

Corporate governance network around social responsibility and activism against the sustainable development goals

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Abstract

The social responsibility aspect of corporate governance is intricately linked to the Sustainable Development Goals, particularly around SDGs 5, 8, 9, and 12. Corporations and companies play a direct and crucial role in achieving these goals. The current state-of-the-art literature often emphasizes the financial aspect without delving into the dimensions that ensure the achievement of these goals. Therefore, the significance of this work lies in its objective to establish a comparative analysis of the findings related to the SDGs reported in the literature and their evaluation by experts in corporate governance and social responsibility. This research, which was documentary, transversal, exploratory, retrospective, and correlational, was conducted with a sample of judges selected for their experience, knowledge, and criteria for evaluating summaries published in journals indexed in international repositories. The results reveal the financial category as the only discrepancy, with the present work considering it as an external factor to corporate governance, unlike the state-of-the-art literature that highlights it as a central node. As a result, we recommend the inclusion of the financial dimension in the analysis of neural networks to establish the degree of learning in this area once the pandemic has passed.

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1. Introduction

The history of corporate governance and corporate social responsibility (CSR) around the Sustainable Development Goals (SDGs) is a broad and complex topic that has evolved significantly over recent decades [1].

Corporate governance, which initially revolved around managing large industrial corporations by their owners or small shareholders, has undergone a significant transformation [2]. The primary concern, once solely about maximizing shareholder value, has expanded to include social and environmental responsibilities. This shift in perception, catalyzed by events such as the Great Depression, has led to the recognition of companies' duties to their shareholders and other stakeholders, including communities and workers. With the increasing globalization and the expansion of multinationals, corporate governance has evolved to focus more on transparency and accountability, which are of utmost importance in today's corporate landscape. This evolution is a crucial aspect that all professionals in the field should be aware of.

Corporate social responsibility (CSR) began to take shape in response to growing social and environmental movements [3]. Companies began to be seen as critical societal actors with responsibilities beyond generating profits. CSR was consolidated, and companies began integrating responsible practices into their operations, covering aspects such as the environment, labor rights, and community development. Sustainable development began to be a central issue. CSR was formally integrated into corporate strategies, focusing on long-term value creation and sustainability. Companies began to publish sustainability reports and adopt international standards such as those of the Global Reporting Initiative (GRI).

In 2015, the UN General Assembly adopted the 17 Sustainable Development Goals as a global agenda to eradicate poverty, protect the planet, and ensure prosperity for all [4]. These goals are designed to be achieved by 2030. The SDGs drove a change in how companies approach CSR, aligning their strategies with the SDGs to contribute to sustainable global development. Companies began to measure and report their impact in critical areas of the SDGs, such as combating climate change (SDG 13), gender equality (SDG 5), and decent work and economic growth (SDG 8). Several global initiatives, such as the UN Global Compact, have worked to mobilize the private sector around the SDGs. These initiatives have encouraged the creation of alliances between the public and private sectors to achieve significant impact. Interest in sustainable and responsible investing has grown, with investors seeking to support companies that contribute positively to the SDGs. Increasing regulatory pressure forces companies to adopt governance and CSR practices that align with the SDGs. Technology is crucial in implementing sustainable practices, allowing companies to innovate in renewable energy, the circular economy, and emissions reduction.

Corporate governance and CSR have evolved from approaches focused exclusively on profits to a more holistic vision that seeks to balance the needs of shareholders with the well-being of society and the environment, aligning with the SDGs as a guide for sustainable development [5]. Corporate governance refers to the mechanisms, processes, and relationships by which corporations are controlled and directed. Theories of corporate governance provide analytical frameworks that allow us to understand how and why companies assume social responsibilities and how they align these responsibilities with the SDGs.

Stakeholder Theory, developed by R. Edward Freeman in 1984, maintains that companies should consider the interests of all interested parties, not just those of shareholders [6]. Stakeholders include employees, customers, suppliers, local communities, and the environment. According to this theory, CSR and the SDGs are closely related, as companies must act in ways that benefit a wide range of stakeholders. For example, companies can fulfill their responsibilities towards different stakeholders by adopting responsible environmental policies (SDG 13: Climate Action) or supporting quality education (SDG 4). Some critics argue that stakeholder theory can lead to conflicts of interest and difficult decisions when the interests of different groups conflict.

