Norwegian School of Economics
Bergen, Autumn, 2024

# "Exploring ESG Discussions in Earnings Calls: A Comparative Analysis of Industry Focus, Sentiment, Emerging Trends, and Topic Modeling"

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Master's Thesis in Business Analytics

MSc in Economics & Business Administration

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# Abstract

*This study explores the evolving role of Environmental, Social, and Governance (ESG) themes in corporate earnings calls, highlighting their increasing prominence as a cornerstone of sustainable business practices. With a dataset of over 7,600 earnings call transcripts spanning multiple industries, the research employs advanced natural language processing (NLP) techniques to analyze how companies communicate their ESG priorities. The study focuses on key aspects such as the frequency of ESG mentions, the tone and sentiment of discussions, and the themes emerging across industries.*

*The findings reveal that industries with inherent sustainability challenges, such as waste management and renewable energy, naturally emphasize ESG-related topics. However, sectors like technology and finance, which are less traditionally associated with sustainability, are also embedding ESG considerations into their strategic communications. Sentiment analysis shows that most industries frame ESG discussions positively, portraying them as opportunities for innovation, compliance, and stakeholder engagement. Temporal trends further indicate that ESG priorities are dynamic, influenced by regulatory shifts, market forces, and public expectations.*

*The research also addresses challenges, such as distinguishing between ESG as a genuine sustainability commitment and as a business opportunity. By analyzing industries with varying levels of ESG integration, it offers a nuanced perspective on how these themes intersect with core business models. Limitations of the study, including the contextual ambiguity of certain terms and reliance on sentiment analysis, are acknowledged, with suggestions for future research to refine methodologies and expand the analysis.*

*This work provides actionable insights for companies, investors, and policymakers, emphasizing the importance of transparent and consistent ESG communication. By bridging gaps in real-time ESG reporting, the study not only contributes to academic discourse but also supports the broader goal of aligning corporate practices with sustainable development.*

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# Acknowledgements

First and foremost, we extend our heartfelt gratitude to our supervisor, Professor Einar Breivik, for his invaluable guidance, encouragement, and constructive feedback throughout the development of this thesis. His expertise and unwavering support have been instrumental in shaping our research.

We also want to acknowledge the Norwegian School of Economics for providing us with an inspiring academic environment in Bergen, Norway. The resources and opportunities available here have greatly enriched our learning experience.

This thesis has been a journey of collaboration and shared ideas across borders, and we are deeply grateful for the support of our families and friends in both Oxford, Mississippi, and Bergen, Norway. Living and working from these two distinct and vibrant places brought unique perspectives and challenges to our research process, which ultimately strengthened our findings.

Finally, we wish to thank everyone who has been a part of this journey, whether through direct contribution to this work or by offering encouragement along the way. Your collective efforts and kindness have made this accomplishment possible.

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# 1. Introduction

Since the 20th century, sustainable development has emerged as a key strategy to address resource depletion and prevent global crises (Meadows and Meadows, 2007). It requires a collaborative effort from global civil society, including shifts in economic development practices, policymaking (Brundtland 1987) and, crucially, a growing emphasis on corporate social responsibility (CSR) and environmental stewardship. In the business world, sustainability is often framed within the context of environmental, social, and governance (ESG) factors (The Korea Chamber ,2021) ESG represents non-financial and social considerations aimed at driving sustainable practices. With increasing stakeholder demands for transparency in company performance and long-term vision, many businesses now disclose their sustainability strategies and accomplishments through corporate sustainability management reports (Velte, 2016). These reports not only highlight ESG outcomes but also demonstrate their broader impact on business performance.

Corporate sustainability management reports serve as an official platform for companies to communicate their contributions to sustainable development, guided by the United Nations' Sustainable Development Goals (SDGs) (United Nations Department of Economic and Social Affairs, 2015). To align stakeholder actions with a shared vision for sustainable development, it is essential to compare individual entities' SDG efforts with the UN's SDGs, which act as global benchmarks. As a widely accepted framework, the SDGs help businesses, governments, and civil society define their sustainability goals and establish a clear direction for achieving corporate sustainability.

Earnings calls are one of the most important forums for companies to disclose financial information to the market (Frankel, Johnson and Skinner, 1999; Kimbrough, 2005; Frankel, Mayew and Sun, 2010). Environmental, social, and governance (ESG) issues are becoming increasingly significant among institutional investors but have yet to find a substantial place in earnings calls (Setterberg and Sjöström, 2021).

This research investigates corporate sustainability management reports to evaluate how companies incorporate the United Nations' Sustainable Development Goals (SDGs) into their strategies. It highlights the increasing significance of Environmental, Social, and Governance (ESG) practices as key indicators of progress toward sustainable development. As global interest in ESG performance continues to grow, this study examines the ways businesses implement ESG principles and the extent to which their sustainability initiatives align with internationally recognized frameworks like the SDGs.

