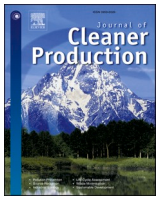
Journal of Cleaner Production 496 (2025) 145143

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



CEOs' and directors' perspective towards environmental sustainability and climate change

Mariana Barbedo [d], Paulo Rita [d,*], Ricardo Ramos [a,b,c]

[a] Instituto Politécnico de Coimbra, ESTGOH, Rua General Santos Costa, 3400-124, Oliveira do Hospital, Portugal
[b] Research Centre for Natural Resources Environment and Society (CERNAS), Polytechnic Institute of Coimbra, Bencanta, 3045-601, Coimbra, Portugal
[c] Instituto Universitário de Lisboa (ISCTE-IUL), ISTAR, Av. Forças Armadas, 1649-026, Lisboa, Portugal
[d] NOVA Information Management School (NOVA IMS), Universidade NOVA de Lisboa, Campus de Campolide, 1070-312, Lisboa, Portugal

ARTICLE INFO

Handling editor: Mattias Lindahl

Keywords:
Environmental sustainability
Climate change
CEOs
Directors
BERT sentiment analysis
BERTopic modeling
World economic forum

ABSTRACT

Understanding leadership perspectives on environmental issues is fundamental in an era where corporate sustainability is a global priority. This study explores the views of CEOs and Directors on environmental sustainability and climate change, investigating how their demographic and professional characteristics are associated with their sentiments. By analyzing 761 comments from the World Economic Forum LinkedIn page, we applied a BERT sentiment analysis and BERTopic modeling to evaluate the sentiments and identify relevant topics. Additionally, Heteroskedasticity-Robust Standard Errors were used to estimate the relationships between variables. Our results reveal that Directors and female leaders exhibit more positive attitudes toward sustainability, and a significant correlation exists between a leader's number of followers and their positive sentiment toward environmental issues. These findings broadly analyze decision-makers' perspectives, supporting strategies for effective engagement plans and policies for these influential stakeholders.

1. Introduction

Climate change is decisive for companies (Terent'ev, 2021). The forecast model published by the OECD predicts that, with temperature rising between 1.5 and 4.5 °C, the annual GDP growth reduction until 2060 could be around two percentage points. This impact is attributed to declining productivity, other adverse health effects on the population, and harm to agriculture (OECD, 2015). Accordingly, the corporate world is witnessing a growing preoccupation with social and environmental dimensions of business performance as stakeholders demand greater responsibility from organizations (Temminck et al., 2015). The consequences of environmental degradation significantly threaten our ecosystem and economic stability, calling for business action to ensure a sustainable future for future generations (Lambin et al., 2018). Managers are vital in balancing business profitability with societal and regulatory demands (Waring, 2008). They are critical in promoting commitment to sustainability efforts to address climate change.

Managers' decisions reflect the strategic organization priorities and corporate culture, shaped by these priorities and their values. These personal values influence leaders' willingness to engage with sustainability challenges (Bacinello et al., 2020). When aligned with corporate governance, these personal beliefs and values give CEOs and boards a solid foundation for prioritizing climate-related initiatives, demonstrating their commitment to sustainability. Personal convictions are a motivational foundation for leaders, shaping their view of sustainability as essential to business success (Mardini and Lahyani, 2024). Additionally, the specific impact of demographic and professional characteristics, such as gender, educational background, professional experience, or culture, on leaders' attitudes toward environmental issues influences the decision-making process and the implementation of sustainable practices within the organizations (Kassinis et al., 2016; Mansi and Pandey, 2016).

Although the impact of corporate governance on sustainability practices is well-documented, less attention has been paid to understanding the personal perspectives of key decision-makers. While previous studies have explored the impact of board attributes, characteristics, diversity and corporate governance on environmental sustainability (Agnese et al., 2023; Alta'any et al., 2024; Disli et al., 2022; Githaiga and Kosgei, 2023; Mardini and Lahyani, 2024; Nguyen and Thanh, 2022), they primarily focused on structural and organizational influences and not adequately addressed the individual perspectives of top leadership, such as demographic and professional

* Corresponding author.
E-mail address: prita@novaims.unl.pt (P. Rita).

https://doi.org/10.1016/j.jclepro.2025.145143
Received 14 March 2024; Received in revised form 30 January 2025; Accepted 24 February 2025
Available online 25 February 2025

characteristics. These studies highlight fundamental aspects such as board size, independence, and governance mechanisms, but they also overlook top executives' personal beliefs and demographic and professional characteristics. This oversight persists despite the evolving expectations for corporate leadership in the face of global environmental challenges. Our study aims to bridge this gap by concentrating on the personal viewpoints on Environmental Sustainability and Climate Change, thereby adding value to our understanding of the topic.

Therefore, this study aims to address the following research questions.

RQ1: What are CEOs' and directors' perspectives regarding Environmental Sustainability and Climate Change?
RQ2: To what extent do demographic and professional characteristics associate with the CEOs and Directors' satisfaction regarding Environmental Sustainability and Climate Change?

This exploratory study aims to understand CEOs and Directors' perspectives regarding Environmental Sustainability and Climate Change and whether their characteristics are associated with variations in these viewpoints. Online reviews by CEOs and Directors on the prestigious non-governmental organization World Economic Forum's (WEF) LinkedIn page were collected and analyzed using text mining techniques. The sentiments and topics derived from this analysis offer insights into the diverse opinions of CEOs and Directors, allowing for a more comprehensive understanding of their perspectives on this study theme. Moreover, by comparing these individuals' demographic and professional characteristics, it is possible to identify patterns and correlations influencing their views on these crucial matters.

The results expect to offer practical insights for stakeholders, such as investors, policymakers, and employees, who are sensitive to understanding the mindsets of business leaders in the climate crisis era. By identifying the patterns and trends in CEOs' and Directors' views, this research also helps predict and guide future corporate actions toward sustainability, thus contributing to global efforts against climate change.

2. Literature review

Understanding the association between of corporate leadership on environmental sustainability practices is fundamental in addressing global environmental challenges (Ahmadi-Gh and Bello-Pintado, 2022). Meeting the demand for sustainable business performance in today's environment necessitates integrating a sustainable approach into the core operations (Phillips et al., 2019). When studying organizational environmental actions, the perspectives concerning CEOs and directors should be considered.

2.1. Managers' perspectives on environmental sustainability and climate change

Understanding managers' perspectives on environmental sustainability and climate change is fundamental, as these leaders play a central role in shaping their organizations' responses to environmental challenges (Chams and García-Blandón, 2019). Managers' decisions directly impact corporate strategies toward sustainability, influencing how companies can mitigate climate change effects and contribute to long-term planetary health (Lambin et al., 2018). The need to adapt business practices to the increasing demands of environmental protection calls for a deep understanding of how managers interpret and react to these challenges.

Environmental understanding among managers refers to their ability to acknowledge key environmental concepts, challenges, and the broader impacts of their decisions on sustainability (Cantor et al., 2012). This comprehension extends beyond theoretical knowledge, encompassing the capacity to model behaviors that promote eco-friendly practices within their organizations. Such understanding is fundamental in fostering an internal culture prioritizing sustainability, influencing everything from daily operational choices to long-term strategic planning (Bacinello et al., 2020).

Research has shown that a complex combination of personal values, societal norms, and the regulatory environment influences manager's environmental perspectives. Individual attitudes and the broader sociocultural context significantly shape sustainable behaviors (Halder et al., 2020; Stern, 2000). Furthermore, leadership styles drive systemic changes necessary for sustainable development (Díaz et al., 2019). Managers' strategies can directly mitigate environmental impacts, emphasizing the direct connection between leadership decisions and environmental outcomes.

2.2. Personal beliefs and values on the decision-making process

Exploring the role of personal beliefs and values in the managers' decision-making process is fundamental for understanding the underlying motivations that drive corporate sustainability actions (Kump, 2021). The personal convictions of those who guide organizations play a central role in shaping their companies' environmental strategies and practices (Mardini and Lahyani, 2024). Understanding these personal dimensions can help predict and enhance the effectiveness of sustainability initiatives, aligning them more closely with the leaders' intrinsic motivations.