Agency Theory focuses on the relationship between the owners of the company (shareholders) and the directors or managers who act on their behalf [7]. Agency theory suggests that there may be a conflict of interest between shareholders, who seek to maximize profits, and managers, who may have other priorities. In the context of the SDGs, agency theory highlights the importance of control and supervision mechanisms to ensure that managers' decisions align shareholders' interests with social and environmental objectives. For example, suppose a company adopts sustainable practices (SDG 12: Responsible Production and Consumption). In that case, shareholders must see these actions as valuable for the company's long-term sustainability. Agency theory can

be limited by focusing primarily on the relationship between shareholders and managers, leaving aside consideration of other stakeholders.

The Resource and Capabilities Theory suggests that firms gain a competitive advantage by developing and exploiting unique resources and capabilities [8]. CSR can be seen as a capability that allows companies to differentiate themselves and achieve sustainable success. Companies that integrate the SDGs into their strategies can develop valuable resources such as reputation, customer loyalty, and operational efficiency. For example, investment in clean technologies (SDG 7: Affordable and Clean Energy) can be seen as a strategic capability that improves long-term competitiveness. The theory may focus too much on the value to the company, leaving aside the ethical motivation behind CSR and the SDGs.

Institutional Theory maintains that companies act in a social and cultural environment that imposes normative, cognitive, and coercive pressures on them [9]. These pressures can lead companies to adopt CSR practices to gain legitimacy and meet social expectations. The SDGs represent a global regulation that encourages companies to adopt sustainable practices. Pressure from consumers, regulators, and non-governmental organizations for companies to contribute to the SDGs is an example of how institutional forces can influence corporate governance. Although it explains well why companies adopt certain practices, institutional theory can underestimate the ability of companies to innovate and lead change rather than follow existing norms.

Legitimacy Theory suggests that companies seek social legitimacy and operate within an implicit “social contract” with society [10]. Legitimacy is crucial to long-term survival, and companies adopt CSR practices to maintain or regain that legitimacy. Aligning with the SDGs can be a strategy for companies to gain or maintain legitimacy in an environment where sustainability is increasingly valued. For example, companies that promote gender equality (SDG 5) or reduce their carbon footprint (SDG 13) can improve their legitimacy in the eyes of consumers and other stakeholders. Legitimacy theory may lead companies to adopt CSR practices superficially, more as a public relations strategy than as a genuine commitment to sustainability.

Corporate governance theories offer different perspectives on how and why companies assume social responsibilities about the SDGs [11]. These theories highlight the importance of considering stakeholder expectations, agency conflicts, the strategic value of resources, institutional pressures, and the search for legitimacy. By applying these theories, a deeper understanding can be gained of how companies can effectively contribute to achieving the SDGs (see Table 1).

Table 1. Comparison between corporate governance and social responsibility towards the SDGs

Aspect	Corporate governance	Corporate social responsibility (CSR)	Relationship with the SDGs
Definition	A company uses a system of rules, practices, and processes to direct and control its operations.	The voluntary commitment of the company to contribute to social, economic, and environmental development.	Both approaches complement each other to achieve sustainable development.
Main Focus	Maximization of value for shareholders, transparency, accountability, and risk control.	Benefit all interested parties (stakeholders), including society, employees, environment, etc.	The SDGs require an alignment between the interests of shareholders and the needs of society.
Key Actors	Board of Directors, shareholders, executives, audit and	Employees, communities, clients, suppliers, NGOs, and governments.	Companies align their governance with the SDGs through CSR