## 1.2 Background

The ESG principle is a framework system including environmental (E), social (S), and governance (G) factors. Responsible investment is the foundation of ESG. "A strategy and practice to incorporate environmental, social, and governance (ESG) factors in investment decisions and active ownership" is how the Principles for Responsible Investment (PRI) define responsible investment. As a result, investors typically utilize ESG as a standard and technique to assess corporate conduct and future financial success. The three fundamental components of ESG are the most important considerations in the process of investment research and decision-making since they are an investment concept for assessing the sustainable development of businesses. Furthermore, the sustainability and social impact of company operations are measured with the aid of environmental, social, and governance (ESG) elements. According to the (European Bank Authority, EBA), ESG factors may have positive or negative impact on the financial performance or solvency of entity, sovereign or individual. So, It can be said that as a value of sustainable and coordinated development considering economic, social, and governance benefit, ESG is an investment policy that pursues long-term value growth. As stakeholder demands for transparency grow, companies have turned to corporate disclosures and direct communications—such as earnings calls—to convey their ESG strategies, achievements, and alignment with global sustainability goals like the United Nations' Sustainable Development Goals (SDGs) (United Nations Department of Economic and Social Affairs, 2015). Earnings calls offer a unique, interactive platform where companies share their financial results and engage directly with analysts and investors on ESG issues. This shift toward ESG in earnings calls highlights a growing commitment to sustainable practices, giving companies a chance to show how their goals align

with established sustainability frameworks while addressing investor concerns. Earnings calls give companies a chance to share their financial results and address questions directly from analysts and investors. Recently, these calls have increasingly focused on ESG topics, showing a broader commitment to sustainable business practices. This approach allows companies to explain how their strategies align with recognized sustainability goals and respond to investors' questions in real-time.

In a typical earnings call, management starts with a prepared statement, often repeating points from the press release, and then opens the floor to analysts' questions. This interaction provides rich insights into the company's performance and priorities. A recent report from (Harvard Law School's Forum) on Corporate Governance also notes that earnings calls now include more ESG content, highlighting the increasing importance of discussing sustainable value with investors

Numerous studies have documented the benefits of integrating ESG criteria into corporate strategy, showing that such practices can lead to improved financial performance, enhanced risk management, and stronger brand reputation (Clark, Feiner and Viehs, 2014).

## 1.3 Research Problem

Research demonstrates that incorporating ESG practices can yield substantial benefits, such as improved financial performance, enhanced risk management, and a stronger brand reputation (Mckinsey, 2019; 'Forum for Sustainable and Responsible Investment, 2016). As global interest in sustainability grows, ESG disclosures in corporate communication—particularly in earnings calls—are emerging as a critical mechanism for conveying a company's progress and priorities to investors (Henry, Jiang and Rozario, 2021).

However, significant challenges remain in how ESG topics are addressed in earnings calls:

1. **Underrepresentation of ESG Topics:**

   Despite increasing global attention to ESG issues, current earnings call practices continue to prioritize short-term financial performance over meaningful discussions on sustainability. (Eckerle, Whelan and Tomlinson, 2020) highlights that ESG disclosures are

often underweighted, creating a gap between investor expectations and corporate communication.

2. **Managerial Opportunism and Transparency Concerns:**

   Studies, such as those by (Kim and Lee, 2023), reveal a negative correlation between ESG performance quality and managerial opportunism in earnings calls, particularly among firms with weaker ESG ratings. Companies may deliberately avoid discussing sensitive ESG topics to evade scrutiny, undermining corporate transparency and investor trust.

3. **Inconsistent ESG Reporting Frameworks:**

   A lack of standardization in ESG reporting exacerbates the challenge for investors. Companies disclose ESG information in varied and inconsistent ways, making it difficult to compare performance across industries. Without a unified framework, stakeholders are left to decipher fragmented and often incomplete ESG data.

4. **Focus on Short-Term Financials:**

   Earnings calls tend to emphasize immediate financial results over long-term ESG goals. This short-term focus raises doubts about a company's true commitment to sustainability, especially in light of global frameworks like the United Nations' SDGs.

However, on the plus side, earnings calls may reflect more true reporting as compared to a response edited to comply with a certain format. Consequently, the source is potentially valuable, but given lack of standardization more difficult to analyze. But given NLP you may be able to gain the advantage and overcome the limitations. While tools like BERT and FinBERT offer opportunities to analyze ESG discussions, their potential remains largely underutilized. Few studies have examined how real-time interactions in earnings calls influence ESG communication quality and clarity. Addressing these issues can provide actionable insights, fostering more consistent and transparent ESG discourse to meet growing investor demands for sustainability reporting.

## 1.4 Research Objectives

To address the challenges outlined above, this study will employ advanced natural language processing (NLP) tools to analyze ESG discussions in earnings calls. The research objectives are as follows:

1. **Track the Frequency of ESG Mentions:**

   Analyze how often ESG issues are discussed in earnings calls across various industries, identifying which ESG factors—environmental, social, or governance—receive the most attention.

2. **Apply Keyword-in-Context (KWIC) and Trend Analysis:**

   Use KWIC and trend analysis to examine whether companies frame ESG discussions as part of their strategies or respond reactively to immediate pressures or external events or just related to their business operation.

3. **Conduct Tone Analysis:**

   Evaluate the sentiment (positive, negative, or neutral) of ESG discussions to determine how companies present their sustainability efforts. Identify variations in tone across industries and assess whether ESG topics are framed optimistically or defensively.

4. **Use Topic Modeling for Recurring Themes:**

   Leverage tools like Latent Dirichlet Allocation (LDA)to uncover recurring ESG themes, highlighting which issues are central to specific industries and identifying any overlooked areas. This analysis will provide a more granular understanding of ESG priorities in corporate communication.