Personal beliefs and values in decision-making refer to individuals' core principles and standards, which guide their judgments and actions, especially in complex situations such as those involving sustainability challenges (Dalvi-Esfahani et al., 2017). In environmental management, these beliefs and values influence how managers prioritize various sustainability issues, make trade-offs, and commit resources to long-term environmental goals (Waring, 2008). They significantly impact managerial behavior and decision-making (Bacinello et al., 2020). Held values shape how environmental information is interpreted and acted upon in corporate settings (Stern, 2000). Managers with pro-environmental solid values are more likely to implement sustainable practices within their organizations. Furthermore, leaders' commitments to sustainability can drive broader organizational changes and influence corporate culture toward greater environmental responsibility (Kump, 2021).

Despite extensive research, a gap exists in understanding how managers' personal beliefs and values influence their perspective on environmental sustainability. Most existing studies aggregate managerial actions without exploring the underlying motivations and beliefs that drive these actions (Amjad et al., 2021; Windolph et al., 2014). New insights can guide more effective engagement strategies and policy formulations to enhance corporate sustainability practices.

2.3. Demographic and professional characteristics of managerial attitudes and beliefs

Understanding the managers' demographic and professional characteristics that influence their attitudes and beliefs in environmental sustainability is crucial, as these traits can significantly shape the strategies and outcomes of corporate sustainability efforts (Kumar, 2023; Zaman et al., 2024). Factors such as gender, culture, experience, and education can determine how managers perceive environmental issues and prioritize them against other business objectives (Kassinis et al., 2016). This understanding is fundamental for designing effective environmental policies and training programs that align with managers' perspectives and drive change.

Demographic characteristics refer to personal attributes such as gender or ethnicity (Goldberg et al., 1998), while professional characteristics include aspects like industry experience or education level (Robinson and Sexton, 1994). In environmental decision-making, these characteristics influence how managers interpret sustainability challenges and opportunities, guiding their strategic choices and leadership

styles in addressing such issues (Chams and García-Blandón, 2019).

Demographic and professional characteristics impact managerial behavior toward environmental sustainability. For instance, women are more likely to be concerned about the environment and climate change than men, expressing more pro-environmental attitudes (McCright, 2010; Zelezny et al., 2000). Furthermore, regional studies suggest that cultural and geographical factors also play a role; European and Asian CEOs have shown different levels of engagement with sustainability practices (Lopatta et al., 2022; Zhang and Liu, 2022). This can be explained by national culture theory, which suggests that managers' environmental attitudes and behaviors vary across different cultures and geographical regions (Song et al., 2018). Hofstede's cultural dimensions theory identifies several dimensions of natural culture, including power distance, individualism vs. collectivism, masculinity vs. femininity, uncertainty avoidance, long-term orientation, and indulgence vs. restraint (Huang et al., 2024). These cultural dimensions can influence how leaders perceive and respond to environmental challenges. Attitude is also influenced by professional background. For instance, CEOs with previous experiences affected their approaches to sustainability disclosures and Corporate Social Responsibility (CSR) initiatives (Ghardallou, 2022; Khalid et al., 2022), while directors with international orientation are keen towards sustainable development (Dobija et al., 2023).

Despite the existing research, there is a gap in analyzing how managers' demographic and professional characteristics influence attitudes and beliefs about environmental sustainability across different contexts. This study examines how these variables influence managers' attitudes and beliefs to foster more effective environmental governance.

3. Methodology

This study investigated CEOs' and Directors' perspectives on environmental sustainability and climate change using comments published on the WEF LinkedIn page. The individual comments on this platform provide an accessible alternative to traditional survey methods, bypassing constraints related to respondents' availability and facilitating data collection at scale. Text mining and statistical analyses were computed to acknowledge the perspectives towards environmental sustainability and climate change.

3.1. Data collection and preparation

Online comments were collected from posts published on LinkedIn's WEF page. Online reviews have been used to understand the perspective and experience of professionals (Ramos et al., 2021). LinkedIn was selected due to its professional profile, making it easier to access the professionals' comments (López-Carril et al., 2020). In the current business scenario, professionals establish a strong presence on LinkedIn, engaging with substantial to enhance their professional reputation, sharing viewpoints, sustainable practices, and upcoming initiatives (Lipińska, 2018). The non-governmental organization WEF was chosen since it is one of the leading worldwide associations that seeks to provide new information and knowledge to discuss essential and updated themes regarding environmental sustainability and climate change (Miró, 2020).

A total of 1042 online reviews were collected from 108 published posts on the WEF LinkedIn page that contained the hashtags #Environment, #Sustainability, and #Climatechange, following the approach of previous studies (Pilař et al., 2019). Additionally, only comments from CEOs and Directors were considered. From each comment, the individual profile was verified to acknowledge the individual's company role. The 'CEO' title was attributed to those with the position of CEO, and those with high-level executive titles and senior director positions (e.g., Director of Logistics or Chief Operating Officer) were designated as 'Directors'. Directors hold significant leadership responsibilities that involve substantial decision-making authority (Kelly and Gennard, 2007). Only those with no less than five words were considered to retrieve relevant information from each comment. This option permitted the elimination of comments that do not contain a detailed opinion, such as a name tag, and comments such as "great", "good news", or "finally a great post". Longer reviews contain more information, offering a more complete and detailed opinion (Huang et al., 2023). This process led to the elimination of 281 comments. The final dataset included 761 comments (31% from individuals titled 'CEO' and 69% from 'Director').

All countries were aggregated into continents (Europe, America, Asia, Oceania, and Africa), and an individual variable was created to evaluate each continent alone. Following previous studies, comments in languages other than English were translated through the Python package Google Translate API ('googletrans' library) (Galhoz et al., 2024). A gender variable was created to study females ('female' = 0) and males ('male' = 1).

The variables depicted in Table 1 were extracted from each comment's profile.

3.2. Data analysis

Data were analyzed using text mining techniques. Text mining extracts information, selects themes, and identifies trends from unstructured textual data (Ramos et al., 2019). For this study, BERT sentiment analysis and BERTopic modeling were computed. Sentiment analysis classifies the sentiment using natural language processing (NLP) techniques, revealing information about the emotional tone of the remarks (Rita et al., 2022).

3.2.1. Sentiment Analysis

Sentiment analysis involves identifying the sentiment expressed within an unstructured text (Moro et al., 2020). This approach made it possible to detect the CEO's and Directors' sentiments through their comments. The comments sentiment was extracted using the BERT base multilingual uncased sentiment model. The BERT models are context-sensitive, returning more accurate results (Susnjak, 2024; Yves, 2020). To perform sentiment analysis, the data was preprocessed to normalize the dataset to maximize the model's efficacy. Following data normalization approaches, several steps were conducted: the 'emoji' package was used to transform emojis into text as they are used to represent sentiments (Palomino and Aider, 2022). The 're' package was used to transform the text into lowercase, and the 'contractions' package was used to expand words into their full expression (e.g., 'it's' to 'it is') to improve the readability and offer coherence in the analysis.

Additionally, the reviews were tokenized. Tokenization splits text streams into phrases or small chunks of textual material. Tokens are pieces of text that make complex textual content straightforward, simplifying the text-mining process. Stop words and Hyperlinks repeatedly appearing in text files were removed (Rita et al., 2022). The sentiment output reveals a numerical sentiment ranging from 1 (very dissatisfied) to 5 (very satisfied). All experiments were conducted in Python.

3.2.2. Regression analysis

For a deeper analysis, we adopted Heteroskedasticity-Robust Standard Errors to estimate the relationships among variables. This approach specifically aims to provide more accurate and reliable statistical inferences, as it adjusts the standard errors of the regression coefficients to account for potential heteroskedasticity (Atkinson et al., 2016; Hayes and Cai, 2007). This method ensures the robustness of the results against any inconsistencies in error variance across observations.

The regression analysis was conducted to explain the sentiment category considering all variables simultaneously, where the dependent variable is 'Sentiment'. This study's p-value of 0.05 or less is considered statistically significant (Calinski et al., 1990).

The regression model can be expressed as follows (equation (1)):

Table 1
Extracted variables: Distribution and averages.