	internal control committees.		policies that involve multiple actors.
Mechanisms and Processes	Internal control policies, audits, regulatory compliance, risk management.	Sustainability programs, social responsibility reports, and participation in global initiatives like the Global Compact.	Efficient corporate governance can support the effective implementation of CSR and contribution to the SDGs.
Aim	Guarantee the long-term success of the company, protecting the interests of shareholders.	Create shared value that benefits both the company and society in general.	The SDGs seek a balance between economic growth, social inclusion, and environmental protection.
Accountability	To shareholders and regulators. It is measured through financial and management indicators.	To all interested parties. It is measured through sustainability reports and social and environmental impact.	Integrating the SDGs into corporate strategy requires broader and more transparent accountability.
Adoption and Implementation	They are driven by regulation, shareholder pressure, and the need to comply with international standards.	Voluntary but increasingly driven by social demand, consumer expectations, and regulatory pressure.	Corporate governance establishes the framework for implementing CSR practices that align the company with the SDGs.
Impact on the Company	It influences reputation, investor confidence, and share value.	It contributes to improving corporate image, customer loyalty, and long-term sustainability.	Adopting the SDGs can enhance the legitimacy and competitiveness of the company.
Current Trends	Greater emphasis on sustainable governance and the inclusion of ESG (Environmental, Social, and Governance) criteria.	Integration of the SDGs into corporate strategy and the value chain.	Trends in governance and CSR are increasingly aligned with the SDGs to face global challenges.
Challenges	Reconcile shareholder interests with long-term sustainability.	Avoid "greenwashing" and ensure genuine commitment to the SDGs.	Companies must bridge the gap between theory and practice in implementing the SDGs.

However, when disseminated, corporate governance, social responsibility, and the Sustainable Development Goals enter into a system of knowledge management and innovation diffusion. Therefore, this work aims to contrast the theoretical mode of corporate governance against the evaluations of experts in the field.

Since corporate governance refers to social responsibility, an area of the SDG, this work aimed to identify the learning sequences related to activism in implementing the SDGs in a literature review from 2020 to 2024. Such a perspective is innovative since the literature reviews are established based on sequences of topics or discussions, advances, and criticisms, but not learning considering the implementation of the SDGs with social responsibility.

Are there significant differences between theoretical corporate governance and corporate governance evaluations in a sample of experts? Corporate governance understood as participation and activism on the Internet in favor of privacy rights and guarantees of data protection, is a central axis in multicultural info diversity. Identity preservation is a priority for minority groups in the face of info diversity [12]. In this sense, Internet governance in its data protection aspect is essential to achieve the co-responsibility that the management of information on the network entails.

The interested parties, public and private sectors, and political and social actors are limited to agreements as long as a system guarantees their participation in terms of voice and vote [13]. Consequently, Internet governance is relevant not only for being a set of guarantees for protecting information but also for being a guarantor of identities under debate. In deliberation, the parties involved require minimum privacy to reach a position on the future of a minority culture against the hegemony of a majority culture. Consequently, Internet governance crystallizes in the opportunity for decision, election, and scrutiny regarding the representativeness of those who govern and govern the groups in controversy regarding the opening or protection of their data.

Furthermore, corporate governance guarantees access to excluded groups and facilitates participation based on a framework of freedom of expression and the right to information. In this way, the corporate governance project achieves a value of use (access, participation, and scrutiny) and change (deliberation and co-responsibility) between the parties involved.

Consequently, significant differences are expected between theoretical and empirical corporate governance related to social responsibility towards the Sustainable Development Goals.

2. Research method

2.1. Design

A cross-sectional, correlational, systematic, and retrospective study was conducted with a sample of corporate governance, social responsibility, and sustainable development goals experts. The study considered their evaluation of categories subtracted from summaries selected through keyword searching and the publication period of 2020 to 2024.

2.2. Instrument

A structured questionnaire collected the experts' opinions and evaluations regarding the study categories (see Appendix A). It includes 20 questions about general information, corporate governance, corporate social responsibility, and proposals to improve practices.

2.3. Procedures

First Round: The experts review and evaluate the abstracts using the questionnaire. Responses are collected and analyzed to identify patterns and areas of consensus or divergence. Second Round: The experts are presented with a summary of the first round's results and any additional comments or questions for clarification. Based on collective feedback, experts can review and adjust their answers. Third Round: An additional round is conducted until a clear consensus is reached or areas of disagreement are identified.

Gathering of all the experts' responses for each evaluated summary. Each response is correctly labeled with the expert's identifier and the corresponding summary. Classification of responses in a database or spreadsheets, separating quantitative responses (ratings) from qualitative responses (open comments). Creation of a table for each article summary with the experts' responses.

A comparison of each summary's means and standard deviations is needed to identify which ones are perceived as more solid and relevant by the experts-identification of summaries with high ratings on most questions and those with low ratings that might need improvement.