5. **Develop a Comparative Framework across industries:**

Integrate these insights into a framework that enables investors and stakeholders to compare ESG communication practices across industries. The framework will help assess a company's alignment with sustainability goals and its business operation.

By achieving these objectives, this study aims to bridge existing gaps in ESG reporting, providing a clearer picture of how companies communicate sustainability efforts in earnings calls.

## 1.5 Research Questions

This study will explore the following questions:

> How frequently are ESG topics discussed in earnings calls across different industries, and which ESG factors are highlighted the most?

> Are these ESG mentions tied to a larger, long-term strategy, or are they more reactive to current events or pressures or merely related to business activities?

> What is the tone of ESG discussions—are they positive, negative, or neutral—and does this vary by industry?

> How can these insights be structured into a framework that allows for easier comparison of ESG communication across industries?

## 1.6 Scope

By examining earnings calls sourced primarily from the SEC's EDGAR database and supplemented with transcripts from companies' Investor Relations pages, this study ensures access to official and reliable data. The choice of these sources is motivated by their credibility, comprehensive coverage, and direct connection to companies' public disclosures, providing a robust foundation for analyzing ESG trends. The inclusion of 7,643 calls reflects a representative sample of publicly traded companies across key sectors, ensuring the findings remain both relevant and thorough

## 1.7 Significance of the Study

This study is important for both companies and investors who rely on clear, consistent ESG reporting. For investors who need to make sense of how companies prioritize sustainability, it offers a way to better understand and compare ESG discussions in earnings calls, helping them make informed, responsible investment choices. Companies can use these insights to improve transparency in their ESG communication, which builds trust and meets the expectations of investors and regulators alike.

In academia, this study addresses an overlooked area by focusing on real-time ESG discussions that happen during earnings calls, rather than in formal reports. By shedding light on these interactions, the study adds new dimensions to ESG research, encouraging further exploration of how companies engage with stakeholders on sustainability issues. It uses tools like sentiment analysis to dive into these conversations, offering new insights into ESG communication that can support future research.

In the big picture, this research encourages companies to be more open about their ESG efforts, which supports the broader movement toward responsible business practices. This study will not only help investors and stakeholders make better decisions but also contribute to a deeper understanding of how companies approach sustainability in today's world.

# 2. Literature Review

## 2.1 Evolution of Sustainability and Its Corporate Relevance

Sustainability, originally rooted in ecological concerns, has expanded over decades to address the broader goal of preserving resources for future generations while supporting present needs (Kuhlman and Farrington, 2010). Early sustainability discussions centered around resource shortages and their potential economic repercussions, with interdisciplinary research emerging to address these challenges (Wilderer, 2007). As industrialization accelerated environmental degradation, sustainability evolved to encompass social and economic aspects, thus establishing

itself as a multidimensional concept central to addressing climate change and resource conservation (Dovers, Norton and Handmer, 1996).

In corporate settings, sustainability was formally recognized through (Elkington, 1998) triple bottom line (TBL) approach, advocating that businesses should balance profitability with social and environmental responsibilities. By adopting TBL, companies could operate with a view toward long-term societal value rather than short-term financial gain, integrating principles of Corporate Social Responsibility (CSR) and establishing sustainability as a core operational objective. The application of these sustainability principles has become a benchmark for modern business practices, shaping the role of corporations as contributors to broader societal welfare rather than purely economic agents.

## 2.2 Sustainable Development Goals and Corporate Accountability

The Sustainable Development Goals (SDGs), established at the United Nations Summit in 2015, provide a global framework for tackling interrelated social, environmental, and economic challenges by 2030. The SDGs consist of 17 comprehensive goals that include measurable targets adaptable to national and regional circumstances (Gupta and Vegelin, 2016; Meschede, 2020). These goals underscore the importance of collaborative efforts across governments, civil society, and businesses to achieve meaningful change, especially in areas like sustainable urban development, environmental assessment, and public policy (Caputo, Costa and Ferrari, 2013). The SDGs highlight the necessity of corporate involvement, pushing companies to align their operations and policies with these goals as part of a global citizenship agenda.

SDG research has increasingly focused on the role of the business sector in transforming traditional models into sustainable, innovation-driven ones that generate both economic and social value (Cordova and Celone, 2019). Through alignment with SDGs, companies are encouraged to adopt innovative ideas, develop sustainable products and services, and engage stakeholders. In recent years, the SDGs have served as a catalyst for corporate transformation, motivating companies to integrate sustainability goals within their core strategies. This study builds on the premise that SDGs provide an essential framework that guides ESG-related discussions within earnings calls, positioning companies as proactive agents of sustainable change.

## 2.3 Environmental, Social, and Governance (ESG) Criteria: Corporate Strategy and Accountability

As sustainability has taken hold in both public and private sectors, Environmental, Social, and Governance (ESG) criteria have emerged as an essential component of corporate strategy, marking a shift from traditional CSR to a more comprehensive approach that incorporates broader environmental and social responsibilities (Gillan, Koch and Starks, 2021). While some scholars argue that ESG represents an evolution of CSR, (Hazen, 2020) posits that it functions as a specialized subset of CSR with a focus on quantifiable sustainability metrics. Regardless of this debate, ESG has become a key measure of corporate accountability and transparency, providing a framework for aligning corporate objectives with societal and environmental values.