Variable	Description	Distribution – Categorical Variables	Average – Quantitative Variables
Occupation	CEO and Directors	31% CEOs 69% Directors	
Gender	Male or female	78% male 22% female	
Followers	Number of followers		3244
Continent	Continent of origin	40% Europe 28% America 21% Asia 6% Oceania 4% Africa	
Total Jobs	Number of jobs		7
Years Experience	Years of working experience		23
Bachelor	With a bachelor's degree	88% have a bachelor	
Nr Education	Number of education qualifications		3
Volunteer	Volunteer experience (yes/no)	67% yes 33% no	
Received	Received recommendations		3
Given	Recommendations given on the profile		3
Groups	Number of groups		21
Comments	Comment posted by the user		1

$$\begin{aligned} Sentiment = {} & \beta 0 + \beta 1^{*}(\text{Occupation}) + \beta 2^{*}(\text{Female}) + \beta 3^{*}(\text{Followers}) \\ & + \beta 4^{*}(\text{Total Jobs}) + \beta 5^{*}(\text{Years of Experience}) + \beta 6^{*}(\text{Bachelor}) \\ & + \beta 7^{*}(\text{Number Education}) + \beta 8^{*}(\text{Volunteer}) \\ & + \beta 9^{*}(\text{Recommendations Received}) \\ & + \beta 10^{*}(\text{Recommendations Given}) + \beta 11^{*}(\text{Groups}) + \beta 12^{*}(\text{Africa}) \\ & + \beta 13^{*}(\text{Asia}) + \beta 14^{*}(\text{Oceania}) + \beta 15^{*}(\text{America}) \end{aligned} \quad (1)$$

Each Beta (β) coefficient represents the expected change in the dependent variable 'Sentiment' for a one-unit change in the respective independent variable, assuming that all other variables are held constant (Field, 2018). $\beta 0$ represents the interception, the expected value of the dependent variable when all the independent variables are zero. The β coefficients for these variables ($\beta 1$ to $\beta 15$) quantify their contribution to the sentiment while controlling the other variables in the model (Hair et al., 2014). To ensure the statistical significance of our findings, variables with high p-values were excluded from the final model, focusing on only the most influential factors. This approach helped identify the variables that significantly contributed to explaining the sentiment expressed by CEOs.

Dummy variable regression is valuable for incorporating categorical predictors into a regression model, such as geographic location (Yip and Tsang, 2007). Creating dummy variables for each continent was used to study the impact of geography on CEOs' sentiments. Since Europe has the highest frequency of observations, Europe was used as the reference category (base case scenario). This means that the coefficients of other dummy variables would represent the difference in the dependent variable (sentiment) between the respective geographical location and Europe.

In the 'Sentiment Analysis across variable divisions' section, a *t*-test to compare the two independent groups was employed. The *t*-test is a statistical hypothesis test used to determine whether there is a significant difference between the means of two groups (Liu and Wang, 2021). When the p-value from the *t*-test is less than our predetermined significance level ($p < 0.05$), we can reject the null hypothesis of equal means, suggesting a statistically significant difference between the two groups (Calinski et al., 1990). For this analysis, the results for each variable were divided into two groups. For the numerical variables, the median is the dividing line. The choice of the median is justified as it splits the data into two halves, thus ensuring the comparability of the groups (Hauke and Kossowski, 2011). Logical divisions were made for the categorical variables. For instance, if a categorical variable is binary (such as yes or no), these become the two groups. Group division based on a natural or logical cutoff enhances analysis interpretability and facilitates meaningful comparisons.

3.2.3. Topic modeling

Topic modeling extracts topics from large volumes of unstructured text to detect hidden topics (Correia et al., 2023). For this approach, the BERTopic modeling was employed. The BERTopic modeling model is grounded on Transformers using BERT embeddings and c-TF-IDF to reveal hidden information within the textual data on consistent topics (Kim et al., 2024). Previous topic modeling analyses are grounded on a frequency-based approach (e.g., Latent Dirichlet Allocation or Non-negative Matrix Factorization). However, the BERTopic modeling is context-sensitive, outperforming other topic modeling methods in capturing the information and generating coherent topics (Egger and Yu, 2022; Udupa et al., 2022). The 'contractions' package was employed for text preprocessing to expand the terms. Only nouns (elements/concepts), verbs (actions/intentions), and adjectives (emotions) were retained (Correia et al., 2023), and lemmatization (i.e., normalize terms into their root form - lemma; e.g., 'environmental' and 'environments' = 'environment') was used to reduce the variability of the terms and provide more accurate results (Berger et al., 2020). The 'Spacy' library was used for natural language processing, including tokenization, lemmatization, and filtering part of speech. The BERTopic modeling approach employs the UMAP (Uniform Manifold Approximation) to reduce the dimensionality and maintain the data's local and global structure, guaranteeing more accurate results (Egger and Yu, 2022). Additionally, it uses the HDBSCAN (Hierarchical Density-Based Spatial Clustering of Applications with Noise) to create dense clusters, providing more interpretable topics, and to isolate outliers to provide more accurate results (Stewart and Al-Khassaweneh, 2022). Using a combination of modeling and topic probabilities, the BERTopic modeling finds the optimal number of topics automatically. Through the β parameter, the terms that best match the topic are revealed. A higher β value suggests a stronger relationship with the topic. 'Matplotlib' library was used for data visualization, and experiments were conducted using Python.

4. Results and discussion

4.1. CEOs' and directors' convergent perspectives

To address RQ1, sentiment analysis and topic modeling approaches were used to uncover the underlying perspectives expressed toward Environmental Sustainability and Climate Change.

The general sentiment characterization is expressed in Table 2.

The results express a generally positive sentiment among the CEOs and Directors. Including the 'satisfied' and 'very satisfied' results, 51% revealed a positive sentiment when exposed to new information and knowledge to mitigate climate change. CEOs and Directors' positive reactions are fundamental for the industry to adopt measures to mitigate climate change and promote environmental sustainability. Companies assume responsibility for their impact by reducing their footprint and driving change toward a sustainable future (Saevarsdottir et al., 2020).

The BERTopic modeling results revealed five topics and one outlier topic (Fig. 1). These topics provide a high-level view of the preliminary discussions, and the associated terms offer deeper insights into the ideas that characterize each topic. In each topic, the words are arranged in decreasing order of β values; therefore, the greater the bar, the higher the representativeness of the word with the topic. The HDBSCAN analysis revealed an outlier topic (Topic −1). Although some terms are similar terms used in other topics, the BERTopic identifies them in different contexts or uses, considering them outliers. The results suggest five primary themes in the CEOs and Directors discourse: 'urgency of action' (Topic 0), 'recycling and plastic reduction' (Topic 1), 'water sustainability and ecosystem conservation' (Topic 2), 'social media impact on environmental discourse and action' (Topic 3), and 'CSR and sustainability initiatives' (Topic 4).

The 'Urgency for Action' topic (Topic 0) is a broadband topic. However, it represents a call to action or a sense of urgency regarding climate change. It captures a general discourse on the urgency of addressing climate change and the urgency of immediate and effective action, demanding a collective responsibility and the need for transformative actions. Individual and societal actions significantly influence sustainability outcomes (IPCC, 2018; Stern, 2000). The company's leaders' reactions suggest their agreement for more proactive measures to fight climate change. These results align with the increased awareness and urgency discussed in the literature concerning imminent environmental crises and the crucial role of swift action (Díaz et al., 2019).

The 'recycling and plastic reduction' topic (Topic 1) suggests a discourse regarding the impact of plastics, especially regarding waste and recycling practices, and the CEOs' and Directors' positive intention of adopting measures to reduce plastic and increase recycling efforts. The topic suggests a general willingness of company leaders to reduce the dependency on plastics, increase recycling efforts, and implement more sustainable practices across operations. This result aligns with a broader environmental issue of CSR (Galhoz et al., 2024). By proactively adopting sustainable measures, companies can stay ahead of regulatory compliance (Willis et al., 2021) and provide companies with a voice in shaping future regulations that affect their industries (Barnes, 2019).