Coding qualitative comments to identify common themes, concerns, praise, and recurring suggestions. Use qualitative analysis software or manual techniques to tag and categorize comments by topic. Analysis of categories to identify emerging patterns, such as the frequency of specific comments (e.g., criticism of methodology, praise of clarity of summary). It highlights areas where there is substantial agreement or disagreement among experts. From the comments, specific recommendations can be extracted to improve the summaries. This may include suggestions for methodology changes, greater presentation clarity, or more robust theoretical approaches. A combination of quantitative and qualitative results is needed to obtain a holistic view of the evaluation of each summary. Identify qualitative data (comments) supporting or contradicting quantitative findings (ratings)—identify consensus and discrepancies by highlighting summaries with high positive consensus among experts. Identify significant discrepancies between quantitative evaluations and qualitative comments and analyze possible reasons.

3. Analysis

For each quantitative question (topic relevance, clarity, and originality), calculation of the central measures - the arithmetic means of the ratings given by the experts. The central value of the ratings helps identify consensus when there is dispersion. Standard deviation to evaluate the dispersion or consensus between the responses. Percentage of consensus of experts who agreed on a specific rating. To test the hypothesis, the centrality, grouping, and structuring coefficients are placed, considering values close to unity as evidence of non-rejection of the hypothesis (see Appendix B).

4. Results

The centrality analysis suggests the surroundings around a connecting node with the other nodes (see Figure 1). The findings indicate that the hegemonic node of centrality, due to its intermediation and influence, is related to contribution.

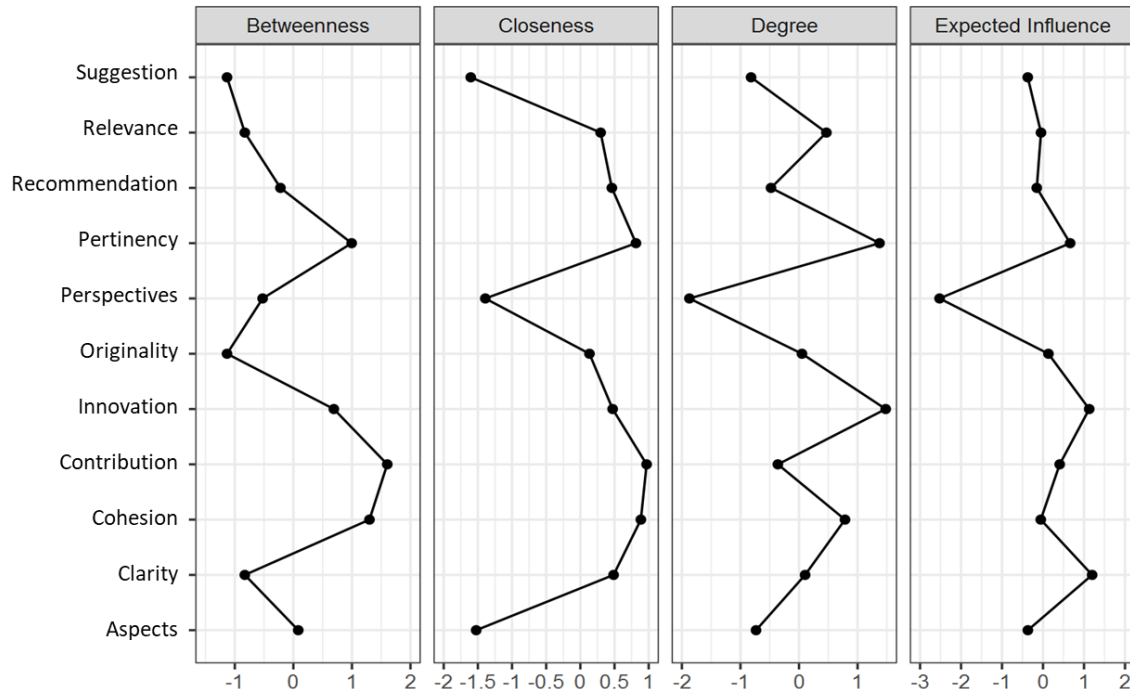


Figure 1. The centrality of corporate governance around the social responsibility of activism toward the sustainable development goals

The clustering analysis based on the profusion indicators indicates the degree of connectivity between the predominant node and the other nodes (see Figure 2). The results show that originality is the node on which the different nodes revolve.