The rise of ESG has solidified its foundation in theories such as stakeholder theory and institutional theory, which frame corporate obligations within the broader context of societal expectations and regulatory standards. Stakeholder theory underscores the importance of reciprocal relationships between corporations and their stakeholders, advocating that companies should manage and address the expectations of diverse groups, including investors, employees, and communities (Li *et al.*, 2021). For instance, (Farooq, Rupp and Farooq, 2017) demonstrated that companies' socially responsible initiatives toward employees foster positive behavioral outcomes, enhancing perceived corporate respect and loyalty. Similarly, (Naughton, Wang and Yeung, 2019) highlighted how investor sentiment toward social responsibility can drive corporate engagement in social initiatives.

From an institutional theory perspective, ESG is viewed as a means for corporations to meet societal and regulatory expectations, thus legitimizing their roles as responsible entities. (Jayachandran, Kalaignanam and Eilert, 2013) found that the social component of ESG, rather than environmental, had a more significant positive impact on corporate performance, reflecting the nuanced value stakeholders place on social engagement. Furthermore, (Nour, Alia and Balout, 2022) emphasized the role of transparency in the social sector for firms in Jordan and Palestine, showing that social disclosures help align corporate actions with community interests, thereby supporting institutional legitimacy.

## 2.4 ESG and Governance: Empirical Insights and Implications

Empirical studies have illustrated the practical benefits of robust ESG practices, particularly within governance. For example, corporate governance features such as board diversity, board size, and transparent compensation practices are linked to improved corporate social responsibility and performance outcomes (KHATIB and NOUR, 2021; Fayyaz *et al.*, 2023). In this context, governance structures serve not only to safeguard financial interests but also to support ESG initiatives, thereby strengthening corporate legitimacy and social trust (Khan, Muttakin and Siddiqui, 2013).

In addition to governance, companies with high ESG scores are increasingly associated with superior stock market performance and resilience to risks, underscoring the material benefits of sustainability-focused corporate strategies (Belghitar, Clark and Deshmukh, 2014). This research provides a foundation for understanding how ESG is framed within corporate earnings calls, where discussions of governance, environmental impact, and social policies reflect corporate commitment to transparency and accountability.

## 2.5 Integrating ESG and SDGs: Building a Sustainable Future

The relationship between ESG practices and the SDGs is an emerging area of interest, with research highlighting the alignment between companies' sustainability disclosures and their contributions to global sustainable development. Scholars like (Indahl and Jacobsen, 2019; Plastun *et al.*, 2020) have explored how countries' positions in SDG rankings correlate with the rigor of their ESG disclosure regulations, indicating that structured ESG efforts are integral to advancing sustainable development goals. This relationship is mirrored in studies by (Bala ,2018) and (Leleux and Van Der Kaaij, 2019), who connected ESG performance with SDG rankings in diverse economic contexts, revealing that companies engaged in explicit ESG initiatives tend to perform better on sustainability indices.

By examining how companies discuss and prioritize ESG within earnings calls, this study aims to provide insights into the ongoing alignment between corporate strategies and SDG-oriented goals. The exploration of this alignment offers a basis for understanding how companies view their role in sustainable development, contributing to a nuanced perspective on ESG as both a strategy and a form of corporate social responsibility.

## 2.6 Text Mining in ESG Analysis: Tools and Techniques

Text mining is a pivotal tool in analyzing large volumes of unstructured text data, allowing researchers to extract hidden patterns, trends, and meaningful insights (VijayGaikwad, Chaugule and Patil, 2014; Inzalkar S., Sharma J. (2015)). As corporate communications increasingly emphasize ESG, text mining has become instrumental in decoding the language of sustainability and evaluating corporate disclosure practices. Over the past few years, text mining has proven effective in identifying themes within sustainability reports, enabling deeper insights into how companies articulate their commitment to sustainability.

Among the prominent techniques in ESG-related text mining is topic modeling, particularly Latent Dirichlet Allocation (LDA), which is frequently used to uncover recurring themes within vast datasets. (Polychronopoulos, Dahle and Reuther, 2021) applied LDA to analyze entrepreneurs' engagement with SDGs, illustrating how topic modeling can reveal the depth and diversity of ESG discussions. Similarly, TF-IDF (Term Frequency-Inverse Document Frequency) analysis, used by (Aiba Y., Ito T., Ibe Y. (2020)) and (Taleb *et al.*, 2020), has emerged as a powerful method for assessing the prominence of ESG-related terms within corporate disclosures.

Network analysis and CONCOR (convergence of iteration correlation) analysis are also valuable for mapping relationships between ESG terms and exploring how they coalesce into broader themes. Studies by (Moon Jihye and Kim, Taesung, 2022) and (조아라 and 김학선, 2017) have shown that these methods are effective in comparing ESG strategies across regions and corporations, identifying unique cultural and regional variations in how companies approach sustainability.

Building on this methodological foundation, this study employs text mining tools like KWIC (Keyword-in-Context) analysis and LDA to analyze ESG topics in earnings calls. By applying these techniques, the study will explore the frequency, sentiment, and thematic context of ESG discussions, providing a comprehensive view of how companies communicate their ESG priorities in response to evolving stakeholder and regulatory expectations.