The 'water sustainability and ecosystem conservation' topic (Topic 2) suggests a discourse reflecting the usage and management of water resources, reflecting a broader concern regarding the sustainability of water practices. The inclusion of 'river' and 'sea' suggests a discussion on the environmental impacts on these ecosystems, possibly including pollution or conservation efforts. The results suggest the acknowledgment of CEOs and Directors for the need for solutions to mitigate the negative impacts of water waste and their openness to adopt new technological and methodological practices in water conservation. Water overuse in the industry (e.g., agriculture) is a global concern, and better water management practices are fundamental to mitigate climate change (Salmoral et al., 2020). The emphasis on the urgent need for change and the focus on climate change and water resources mirrors the global discourse about environmental sustainability, as evidenced in the discussions surrounding the Paris Agreement (Rogelj et al., 2016). By mitigating the negative impacts on water ecosystems, companies can enhance their reputation and build trust with stakeholders, including consumers, investors, regulators, and the community (Voogd et al., 2021).

Table 2
– Sentiment classification.

Classification of Comments	Number of Comments	% of the total
Very satisfied	293	39%
Satisfied	95	12%
Neutral	106	14%
Dissatisfied	113	15%
Very dissatisfied	154	20%
Total	761	100%

The 'social media impact on environmental discourse and action' topic (Topic 3) reflects an interaction between professionals concerning climate change, highlighting the casual networking ('friend' and 'goooood') aspect of social media and serious debates ('accuse' and 'screw') over environmental strategies. The informal and disagreement public discourse reflects the ongoing public and private debates about the best paths to sustainability. These discussions can influence public perceptions and policy decisions and reflect the relevance of engagement on platforms such as LinkedIn, which is fundamental for shaping and steering industry responses to environmental challenges (Cann et al., 2021; Walter et al., 2019).

The 'CSR and sustainability initiatives' topic (Topic 4) suggests a discussion on initiatives related to climate change, such as CSR projects or sustainability campaigns that companies are launching or participating in. The term 'voluntourist' may suggest opportunities for employees to engage in sustainable efforts, potentially in partnership with NGOs or local communities (Plewa et al., 2015). Companies such as manufacturing, energy, and technology may showcase these initiatives to demonstrate their commitment to environmental goals, which could serve as differentiators in markets increasingly sensitive to corporate environmental practices (Lii et al., 2013). Positive engagement and visible commitment to meaningful causes can enhance brand reputation and loyalty among customers and attract and retain employees who value CSR, enhancing overall job satisfaction and company culture (Moro et al., 2020).

These results match the prevalent sentiment in the literature that encourages the sharing of successful sustainability initiatives. This positive reinforcement promotes networking and replication of best practices in different contexts, fostering an overall culture of sustainability (Porter and Kramer, 2007).

4.2. Impact of demographic and professional characteristics on sentiment responses

This section outlines the impact of the demographic and professional characteristics influencing the CEO's and Directors' sentiment responses to RQ2. This analysis can help understand if demographic and professional characteristics are associated with the positive or negative inclinations of these leaders towards sustainability initiatives. By employing the variables' relationship under study, a deeper interpretation of the data is acknowledged, enabling informed decision-making and insight development.

Our data were analyzed using heteroskedasticity-robust standard errors. This approach addresses the potential issue of non-constant variance in the error terms (Atkinson et al., 2016), which is relevant given the diverse nature of our dataset that addresses multiple demographic and professional characteristics. The robust analysis provides a more conservative statistical significance estimation, ensuring that outliers do not influence the results (Hayes and Cai, 2007). Considering the sentiment as the dependent variable, the variables Occupation, Gender, and Followers are the ones with significant coefficients from the analysis ($p < 0.05$) (Table 3).

The significant findings for the Occupation variable indicate a distinctly different sentiment expressed by Directors and CEOs, with Directors exhibiting a more positive perspective toward environmental sustainability and climate change. This result reveals different leadership attitudes within organizations. Directors may prioritize long-term

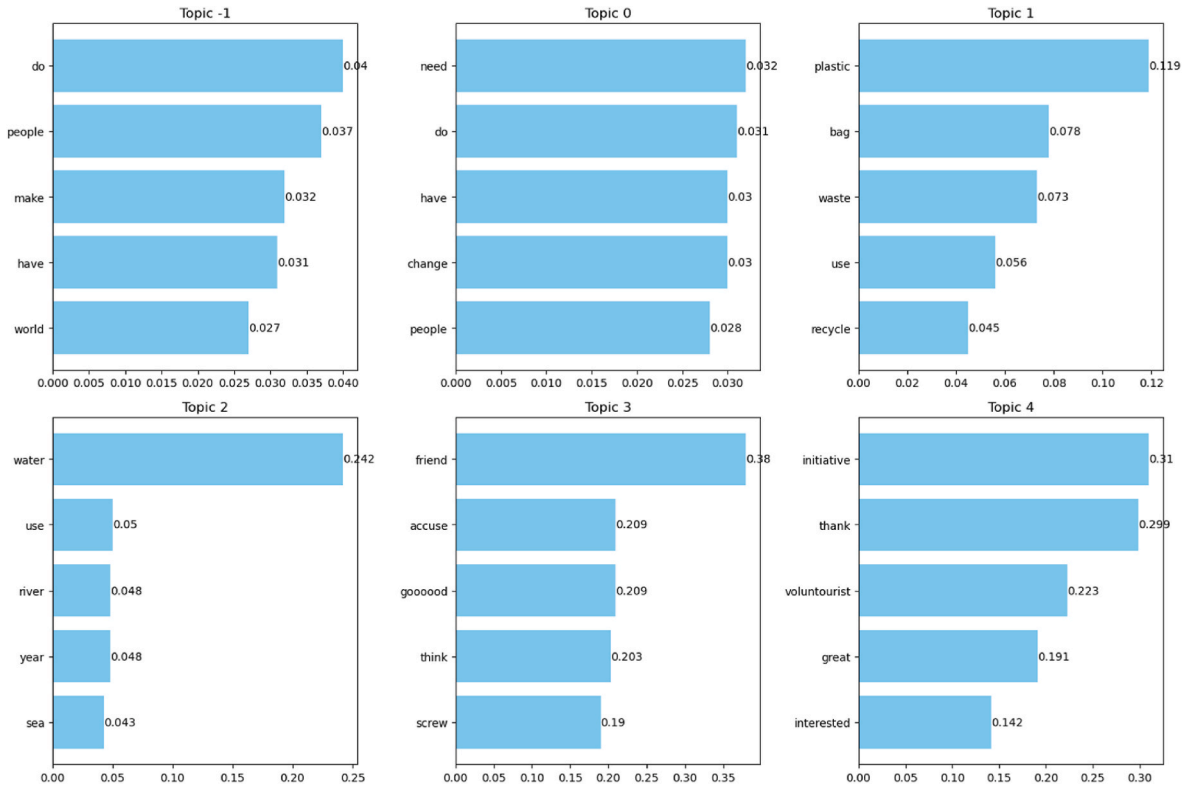


Fig. 1. Topic modeling results.

Table 3
Coefficients and heteroskedasticity-robust standard errors.