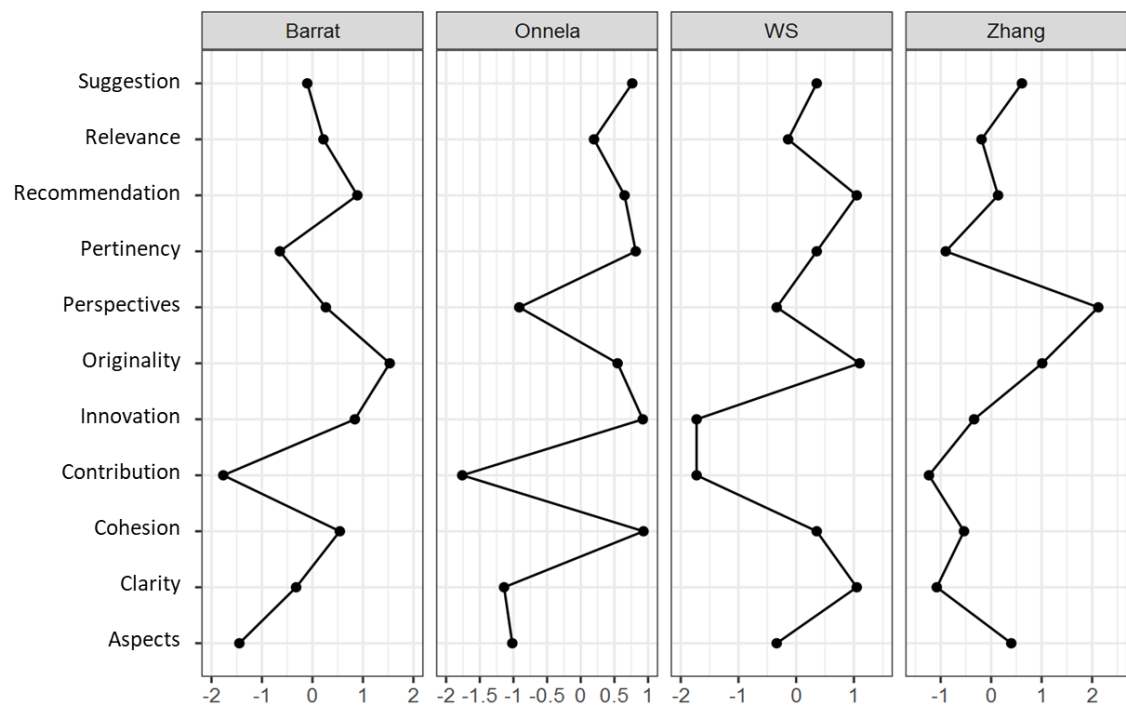


Figure 2. Corporate governance groups around the social responsibility of activism against the sustainable development goals

The structuring analysis suggests the degree of learning between the nodes that comprise the dimensions of corporate governance and social responsibility regarding the SDGs (see Figure 3). The results indicate that the process begins with the node related to the recommendation and culminates with cohesion. In other words, the governance structure involves a system of recommendations, contributions, originalities, and cohesion.