# 3. Methodology

## 3.1 Data

For our analysis, we utilize earnings call transcripts sourced from S&P Global. This dataset is widely regarded within the investment community as a high-quality and comprehensive repository of earnings call transcripts. Our study focuses on data from October 4, 2021, to August 30, 2023, based on the recorded date range in the dataset. The dataset comprises 7,643 entries detailing earnings call transcripts from various companies.

## 3.2 Data Wrangling

To analyze the earnings call transcripts, we began by compiling the provided RDS files and extracting essential details, including the call date, ticker symbol, and transcript content. These were then combined into a unified data frame. For our initial task, which required industry-specific data, we collected this information for each company by scraping Yahoo Finance. Additionally, the transcripts' textual content underwent a cleaning process to remove HTML artifacts, decode entities, eliminate extra whitespace, and standardize the text by converting it to lowercase. Finally, we got a total of 139 industries.

Exhibit 1 illustrates the top 10 industries in our dataset based on the frequency of earnings calls. The Biotechnology industry leads with the highest number of calls, followed by Banks—Regional and Software—Application, reflecting their critical role in market dynamics during the observed period. Other industries, such as Medical Devices and Semiconductors, highlight the prominence of healthcare and technology sectors, particularly during times of innovation and market growth. This distribution indicates that the dataset covers a diverse range of industries with a strong focus on sectors that drive economic and technological advancements.

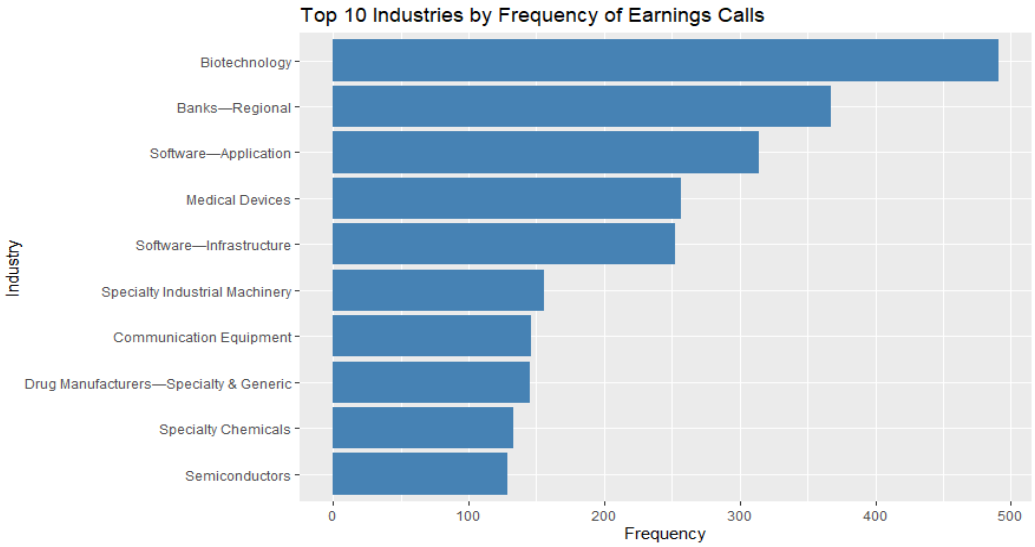


*Exhibit 1. Top Ten Industries by Frequency of Earnings Calls*

Exhibit 2 presents the frequency trends of the top 5 industries from Exhibit 1 over time, revealing cyclical patterns consistent with quarterly reporting schedules. Banks—Regional and Biotechnology exhibit notable peaks, likely aligning with key reporting periods, financial disclosures, and market events, suggesting heightened industry activity during these times. In contrast, Software—Application shows more stable and consistent activity, which could reflect the continuous nature of software updates and development cycles. The Medical Devices and Software—Infrastructure industries demonstrate steady engagement across earnings calls, indicating their ongoing relevance in the healthcare and technology sectors, respectively.

Overall, these patterns highlight the temporal dynamics of reporting, where industries such as finance and biotechnology tend to respond to external triggers like quarterly earnings or regulatory announcements, while technology and healthcare sectors maintain a consistent presence due to their foundational role in the economy.