Variable	Coefficient	Robust Std. Error	t-Statistic	P-value*	95% Conf. Interval
const	3.5862	0.3098	11.5775	0.0000	[2.978, 4.1943]
Occupation	0.2638	0.1300	2.0298	**0.0427**	[0.0087, 0.5190]
Gender (male)	−0.3614	0.1374	−2.6298	**0.0087**	[-0.6311, −0.916]
Followers	1.27e-05	6.20e-06	2.0471	**0.0410**	[5,20e-07, 2,49e-05]
Total Jobs	0.0021	0.0130	0.1612	0.8720	[-0.0234, 0.276]
Years Experience	−0.0032	0.0055	−0.5761	0.5647	[-0.0139, 0.0076]
Bachelor	0.1768	0.1956	0.9039	0.3664	[0.2072, 0.5607]
Number of Education	−0.0013	0.0271	−0.0467	0.9627	[-0.0545, 0.0520]
Volunteer	−0.0389	0.1313	−0.2963	0.7671	[-0.2966, 0.2188]
Received	0.0082	0.0093	0.8835	0.3773	[-0.0100, 0.0264]
Given	−0.0025	0.0103	−0.2451	0.8064	[-0.0227, 0.0177]
Groups	−0.0007	0.0031	−0.216	0.8290	[-0.0069, 0.0055]
Continent	−0.0706	0.0435	−1.6235	0.1049	[-0.1561, 0.0148]

* Significance at 5%.

strategic issues, such as environmental sustainability, that are fundamental to corporate health and reputation (Ludwig and Sassen, 2022). Contrarily, CEOs may focus on immediate financial performance and operational concerns (Kartadjumena and Rodgers, 2019). The distinct sentiment revealed by Directors and CEOs can be interpreted through the lens of organizational behavior (Ketprapakorn and Kantabutra, 2022) and stakeholder theory (Bello-Pintado et al., 2023). Often tasked with aligning corporate strategy with long-term shareholder and stakeholder interests, Directors might see proactive environmental strategies as essential for mitigating future risks and leveraging new market opportunities (Huo et al., 2021). This alignment may also reflect their role in governance, where there is increasing pressure to adopt sustainable practices in response to global environmental challenges and stakeholder demands. In turn, the relative reticence of CEOS could stem from the operational challenges and immediate financial implications of implementing such strategies, as shifts toward sustainability might disrupt established operational processes (Chams and García-Blandón, 2019).

The findings regarding the Gender variable show a statistically significant difference in sentiments expressed by male and female leaders, with females exhibiting a more positive perspective towards environmental sustainability and climate change. Given that the gender variable is coded as 'female = 0' and 'male = 1', the negative coefficient indicates that males exhibit less positive sentiment than females towards environmental sustainability. The significant gender difference in sustainability sentiments confirmed by our analysis aligns with existing literature that suggests a correlation between gender and environmental attitudes. Women often express stronger pro-environmental attitudes than men (McCright, 2010; Zelezny et al., 2000). However, our findings contribute new insights by quantifying this effect within the specific context of corporate leadership, an area that could be more exhaustively covered in previous research. Furthermore, Shinbrot et al. (2019) discuss varied perceptions and approaches to leadership based on gender, which supports our findings. However, our study extends this by linking these attitudes directly to environmental sustainability efforts in corporate settings. Gender roles and societal expectations may be associated with leaders' approaches to sustainability. The positive sentiment towards environmental sustainability among female leaders could reflect broader societal trends where women are often seen as more cooperative and altruistic (Birindelli et al., 2019). These traits align well with sustainability and CSR. This linkage suggests that incorporating

diverse gender perspectives in top leadership positions might enhance a company's commitment to sustainability. Additionally, the collaboration between genders is fundamental, indicating that fostering a gender-inclusive leadership team could be beneficial for advancing environmental sustainability policies within organizations.

The Follower's result revealed a statistically significant difference. This result indicates that more followers correlate with more positive sentiments about environmental sustainability. The number of followers can be a proxy for a leader's online influence and visibility (De Veirman et al., 2017). Accordingly, more visible and influential online leaders might be more vocal and positive in their commitments publicly. In addition to potentially influencing public and corporate policies on sustainability, they may feel a heightened sense of accountability, knowing that their actions are closely watched and can significantly influence their organization's reputation. A mismatch between a leader's public statements and their company's actions can lead to accusations of greenwashing, damaging a company's reputation (de Jong et al., 2020). This result can be interpreted through the lens of social accountability and leadership theories (Ruppen and Brugger, 2022; Sajjad et al., 2024). Leaders with larger follower counts may feel a heightened sense of public accountability, prompting them to adopt and express more sustainable and ethically sound practices (Balasubramanian et al., 2021). This public accountability likely pressures leaders to align their statements with their organizational policies to maintain their reputation and avoid the peril of greenwashing (Wang and Chaudhri, 2009). Thus, our findings suggest that social media may be a powerful tool for enhancing corporate transparency and encouraging sustainability practices among high-profile leaders.

The variables number of jobs, years of experience, level of education (bachelor's degree), number of courses taken, participation in volunteer actions, the number of received and given recommendations, number of groups, and continent do not show a statistical association with satisfaction as the p-values were above 5%. The lack of a significant relationship between the number of jobs or the years of experience and sentiment toward sustainability suggests that attitudes towards environmental issues may be less about how long an executive has been in the workforce or the variety of their professional experiences but more about personal values or the specific culture of the industry or culture they are in (Rickaby et al., 2020). Similarly, the level of formal education and additional courses taken do not show a statistical association with sentiments, suggesting that educational background does not necessarily correlate with leaders taking a proactive position on sustainability. This might imply that the type of education, such as specific courses related to sustainability, could be more influential than the level of education (Tasdemir and Gazo, 2020). The volunteer actions, recommendations, and group membership results suggest that social and professional networking do significantly shape leaders' sentiments toward sustainability. This could indicate that while networking and social engagement are valuable for career development and business operations, they are not related to how leaders feel about sustainability. The absence of statistical differences between continents might be related to the global nature of environmental challenges (Chams and García-Blandón, 2019). The international discourse around environmental sustainability may have created a more uniform approach to environmental responsibility among corporate leaders worldwide. This could indicate a shift towards a global corporate culture prioritizing sustainability beyond regional differences.

5. Conclusion

This study aimed to examine two fundamental questions concerning the role of corporate leadership in addressing environmental sustainability and climate change. The first research question (RQ1) aimed to understand the specific perspectives of CEOs and Directors regarding environmental sustainability and climate change. Our findings reveal that the dominant topics discussed include the 'Urgency for action', 'Recycling and Plastic Reduction', 'Water Sustainability and Ecosystem Conservation', 'Social Media Impact on Environmental Discourse and Action', and 'CSR and Sustainability Initiatives'. These topics highlight today's corporate leaders' areas of concern and priority in addressing environmental challenges.

Regarding the second research question (RQ2), our study investigated how demographic and professional characteristics are associated with these leaders' satisfaction and perspectives toward environmental sustainability. The analysis indicated that occupation, gender, and the number of social media followers significantly impact leaders' expressions and sentiments regarding the topic. Directors often displayed a more proactive posture than CEOs, potentially due to their roles involving more governance and oversight (Ludwig and Sassen, 2022). Furthermore, female leaders and those with a more significant following on social media tended to express more positive sentiments toward sustainability, suggesting that public visibility and gender may play crucial roles in shaping environmental advocacy among top executives.

This study represents a significant advance in the field by systematically analyzing how intrinsic and extrinsic factors relate to the environmental discourse among top corporate executives. Integrating quantitative findings regarding demographic influences with qualitative insights into the topics of concern offers an integrated view of how leadership impacts corporate sustainability practices. It also sets the stage for future studies to explore interventions that enhance the effectiveness of corporate leadership in fostering environmental sustainability.

5.1. Theoretical implications

Our study contributes to the fields of leadership, CSR, stakeholder theory, and sustainability management. By revealing that Directors and female leaders exhibit more positive attitudes toward environmental sustainability and climate change, the research enhances leadership theory by highlighting how hierarchical position and gender influence environmental perspectives. This finding supports existing theories on transformational and ethical leadership, emphasizing the importance of leader characteristics when examining organization commitment to environmental issues. The link between the number of followers and positive sentiment toward environmental issues supports social influence theory. This insight helps us understand how social capital and network influence can shape leaders' engagement with sustainability. Additionally, the findings have implications for stakeholder theory and corporate governance. Recognizing that some leader demographics are positively inclined toward environmental issues may guide boards and stakeholders when making leadership appointments or developing engagement strategies.

5.2. Managerial implications

This study's findings highlight the importance of incorporating sustainability into leadership training and development programs. Organizations might consider developing specialized training that enhances leaders' understanding and commitment to sustainability. Given the differences in perspectives towards sustainability based on demographic factors such as gender and role within the organization, companies might adjust their recruitment and promotion strategies to foster diversity in their leadership ranks. The results suggest that Directors may prioritize sustainability more than CEOs. This could guide corporate boards in structuring their governance policies to ensure sustainability is fundamental to strategic discussions and decision-making processes. Understanding that leaders with more followers are more likely to express positive sentiments underscores the importance of active and transparent stakeholder engagement via digital platforms. Organizations might leverage their leaders' social media presence to communicate their sustainability efforts more effectively and build a reputation around being environmentally conscious. Given the potential

reputational risks associated with discrepancies between public statements on sustainability and actual practices (greenwashing), it might be essential to ensure that tangible actions substantiate their sustainability claims.