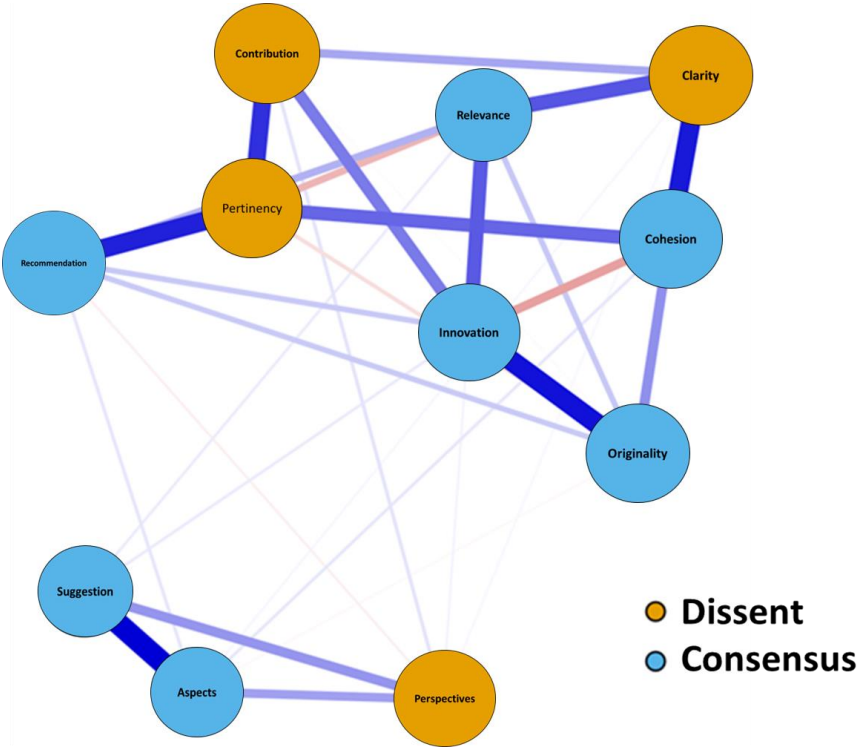


Figure 3. Structuring corporate governance around the social responsibility of activism against the sustainable development goals

The values of centrality, grouping, and structuring indicate the non-rejection of the hypothesis related to the significant differences between the theoretical structures regarding the qualifications of the expert judges regarding corporate governance and social responsibility regarding the SDGs.

5. Discussion

This work's contribution to the state of the art lies in establishing a learning neural network on corporate governance and social responsibility towards the SDGs. The results suggest a process around recommendations, contributions, originality, and cohesion. The concept of Corporate social responsibility (CSR) has evolved to encompass new environmental, social, and governance (ESG) frameworks that align with global sustainability goals [14]. These frameworks are crucial to addressing challenges such as poverty, inequality, climate change, and pandemics that hinder sustainable development [15]. Research has shown a mediating role of Research and Development (R&D) in achieving sustainable development goals through ESG practices. Corporate sustainability and responsibility, also known as CSR or responsible business conduct, are essential duties that companies must fulfill [16]. Companies increasingly face new challenges in sustainability reporting, emphasizing social and environmental responsibility [17]. Through unified ESG frameworks such as RISE, companies aim to create a more responsible, inclusive, and sustainable business environment [18]. To build trust and accountability, corporate citizenship involves sustainability programs, social responsibility initiatives, and corporate governance practices.

Large companies and companies listed on stock exchanges must publish reports on the social and environmental risks they face, highlighting the importance of transparency in corporate sustainability reporting [19]. The Responsible Investment Principles underline the impact of environmental, social, and corporate governance (ESG) issues on investment portfolio performance [20]. Companies actively support the United Nations SDGs through responsible corporate governance practices [21]. By aligning with the SDGs and integrating ESG principles into their operations, companies can contribute to global sustainability efforts and improve their social and environmental impact.

In contrast to the prevailing corporate governance models that emphasize investing in environmentally impactful and sustainable opportunity areas, this study assumes that social responsibility should be a factor in directing investments toward the UN Sustainable Development Goals and mitigating ecological impacts. As a result, this work focuses on examining the financial outcomes of investing in social responsibility and socially responsible companies. Including this perspective is advisable for anticipating both environmental impacts and financial sustainability scenarios.

Unlike the cited literature where the implementation of the SDGs is part of financial governance, this paper analyses the learning of the SDGs from the integration of the phases and structures of governance without considering investment, accountability, transparency, technology, regulation, co-responsibility and resilience as determinants of social responsibility (Table 2).

Table 2. Comparison between the present study and the state-of-the-art

Aspect	Crespo et al. (2024)	Literature review (2020–2024)
Focus	Emphasizes a neural network framework around recommendations, originality, and cohesion for SDG integration.	Focuses on integrating ESG (environmental, social, governance) criteria as a strategic priority for SDG alignment.
Financial Dimension	Identified as external to corporate governance.	Highlighted as a central element influencing governance and CSR, emphasizing responsible investment.