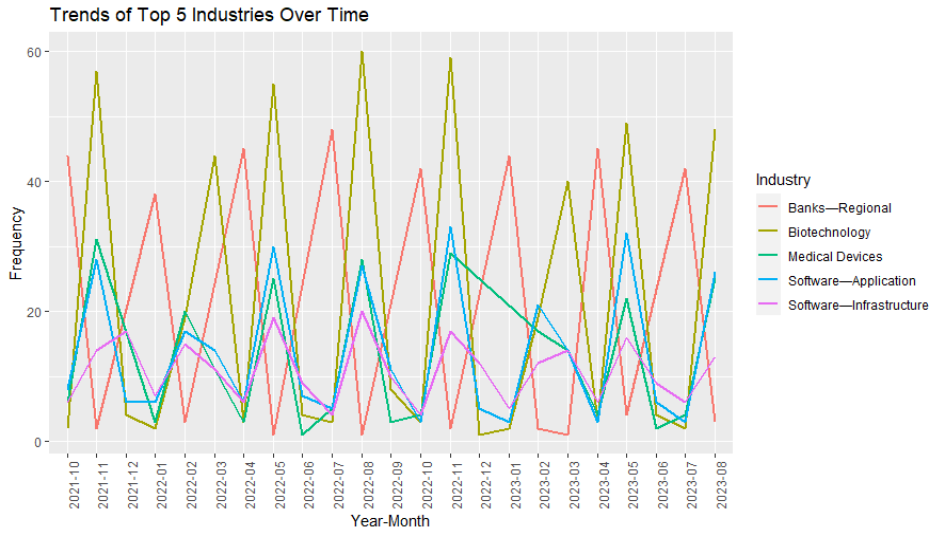


*Exhibit 2. Trends of Top 5 Industries over time*

## 3.3 Analysis

As illustrated in Figure 1, this study follows a structured workflow of natural language processing and text analysis to explore ESG discussions in corporate earnings calls. The analysis progresses through several stages to address the research objectives and provide insights into how companies prioritize and communicate ESG topics.

The process begins with data collection, where earnings call transcripts are gathered, followed by data preprocessing to prepare the text for analysis, including tokenization and cleaning. The next stage involves frequency analysis, using unigram frequency techniques to identify key ESG-related terms and their prominence across industries. To contextualize these findings, a contextual analysis (Key Word in Context - KWIC) was conducted to understand how specific ESG terms are discussed and prioritized by different companies.

Further, sentiment analysis was performed to assess the tone of ESG discussions, identifying whether companies frame these topics positively or negatively. Topic modeling using Latent Dirichlet Allocation (LDA) was applied to uncover latent themes and explore the underlying topics emphasized in ESG discussions.

The results of these analyses were consolidated through industry comparison and emerging trends analysis, providing a macro-level view of how industries differ in their ESG focus and how these discussions have evolved over time. Ultimately, the findings contribute to identifying risks and opportunities, offering practical insights into corporate ESG strategies and their alignment with broader sustainability goals. This systematic approach enables a comprehensive understanding of

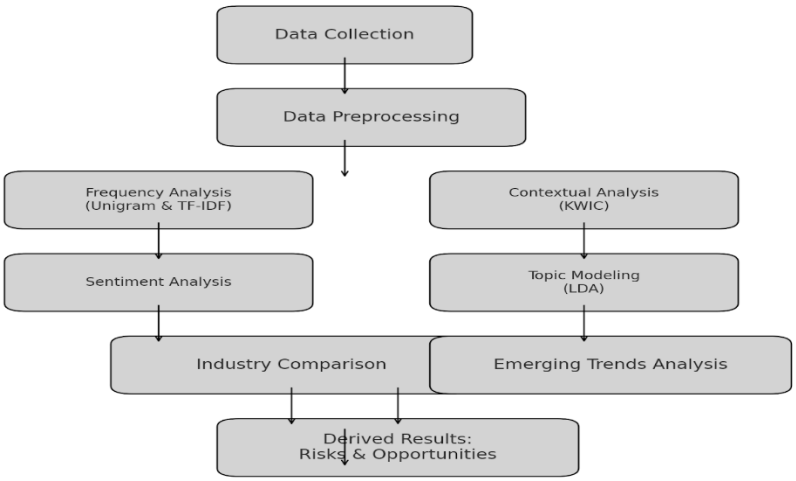


*Exhibit 3. Analysis flow chart*

ESG practices and their implications in a corporate context.

### 3.3.1 Developing the ESG Word List for Quantitative Analysis

To determine the extent of ESG (Environmental, Social, and Governance) activity within a firm's financial disclosures, this research employs a systematic approach to define and quantitatively describe ESG content. The foundation of this analysis is an ESG word list that can serve not only as the basis for this study but also for future research in Corporate Social Responsibility (CSR) and Socially Responsible Investment (SRI) strategies. By leveraging existing textual analysis literature and following established guidelines, the study ensures the creation of a meaningful and comprehensive list of ESG-related terms.

The development of the ESG word list is informed by (BD Prasad, LD DK, V Bhaskaran, 2008) methodology for content analysis, which emphasizes the importance of developing robust content

categories. The computational linguistics literature also underlines that the quality of the results is highly dependent on the precision and relevance of these categories (Albig, 1952). In this context, the ESG word list is built around three primary dimensions: environmental, social, and governance.

### 3.3.2 Categorization Framework

Several ESG categorization schemes, such as those proposed by , and (Lokuwaduge and Heenetigala, 2017), provide structured frameworks for organizing ESG content. Among these, Dimson et al.'s (2015) scheme is particularly meaningful and has been adopted as the foundation for this study. To ensure a more comprehensive definition of ESG, additional categories have been integrated during the word list creation process.

The word list is structured using a three-level approach, where ESG topics are first subdivided into 10 broad categories, which are then further divided into 40 subcategories. This hierarchical approach allows for detailed analysis and classification of ESG topics, ensuring that all relevant aspects of sustainability are captured.

### 3.3.3 ESG Keywords and Patterns

For the purpose of textual analysis, an extensive ESG keyword list is developed to capture the breadth of sustainability discussions. This list includes terms such as "ethics," "sustainability," "climate," "diversity," "pollution," and "shareholder," among others. The keywords are divided into three main categories:

1. **Environmental**:
    - Keywords: "climate change," "carbon footprint," "renewable energy," "sustainability," "biodiversity."
    - Focus: Captures firms' discussions related to environmental risks, carbon reduction initiatives, and renewable resource adoption.
2. **Social**:
    - Keywords: "diversity," "human rights," "employee well-being," "community engagement."