5.3. Limitations and future research

This study presented some limitations. Data aggregation by continent may need to investigate regional differences due to diverse development and policy levels. WEF may be biased toward Leaders with a high interest in these topics, limiting generalizability. While online comments provide accessible insights into corporate leaders' public statements, acknowledging that they may not always represent personal, intrinsic individual opinions is essential. Their communication or press teams may curate the posts to reflect a strategic image rather than unfiltered personal views. Future research could expand to other levels of stakeholder groups to get a broader view, using diverse data sources for a complete picture, or structure the analysis to study different industries' viewpoints besides all the CEOs and Directors. Additionally, more studies could benefit from applying institutional theory to examine how external pressures, such as regulatory frameworks and industry standards, shape corporate leaders' approaches to sustainability. Future research could explore whether leaders from different cultures prioritize sustainability differently or if experience in specific industries influences their approach to climate change. Another area of interest could be the interaction between corporate governance and personal values, offering further insights. Studies could examine how governance policies can be designed to support leaders' commitments to sustainability. By addressing these topics, future research can build upon the findings of this study and deepen our understanding of the factors that influence corporate leaders' views on environmental sustainability and climate change.

CRediT authorship contribution statement

Mariana Barbedo: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Paulo Rita:** Writing – original draft, Methodology, Formal analysis, Conceptualization. **Ricardo Ramos:** Writing – original draft, Methodology, Formal analysis, 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.

Acknowledgment

Paulo Rita was supported by national funds through FCT (Fundação para a Ciência e a Tecnologia), under the project - UIDB/04152/2020 - Centro de Investigação em Gestão de Informação (MagIC)/NOVA IMS) (https://doi.org/10.54499/UIDB/04152/2020).

Data availability

Data will be made available on request.

References

Agnese, P., Battaglia, F., Busato, F., Taddeo, S., 2023. Do board characteristics affect banks' environmental performance? Glob. Bus. Rev. 0 (0). https://doi.org/10.1177/09721509231162485.

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.

Alta'any, M., Tauringana, V., Zalata, A., Achiro, L.O., 2024. Unpacking sustainability reporting dimensions: the impact of board characteristics. J. Financ. Report. Account. https://doi.org/10.1108/JFRA-09-2023-0568 ahead-of-print.

Amjad, F., Abbas, W., Zia-Ur-Rehman, M., Baig, S.A., Hashim, M., Khan, A., Rehman, H., 2021. Effect of green human resource management practices on organizational sustainability: the mediating role of environmental and employee performance. Environ. Sci. Pollut. Control Ser. 28 (22), 28191–28206. https://doi.org/10.1007/s11356-020-11307-9.

Atkinson, A.C., Riani, M., Torti, F., 2016. Robust methods for heteroskedastic regression. Comput. Stat. Data Anal. 104, 209–222. https://doi.org/10.1016/j.csda.2016.07.002.

Bacinello, E., Tontini, G., Alberton, A., 2020. Influence of maturity on corporate social responsibility and sustainable innovation in business performance. Corp. Soc. Responsib. Environ. Manag. 27 (2), 749–759. https://doi.org/10.1002/csr.1841.

Balasubramanian, S.K., Fang, Y., Yang, Z., 2021. Twitter presence and experience improve corporate social responsibility outcomes. J. Bus. Ethics 173 (4), 737–757. https://doi.org/10.1007/s10551-020-04537-x.

Barnes, S.J., 2019. Out of sight, out of mind: plastic waste exports, psychological distance and consumer plastic purchasing. Glob. Environ. Change 58, 101943. https://doi.org/10.1016/j.gloenvcha.2019.101943.

Bello-Pintado, A., Machuca, J.A.D., Danese, P., 2023. Stakeholder pressures and sustainability practices in manufacturing: consideration of the economic development context. Bus. Strat. Environ. 32 (7), 4084–4102. https://doi.org/10.1002/bse.3355.

Berger, J., Humphreys, A., Ludwig, S., Moe, W.W., Netzer, O., Schweidel, D.A., 2020. Uniting the tribes: using text for marketing insight. J. Market. 84 (1), 1–25. https://doi.org/10.1177/0022242919873106.

Birindelli, G., Iannuzzi, A.P., Savioli, M., 2019. The impact of women leaders on environmental performance: evidence on gender diversity in banks. Corp. Soc. Responsib. Environ. Manag. 26 (6), 1485–1499. https://doi.org/10.1002/csr.1762.

Calinski, T., Moore, D.S., McCabe, G.P., 1990. Introduction to the practice of statistics. Biometrics 46 (3), 884. https://doi.org/10.2307/2532120.

Cann, T.J.B., Weaver, I.S., Williams, H.T.P., 2021. Ideological biases in social sharing of online information about climate change. PLoS One 16 (4), e0250656. https://doi.org/10.1371/journal.pone.0250656.

Cantor, D.E., Morrow, P.C., Montabon, F., 2012. Engagement in environmental behaviors among supply chain management employees: an organizational support theoretical perspective. J. Supply Chain Manag. 48 (3), 33–51. https://doi.org/10.1111/j.1745-493X.2011.03257.x.

Chams, N., García-Blandón, J., 2019. Sustainable or not sustainable? The role of the board of directors. J. Clean. Prod. 226, 1067–1081. https://doi.org/10.1016/j.jclepro.2019.04.118.

Correia, A., Moro, S., Rita, P., 2023. The travel dream experience in pandemic times. Anatolia 34 (3), 373–388. https://doi.org/10.1080/13032917.2022.2041444.

Dalvi-Esfahani, M., Ramayah, T., Rahman, A.A., 2017. Moderating role of personal values on managers' intention to adopt Green IS. Ind. Manag. Data Syst. 117 (3), 582–604. https://doi.org/10.1108/IMDS-02-2016-0049.

de Jong, M.D.T., Huluba, G., Beldad, A.D., 2020. Different shades of greenwashing: consumers' reactions to environmental lies, half-lies, and organizations taking credit for following legal obligations. J. Bus. Tech. Commun. 34 (1), 38–76. https://doi.org/10.1177/1050651919874105.

De Veirman, M., Cauberghe, V., Hudders, L., 2017. Marketing through Instagram influencers: the impact of number of followers and product divergence on brand attitude. Int. J. Advert. 36 (5), 798–828. https://doi.org/10.1080/02650487.2017.1348035.

Díaz, S., Settele, J., Brondízio, E.S., Ngo, H.T., Agard, J., Arneth, A., Balvanera, P., Brauman, K.A., Butchart, S.H.M., Chan, K.M.A., Garibaldi, L.A., Ichii, K., Liu, J., Subramanian, S.M., Midgley, G.F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., et al., 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. Science 366 (6471). https://doi.org/10.1126/science.aax3100.

Disli, M., Yilmaz, M.K., Mohamed, F.F.M., 2022. Board characteristics and sustainability performance: empirical evidence from emerging markets. Sustainability Accounting, Management and Policy Journal 13 (4), 929–952. https://doi.org/10.1108/SAMPJ-09-2020-0313.

Dobija, D., Arena, C., Kozłowski, Ł., Krasodomska, J., Godawska, J., 2023. Towards sustainable development: the role of directors' international orientation and their diversity for non-financial disclosure. Corp. Soc. Responsib. Environ. Manag. 30 (1), 66–90. https://doi.org/10.1002/csr.2339.

Egger, R., Yu, J., 2022. A topic modeling comparison between LDA, NMF, Top2Vec, and BERTopic to demystify twitter posts. Frontiers in Sociology 7. https://doi.org/10.3389/fsoc.2022.886498.

Galhoz, I., Ramos, R.F., Biscaia, R., 2024. Airline environmental sustainability actions and CSR impact on customer behavior. Research in Transportation Business & Management 53, 101111. https://doi.org/10.1016/j.rtbm.2024.101111.