Aspect	Crespo et al. (2024)	Literature review (2020–2024)
Stakeholder Involvement	Encourages multi-actor participation, including public and private sectors, to ensure inclusive governance.	Recent works stress increased accountability to diverse stakeholders and enhanced transparency in decision-making.
Technological Role	Limited emphasis on technology's role in governance transformation.	Recognizes technology as a critical enabler, especially for monitoring ESG metrics and enhancing sustainability practices.
Key Challenges	Notes discrepancies between theoretical and empirical governance practices.	Highlights "greenwashing" and regulatory inconsistencies as critical barriers to achieving SDGs through governance.
Methodological Insights	Utilizes expert evaluations (Delphi method) for consensus building in governance practices.	Advocates data-driven approaches, including AI, for analyzing corporate contributions to SDGs.
Trends in CSR	Aligns CSR with activism and SDG-oriented corporate strategies.	Broader integration of CSR into business models, leveraging public-private partnerships and global initiatives.
Impact of COVID-19	Indirectly alludes to the pandemic's influence on corporate practices and SDG prioritization.	COVID-19 directly accelerated the adoption of CSR as a resilience-building mechanism in corporate governance.
Accountability Mechanisms	Suggests broad accountability beyond shareholders to include environmental and societal impacts.	Strong push towards adopting measurable ESG indicators to ensure comprehensive accountability.

5.1. Limitations of the present study

Limited Scope on Financial Dimensions: The document excludes the financial aspect as a central element of corporate governance, treating it as external. This contrasts with its pivotal role in many governance frameworks where financial accountability and responsible investment are critical for SDG alignment.

Lack of Emphasis on Technological Integration: While the document acknowledges governance structures and processes, it overlooks technology's transformative potential in monitoring, analyzing, and implementing ESG practices and SDGs.

Methodological Constraints: The reliance on expert evaluations (Delphi method) provides valuable insights but may lack the depth and robustness of empirical data collected directly from organizations, limiting the generalizability of findings.

Insufficient Attention to Emerging Trends: The analysis does not fully engage with recent developments, such as the rise of ESG investing, stakeholder capitalism, and enhanced regulatory frameworks post-pandemic.

Superficial Treatment of COVID-19 Impacts: Although the pandemic's influence is mentioned, the analysis does not profoundly explore its effects on corporate governance and CSR, particularly in adapting to disruptions and prioritizing resilience.

Theoretical Overemphasis: The document places significant weight on theoretical constructs and expert opinions, potentially underestimating organizations' practical challenges when implementing SDG-focused strategies.

5.2. Limitations of the State of the Art (2020–2024)

Greenwashing and Superficial Commitments: Recent literature highlights the prevalence of "greenwashing," where companies superficially adopt sustainability practices for reputation without genuine impact on the SDGs [22-23].

Regulatory Inconsistencies: Despite advances in regulatory frameworks, inconsistencies between regions and industries create challenges for uniform adoption of governance and CSR practices aligned with SDGs [24].

Over-Reliance on ESG Metrics: While ESG indicators provide measurable frameworks, critics argue that they may oversimplify complex social and environmental issues, leading to inadequate representation of actual impacts [25].

Limited Inclusion of Stakeholders: Many studies acknowledge the importance of stakeholder engagement but report gaps in translating this into practice, particularly in marginalized or underrepresented communities [26].

Insufficient Integration of Digital Innovation: Although technology is recognized as a critical enabler, its application in governance remains uneven, with organizations often lagging in adopting AI or blockchain for sustainability reporting and monitoring [27].

Short-term Focus: Research and corporate practices prioritize short-term gains, such as immediate ESG ratings, over long-term systemic changes necessary to achieve SDGs [28-29].

6. Conclusions

This study aimed to develop a neural network by analyzing the governance reported in leading research and comparing it with expert evaluations of corporate social responsibility and SDG. The findings indicate a high level of agreement between the theoretical and empirical structures, except for the financial issue identified in the literature review and consequently omitted from this study.

Declaration of competing interest

The authors declare that they have no conflict of interest, and all the authors agree to publish this paper under academic ethics.

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Author contribution

JEC and CGL contributed to the study design and data analysis. SSVB, ASS, and CYQC focused on interpreting the results. ICRR, JECM, VHMC, and MRMG were responsible for data collection and preparing the manuscript draft. All authors reviewed and approved the final version of the manuscript.