- Focus: Highlights issues related to inclusivity, workforce management, and social impact strategies.

3. **Governance**:
    - Keywords: "shareholder rights," "board diversity," "executive compensation," "transparency."
    - Focus: Addresses corporate structure, ethical practices, and stakeholder management.

### 3.3.4 Analytical Techniques

The ESG word list is utilized across multiple textual analysis methods to provide a detailed understanding of firms' sustainability efforts. These methods include:

#### *3.3.4.1. Frequency Analysis:*

To gain a detailed understanding of firms' sustainability efforts, this study employs Frequency Analysis as the primary textual analysis method. Frequency analysis provides a clear, quantitative measure of how often specific ESG-related terms—such as *"sustainability," "carbon footprint,"* or *"governance practices"*—appear in earnings call transcripts. By systematically counting the occurrences of these terms, this approach reveals the prominence of ESG topics across industries and helps identify patterns in corporate communication.

Frequency analysis works by calculating the relative occurrence of specific terms within a document. For example, the frequency of a word can be determined using the following formula:

$$\text{Frequency (F)} = \frac{\text{Count of ESG term occurrences}}{\text{Total word count in the document}} \times 100$$

This formula normalizes the results, allowing for consistent comparisons across transcripts of varying lengths. As (Manning, Raghavan and Schütze, 2008) explain, word frequency is a foundational step in natural language processing (NLP) that enables deeper insights, such as term significance, sentiment analysis, and trend detection. By focusing on quantitative word counts, frequency analysis offers an objective way to identify the most emphasized ESG topics and provides a strong basis for further investigations.

In this study, ESG-related terms were extracted and analyzed from a large collection of earnings call transcripts. The analysis aimed to determine which industries emphasize ESG communication the most and to explore any differences in focus between companies within the same sector. For example, industries such as renewable energy or finance may emphasize environmental sustainability or governance topics more frequently. However, companies in similar sectors can still show unique variations due to their specific strategies, stakeholder demands, or market conditions. (David M. Blei Andrew Y. Ng Michael Jordan, 2001) note that such textual methods are particularly effective for uncovering differences in thematic emphasis within and across industries.

The insights from frequency analysis are particularly valuable for understanding the depth and focus of corporate sustainability communication. They highlight which industries are more proactive in discussing ESG topics and where gaps or inconsistencies may exist. This aligns with findings from previous studies (Clark, Feiner and Viehs, 2014), which demonstrate that effective ESG communication not only signals transparency but also helps build investor trust and long-term value.

By identifying key trends and recurring patterns, frequency analysis provides a systematic framework for evaluating how companies align their communication with broader sustainability goals, such as the United Nations' Sustainable Development Goals (SDGs). This study builds upon established methodologies in textual analysis while applying them to the evolving landscape of ESG communication in earnings calls.

#### *3.3.4.2. Keyword-in-Context (KWIC) Analysis:*

Keyword-in-Context (KWIC) analysis is used in this study to uncover the context in which ESG-related terms appear in earnings call transcripts. This method examines a window of 20 words before and after each keyword to provide a detailed understanding of how ESG topics are discussed. For instance, terms like *"sustainability," "carbon footprint,"* or *"diversity"* are not analyzed in isolation but within their surrounding context to reveal the specific framing, actions, or attitudes tied to them.

To enrich the analysis, Part-of-Speech (POS) tagging is applied, which categorizes words into nouns, verbs, and adjectives. This additional step helps identify action-oriented language

connected to ESG terms. Verbs like *"improve," "reduce," "enhance,"* or *"address"* often signal proactive efforts, such as *"improve sustainability practices"* or *"reduce carbon emissions."* Meanwhile, the absence of strong action verbs might indicate vague or superficial commitments. As (John Sinclair, 1991) highlights, exploring words in their immediate context allows for deeper insights into their meaning and use, particularly when analyzing patterns in large datasets.

KWIC analysis was chosen for this study because it goes beyond simple word frequency counts to reveal how ESG topics are framed in corporate communication. This method captures subtle differences in language, helping identify whether companies emphasize concrete actions or rely on generalized statements. For example, phrases like *"actively reducing emissions"* carry a stronger commitment than passive mentions such as *"we aim to focus on sustainability."*

In this research, the KWIC analysis was applied across a large dataset of earnings call transcripts to:

- Identify the context in which ESG terms are mentioned, revealing whether they are associated with strategic initiatives, challenges, or external pressures.
- Highlight the use of action verbs and descriptive language to gauge the specific steps companies claim to take in addressing ESG concerns.
- Compare how ESG terms are framed across industries—for example, energy companies might frequently use verbs like *"reduce"* and *"achieve"* when discussing emissions, whereas financial firms might focus on *"improve governance structures"* or *"enhance transparency."*

The insights gained from KWIC analysis are particularly valuable for understanding the framing and tone of ESG discussions. It allows us to see whether companies use language that reflects genuine, actionable commitments or simply responds reactively to market or regulatory pressures. Manning, Raghavan, and Schütze (2008) emphasize the importance of such methods in text analysis, as they provide a richer, more contextual understanding of word usage within large bodies of text.

