1%	Banking & investment services	11%
Latin America and the Caribbean (LAC)	2%	Chemicals	3%
Northern Africa	0%	Collective investments	0%
Northern America	42%	Consumer goods conglomerates	1%
Northern Europe	14%	Cyclical consumer products	4%
South-eastern Asia	4%	Cyclical consumer services	5%
Southern Asia	1%	Energy - fossil fuels	4%
Southern Europe	3%	Financial technology (Fintech) & infrastructure	0%
Sub-Saharan Africa	1%	Food & beverages	4%
Western Asia	2%	Food & drug retailing	1%
Western Europe	10%	Healthcare services & equipment	4%
Total	100%	Industrial & Commercial Services	6%
		Industrial goods	7%
Country income level		Insurance	2%
High income	80%	Investment holding companies	0%
Low income	0%	Mineral resources	4%
Lower-middle income	2%	Personal & household products & services	1%
Part of GBR	0%	Pharmaceuticals & medical research	8%
Upper-middle income	18%	Real estate	6%
Total	100%	Renewable energy	1%
		Retailers	3%
Business size[a]		Software & IT services	7%
Large	86%	Technology equipment	5%
Small/medium enterprises (SMEs)	14%	Telecommunications services	2%
Total	100%	Transportation	3%
		Uranium	0%
		Utilities	3%
		Total	100%

Note: Several features display 0% due to a small number of samples with those characteristics (ranging from 1 to 33 observations).
[a]Companies were classified into two sizes, which are large and SMEs, based on the number of full-time employees. We refer to a criterion given by the Organization for Economic Co-operation and Development (OECD) (https://data.oecd.org/entrepreneur/enterprises-by-business-size.htm, Accessed on February 28, 2023).