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APPENDIX A

Delphi Questionnaire: Corporate Governance and Social Responsibility towards the SDGs

Section 1: General Information

1. Name:
2. Position/Position:
3. Years of experience in the area of Corporate Governance:
4. Sector in which you work (e.g., private, public, NGOs):
5. Country of residence:

Section 2: Corporate Governance

1. What aspects do you consider most relevant in corporate governance to align business practices with the SDGs?
 - a) Transparency
 - b) Accountability
 - c) Participation of interest groups
 - d) Others (specify)
2. What are corporate governance's main obstacles in effectively implementing the SDGs?
 - a) Lack of commitment on the part of senior management
 - b) Lack of resources
 - c) Lack of adequate regulation
 - d) Others (specify)
3. What corporate governance mechanisms are most effective in promoting SDG compliance?
 - a) Sustainability committees
 - b) Internal and external audits
 - c) Integration of ESG (Environmental, Social, and Governance) criteria in decision making
 - d) Others (specify)

Section 3: Corporate Social Responsibility (CSR)

4. What areas of CSR do you consider a priority to contribute to the SDGs?
 - a) Environment
 - b) Human rights
 - c) Business ethics
 - d) Others (specify)
5. What CSR strategies are most effective in achieving the SDGs?
 - a) Investment in sustainable projects
 - b) Collaboration with NGOs and local communities
 - c) Implementation of fair labor policies
 - d) Others (specify)
6. Do you consider companies sufficiently committed to CSR to achieve the SDGs?
 - a) Yes
 - b) No
 - c) Not sure
7. What role should the board of directors play in overseeing CSR about the SDGs?
 - a) Lead the CSR strategy
 - b) Monitor and evaluate compliance with the SDGs

- c) Promote transparency in CSR practices
- d) Others (specify)

Section 4: Assessment of SDG Implementation

8. On a scale of 1 to 5, how would you rate your organization's commitment to the SDGs?

- 1: Very low
- 2: Low
- 3: Moderate
- 4: High
- 5: Very high

9. What specific actions has your organization taken to advance the SDGs? (Please provide concrete examples).

10. What indicators does your organization use to measure progress towards the SDGs?

Section 5: Future Perspectives

11. What are the emerging trends in corporate governance that could impact compliance with the SDGs?

- a) Increased regulation
- b) Greater pressure from investors
- c) Technological innovation
- d) Others (specify)

12. What will be the biggest challenge for companies in integrating the SDGs into their corporate strategy in the next five years?

13. What recommendations would you offer to improve the alignment between corporate governance, CSR, and the SDGs?

Section 6: Final Comments

14. Do you have additional comments on corporate governance and social responsibility towards the SDGs?

APPENDIX B

```

import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout
# Step 1: Load the dataset
# Each row is a set of answers from an expert
# Each column corresponds to a question or characteristic
# We assume that the responses have already been preprocessed and digitized
# Load a dataset from a CSV file
data = pd.read_csv('delphi_responses.csv')
# Step 2: Separate features (X) and labels (y)
# Suppose the last column is the label or the value to be predicted
X = data.iloc[:, :-1].values # All columns except the last
y = data.iloc[:, -1].values # Last column only
# Step 3: Divide the dataset into training and test set
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
#Step 4: Scaling Features
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
#Step 5: Build the neural network
model = Sequential()
#Input layer and first hidden layer
model.add(Dense(units=64, activation='relu', input_dim=X_train.shape[1]))
# Additional hidden layer
model.add(Dense(units=32, activation='relu'))
# Output layer
# For a binary classification problem (e.g., consensus or non-consensus):
model.add(Dense(units=1, activation='sigmoid'))
# If it is a classification problem with multiple classes:
# model.add(Dense(units=num_classes, activation='softmax'))
# Compile the model
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])
# For a multiple classification problem:
# model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
#Step 6: Train the neural network
model.fit(X_train, y_train, epochs=50, batch_size=10, validation_split=0.2)
#Step 7: Evaluate the model on the test set
loss, accuracy = model.evaluate(X_test, y_test)
print(f"Accuracy on test set: {accuracy * 100:.2f}%")

```

```
#Step 8: Make predictions
y_pred = model.predict(X_test)
y_pred = (y_pred > 0.5) # Threshold for binary classification
# If it is a multiple classification problem:
# y_pred = np.argmax(y_pred, axis=1)
```