Ghardallou, W., 2022. Corporate sustainability and firm performance: the moderating role of CEO education and tenure. Sustainability 14 (6), 3513. https://doi.org/10.3390/su14063513.

Githaiga, P.N., Kosgei, J.K., 2023. Board characteristics and sustainability reporting: a case of listed firms in East Africa. Corp. Gov.: The International Journal of Business in Society 23 (1), 3–17. https://doi.org/10.1108/CG-12-2021-0449.

Goldberg, L.R., Sweeney, D., Merenda, P.F., Hughes, J.E., 1998. Demographic variables and personality: the effects of gender, age, education, and ethnic/racial status on self-descriptions of personality attributes. Pers. Indiv. Differ. 24 (3), 393–403. https://doi.org/10.1016/S0191-8869(97)00110-4.

Halder, P., Hansen, E.N., Kangas, J., Laukkanen, T., 2020. How national culture and ethics matter in consumers' green consumption values. J. Clean. Prod. 265, 121754. https://doi.org/10.1016/j.jclepro.2020.121754.
Hauke, J., Kossowski, T., 2011. Comparison of values of pearson's and spearman's correlation coefficients on the same sets of data. QUAGEO 30 (2), 87–93. https://doi.org/10.2478/v10117-011-0021-1.
Hayes, A.F., Cai, L., 2007. Using heteroskedasticity-consistent standard error estimators in OLS regression: an introduction and software implementation. Behav. Res. Methods 39 (4), 709–722. https://doi.org/10.3758/BF03192961.
Huang, C.-J., Chuang, S.-C., Cheng, Y.-H., Hsieh, C.-C., 2023. The longer the better? The impact of online review length on tourist trust and visit intention. J. Vacat. Mark. 0 (0). https://doi.org/10.1177/13567667231193436.
Huang, C.-J., Liu, H.-Y., Lin, T.-L., Lai, J.-Y., 2024. Revisiting Hofstede's dimensions of national culture and environmental sustainability. Energy Environ. 35 (3), 1251–1269. https://doi.org/10.1177/0958305X221140579.
Huo, B., Wang, K., Zhang, Y., 2021. The impact of leadership on supply chain green strategy alignment and operational performance. Operations Management Research 14 (1–2), 152–165. https://doi.org/10.1007/s12063-020-00175-8.
IPCC, 2018. Special Report: Global Warming of 1.5°C.
Kartadjumena, E., Rodgers, W., 2019. Executive compensation, sustainability, climate, environmental concerns, and company financial performance: evidence from Indonesian commercial banks. Sustainability 11 (6), 1673. https://doi.org/10.3390/su11061673.
Kassinis, G., Panayiotou, A., Dimou, A., Katsifaraki, G., 2016. Gender and environmental sustainability: a longitudinal analysis. Corp. Soc. Responsib. Environ. Manag. 23 (6), 399–412. https://doi.org/10.1002/csr.1386.
Kelly, J., Gennard, J., 2007. Business strategic decision making: the role and influence of directors. Hum. Resour. Manag. J. 17 (2), 99–117. https://doi.org/10.1111/j.1748-8583.2007.00038.x.
Ketprapakorn, N., Kantabutra, S., 2022. Toward an organizational theory of sustainability culture. Sustain. Prod. Consum. 32, 638–654. https://doi.org/10.1016/j.spc.2022.05.020.
Khalid, F., Ye, Z., Voinea, C.L., Naveed, K., 2022. Carbon disclosure project: Chinese chief executive officer background and corporate voluntary climate change reporting. Carbon Manag. 13 (1), 321–336. https://doi.org/10.1080/17583004.2022.2083983.
Kim, K., Kogler, D.F., Maliphol, S., 2024. Identifying interdisciplinary emergence in the science of science: combination of network analysis and BERTopic. Humanities and Social Sciences Communications 11 (1), 603. https://doi.org/10.1057/s41599-024-03044-y.
Kumar, A., 2023. Leadership and decision-making: top management team age demographic and environmental strategy. J. Manag. Organ. 29 (1), 69–85. https://doi.org/10.1017/jmo.2019.91.
Kump, B., 2021. When do threats mobilize managers for organizational change toward sustainability? An environmental belief model. Bus. Strat. Environ. 30 (5), 2713–2726. https://doi.org/10.1002/bse.2773.
Lambin, E.F., Gibbs, H.K., Heilmayr, R., Carlson, K.M., Fleck, L.C., Garrett, R.D., Le Polain De Waroux, Y., McDermott, C.L., McLaughlin, D., Newton, P., Nolte, C., Pacheco, P., Rausch, L.L., Streck, C., Thorlakson, T., Walker, N.F., 2018. The role of supply-chain initiatives in reducing deforestation. In: Nature Climate Change, vol. 8. Springer, US, pp. 109–116. https://doi.org/10.1038/s41558-017-0061-1, 2.
Lii, Y., Wu, K., Ding, M., 2013. Doing good does good? Sustainable marketing of CSR and consumer evaluations. Corp. Soc. Responsib. Environ. Manag. 20 (1), 15–28. https://doi.org/10.1002/csr.294.
Lipińska, M., 2018. Corporate communication in social media with the use of linkedin. Social Communication 4 (s1), 23–29. https://doi.org/10.2478/sc-2018-0020.
Liu, Q., Wang, L., 2021. t-Test and ANOVA for data with ceiling and/or floor effects. Behav. Res. Methods 53 (1), 264–277. https://doi.org/10.3758/s13428-020-01407-2.
Lopatta, K., Kaspereit, T., Tideman, S.A., Rudolf, A.R., 2022. The moderating role of CEO sustainability reporting style in the relationship between sustainability performance, sustainability reporting, and cost of equity. J. Bus. Econ. 92 (3), 429–465. https://doi.org/10.1007/s11573-022-01082-z.
López-Carril, S., Anagnostopoulos, C., Parganas, P., 2020. Social media in sport management education: introducing LinkedIn. J. Hospit. Leisure Sports Tourism Educ. 27, 100262. https://doi.org/10.1016/j.jhlste.2020.100262.
Ludwig, P., Sassen, R., 2022. Which internal corporate governance mechanisms drive corporate sustainability? J. Environ. Manag. 301, 113780. https://doi.org/10.1016/j.jenvman.2021.113780.
Mansi, M., Pandey, R., 2016. Impact of demographic characteristics of procurement professionals on sustainable procurement practices: evidence from Australia. J. Purch. Supply Manag. 22 (1), 31–40. https://doi.org/10.1016/j.pursup.2015.06.001.
Mardini, G.H., Lahyani, F., 2024. The relevance of carbon performance and board characteristics on carbon disclosure. Stud. Econ. Finance 41 (3), 660–683. https://doi.org/10.1108/SEF-02-2023-0056.
McCright, A.M., 2010. The effects of gender on climate change knowledge and concern in the American public. Popul. Environ. 32 (1), 66–87. https://doi.org/10.1007/s11111-010-0113-1.
Miró, A.-P., 2020. World economic Forum: present and future. Dimensión Empresarial 18 (2). https://doi.org/10.15665/dem.v18i2.2280.
Moro, S., Ramos, R.F., Rita, P., 2020. What drives job satisfaction in IT companies? Int. J. Prod. Perform. Manag. 70 (2), 391–407. https://doi.org/10.1108/IJPPM-03-2019-0124.
Nguyen, L.-T., Thanh, C.-L., 2022. The influence of board characteristics on environmental performance: evidence from East Asian manufacturing industries. Int. J. Emerg. Mark. 17 (10), 2702–2720. https://doi.org/10.1108/IJOEM-07-2020-0744.
OECD, 2015. The Economic Consequences of Climate Change.
Palomino, M.A., Aider, F., 2022. Evaluating the effectiveness of text pre-processing in sentiment analysis. Appl. Sci. 12 (17), 8765. https://doi.org/10.3390/app12178765.
Phillips, S., Thai, V.V., Halim, Z., 2019. Airline value chain capabilities and CSR performance: the connection between CSR leadership and CSR culture with CSR performance, customer satisfaction and financial performance. The Asian Journal of Shipping and Logistics 35 (1), 30–40. https://doi.org/10.1016/j.ajsl.2019.03.005.
Pilař, L., Kvasničková Stanislavská, L., Pitrová, J., Krejčí, I., Tichá, I., Chalupová, M., 2019. Twitter analysis of global communication in the field of sustainability. Sustainability 11 (24), 6958. https://doi.org/10.3390/su11246958.
Plewa, C., Conduit, J., Quester, P.G., Johnson, C., 2015. The impact of corporate volunteering on CSR image: a consumer perspective. J. Bus. Ethics 127 (3), 643–659. https://doi.org/10.1007/s10551-014-2066-2.
Porter, M.E., Kramer, M.R., 2007. Strategy and society: the link between competitive advantage and corporate social responsibility. Strat. Dir. 23 (5). https://doi.org/10.1108/sd.2007.05623ead.006.
Ramos, R.F., Rita, P., Moro, S., 2019. From institutional websites to social media and mobile applications: a usability perspective. European Research on Management and Business Economics 25 (3), 138–143. https://doi.org/10.1016/j.iedeen.2019.07.001.
Ramos, R.F., Rita, P., Moro, S., 2021. Is this the beginning of the end for retail websites A professional perspective. Int. J. Internet Market Advert. 15 (3), 260. https://doi.org/10.1504/IJIMA.2021.115422.
Rickaby, M.A., Glass, J., Fernie, S., 2020. Conceptualizing the relationship between personal values and sustainability—a TMO case study. Adm. Sci. 10 (1), 15. https://doi.org/10.3390/admsci10010015.
Rita, P., Ramos, R., Borges-Tiago, M.T., Rodrigues, D., 2022. Impact of the rating system on sentiment and tone of voice: a Booking.com and TripAdvisor comparison study. Int. J. Hospit. Manag. 104, 103245. https://doi.org/10.1016/j.ijhm.2022.103245.
Robinson, P.B., Sexton, E.A., 1994. The effect of education and experience on self-employment success. J. Bus. Ventur. 9 (2), 141–156. https://doi.org/10.1016/0883-9026(94)90006-X.
Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K., Meinshausen, M., 2016. Paris Agreement climate proposals need a boost to keep warming well below 2 °C. Nature 534 (7609), 631–639. https://doi.org/10.1038/nature18307.
Ruppen, D., Brugger, F., 2022. "I will sample until things get better – or until I die." Potential and limits of citizen science to promote social accountability for environmental pollution. World Dev. 157, 105952. https://doi.org/10.1016/j.worlddev.2022.105952.
Saevarsdottir, G., Kvande, H., Welch, B.J., 2020. Aluminum production in the times of climate change: the global challenge to reduce the carbon footprint and prevent carbon leakage. J. Occup. Med. 72 (1), 296–308. https://doi.org/10.1007/s11837-019-03918-6.
Sajjad, A., Eweje, G., Raziq, M.M., 2024. Sustainability leadership: an integrative review and conceptual synthesis. Bus. Strat. Environ. 33 (4), 2849–2867. https://doi.org/10.1002/bse.3631.
Salmoral, G., Zegarra, E., Vázquez-Rowe, I., González, F., del Castillo, L., Saravia, G.R., Graves, A., Rey, D., Knox, J.W., 2020. Water-related challenges in nexus governance for sustainable development: insights from the city of Arequipa, Peru. Sci. Total Environ. 747, 141114. https://doi.org/10.1016/j.scitotenv.2020.141114.
Shinbrot, X.A., Wilkins, K., Gretzel, U., Bowser, G., 2019. Unlocking women's sustainability leadership potential: perceptions of contributions and challenges for women in sustainable development. World Dev. 119, 120–132. https://doi.org/10.1016/j.worlddev.2019.03.009.
Song, F. Sophie, Montabon, F., Xu, Y., 2018. The impact of national culture on corporate adoption of environmental management practices and their effectiveness. Int. J. Prod. Econ. 205, 313–328. https://doi.org/10.1016/j.ijpe.2018.09.020.
Stern, P.C., 2000. New environmental theories: toward a coherent theory of environmentally significant behavior. J. Soc. Issues 56 (3), 407–424. https://doi.org/10.1111/0022-4537.00175.
Stewart, G., Al-Khassaweneh, M., 2022. An implementation of the HDBSCAN* clustering algorithm. Appl. Sci. 12 (5), 2405. https://doi.org/10.3390/app12052405.
Susnjak, T., 2024. Applying BERT and ChatGPT for Sentiment Analysis of Lyme Disease in Scientific Literature, pp. 173–183. https://doi.org/10.1007/978-1-0716-3561-2_14.
Tasdemir, C., Gazo, R., 2020. Integrating sustainability into higher education curriculum through a transdisciplinary perspective. J. Clean. Prod. 265, 121759. https://doi.org/10.1016/j.jclepro.2020.121759.
Temminck, E., Mearns, K., Fruhen, L., 2015. Motivating employees towards sustainable behaviour. Bus. Strat. Environ. 24 (6), 402–412. https://doi.org/10.1002/bse.1827.
Terent'ev, N.E., 2021. Climate change as a factor in the development of companies: corporate strategies and guidelines for state industrial policy. Stud. Russ. Econ. Dev. 32 (5), 485–491. https://doi.org/10.1134/S1075700721050130.
Udupa, A., Adarsh, K.N., Aravinda, A., Godihal, N.H., Kayarvizhy, N., 2022. An exploratory analysis of GSDMM and BERTopic on short text topic modelling. 2022 Fourth International Conference on Cognitive Computing and Information Processing (CCIP), pp. 1–9. https://doi.org/10.1109/CCIP57447.2022.10058687.
Voogd, R., de Vries, J.R., Beunen, R., 2021. Understanding public trust in water managers: findings from The Netherlands. J. Environ. Manag. 300, 113749. https://doi.org/10.1016/j.jenvman.2021.113749.

Walter, S., Lörcher, I., Brüggemann, M., 2019. Scientific networks on Twitter: analyzing scientists' interactions in the climate change debate. Publ. Understand. Sci. 28 (6), 696–712. https://doi.org/10.1177/0963662519844131.

Wang, J., Chaudhri, V., 2009. Corporate social responsibility engagement and communication by Chinese companies. Public Relat. Rev. 35 (3), 247–250. https://doi.org/10.1016/j.pubrev.2009.04.005.

Waring, P., 2008. Rethinking directors' duties in changing global markets. Corp. Gov.: The International Journal of Business in Society 8 (2), 153–164. https://doi.org/10.1108/14720700810863788.

Willis, K.A., Hardesty, B.D., Wilcox, C., 2021. State and local pressures drive plastic pollution compliance strategies. J. Environ. Manag. 287, 112281. https://doi.org/10.1016/j.jenvman.2021.112281.

Windolph, S.E., Harms, D., Schaltegger, S., 2014. Motivations for corporate sustainability management: contrasting survey results and implementation. Corp. Soc. Responsib. Environ. Manag. 21 (5), 272–285. https://doi.org/10.1002/csr.1337.

Yip, P.S.L., Tsang, E.W.K., 2007. Interpreting dummy variables and their interaction effects in strategy research. Strateg. Organ. 5 (1), 13–30. https://doi.org/10.1177/1476127006073512.

Yves, P., 2020. Bert base multilingual uncased sentiment. Hugging Face. https://huggingface.co/nlptown/bert-base-multilingual-uncased-sentiment.

Zaman, R., Asiaei, K., Nadeem, M., Malik, I., Arif, M., 2024. Board demographic, structural diversity, and eco-innovation: international evidence. Corp. Govern. Int. Rev. 32 (3), 374–390. https://doi.org/10.1111/corg.12545.

Zelezny, L.C., Chua, P.-P., Aldrich, C., 2000. New ways of thinking about environmentalism: elaborating on gender differences in environmentalism. J. Soc. Issues 56 (3), 443–457. https://doi.org/10.1111/0022-4537.00177.

Zhang, J., Liu, Y., 2022. The effect of coronavirus exposure on CEO perceptions of climate change. Front. Psychol. 13, 943952. https://doi.org/10.3389/fpsyg.2022.943952.