By examining the surrounding context of ESG keywords, KWIC analysis adds depth to the study, uncovering patterns in corporate sustainability communication that may otherwise remain hidden.

This method enables stakeholders, including investors and analysts, to assess how companies frame their ESG priorities and commitments within earnings calls—helping distinguish between meaningful strategies and superficial claims.

#### *3.3.4.3. Word Cloud Analysis*

Word cloud analysis is a visual technique that represents text data by displaying words in varying sizes based on their frequency of occurrence. In this study, word clouds provide an intuitive, high-level view of the dominant ESG terms appearing in corporate earnings call transcripts. For example, words like *"emissions," "diversity,"* and *"sustainability"* might appear larger if they occur more frequently, offering a quick overview of which ESG topics are emphasized most.

To ensure meaningful results, the transcripts underwent thorough text preprocessing, which included cleaning, tokenization (splitting text into individual words), and the removal of common stopwords such as *"and," "the,"* and other irrelevant terms. Additionally, ESG-specific dictionaries were applied to ensure the analysis focused exclusively on sustainability-related terms. Once the preprocessing was complete, the frequency of each word was calculated, and word clouds were generated.

The analysis was conducted across the full dataset and separately for individual industries (e.g., energy, finance, and manufacturing). This allowed for a comparison of sector-specific ESG priorities, revealing how industries differ in their focus. For instance, energy companies might highlight terms like *"carbon neutrality"* and *"renewable energy,"* while financial firms might emphasize *"corporate governance"* or *"risk management."*

Word cloud analysis was chosen because of its ability to offer a visual snapshot of recurring themes in large datasets. As Blei et al. (2003) note, visualizations can complement quantitative analysis by uncovering patterns that might otherwise be overlooked.

By visually representing ESG communication, word cloud analysis offers a valuable entry point for identifying overarching trends, which are then explored in greater detail through contextual methods like KWIC and topic modeling.

#### *3.3.4.4. Sentiment Analysis:*

Sentiment analysis examines the emotional tone of ESG discussions, classifying text as positive, negative, or neutral. In this study, the Loughran-McDonald (LM) dictionary—a lexicon

specifically designed for financial text (Loughran and Mcdonald, 2011) — was used to assess sentiment in sentences containing ESG-related terms. The LM dictionary's focus on financial language ensures that words like *"risk"* or *"loss"* are correctly interpreted in a financial context, rather than in general usage.

The analysis works by assigning a sentiment score to each sentence:

$$\textbf{Net Sentiment Score} = \textbf{Positive Words} - \textbf{Negative Words}$$

This score provides a numerical representation of the overall tone of ESG discussions. Sentences with more positive words reflect a favorable stance, while higher occurrences of negative words indicate challenges or risks.

The application in this study involved evaluating all sentences containing ESG terms in earnings call transcripts. By calculating net sentiment scores for each industry, the analysis identifies trends and variations across sectors. For example, tech firms discussing innovation in sustainability might show predominantly positive sentiment, while fossil fuel companies addressing emissions reductions might exhibit mixed or negative tones due to the associated challenges.

Sentiment analysis was chosen because it helps uncover corporate attitudes toward ESG topics. It reveals whether companies highlight achievements (positive sentiment) or focus on risks and challenges (negative sentiment). Furthermore, it can identify potential greenwashing, where overly positive language may mask poor performance or insufficient action.

#### *3.3.4.5. Topic Modeling (LDA):*

Topic modeling, specifically Latent Dirichlet Allocation (LDA), is a statistical method that identifies hidden themes in large textual datasets by grouping words that frequently appear together (David M. Blei Andrew Y. Ng Michael Jordan, 2001).For example, words like *"carbon," "climate,"* and *"emissions"* might cluster into a topic labeled *"environmental sustainability,"* while terms like *"governance," "board structure,"* and *"compliance"* could form a *"corporate governance"* topic.

The process begins with text preprocessing, where transcripts are tokenized, stopwords are removed, and words are lemmatized (converted to their base form) to standardize the data. The LDA model then calculates the probability distribution of topics across the text. The optimal

number of topics is determined using coherence scores and perplexity measures, ensuring that the extracted topics are both meaningful and interpretable.

The LDA method was chosen because of its ability to analyze unstructured text and automatically identify patterns, providing a structured overview of ESG discussions. As IBM (2024) highlights, topic modeling is particularly useful for uncovering latent themes in large corpora, making it ideal for analyzing complex sustainability-related conversations.

#### *3.3.4.6. Bigram and Network Analysis:*

Bigram analysis identifies pairs of words that frequently occur together, such as *"carbon footprint," "diversity initiative,"* or *"governance framework."* This technique moves beyond individual words to capture relationships and common phrases in ESG communication. For example, analyzing bigrams can highlight whether companies frequently discuss *"climate action"* or *"regulatory compliance,"* providing insights into recurring themes.

Building on bigram analysis, semantic network analysis visualizes the connections between ESG terms by constructing a network graph. Using cosine similarity, the strength of relationships between words is calculated and mapped into a network. Tools like CONCOR analysis are then used to cluster related terms into thematic groups, offering a holistic view of how ESG concepts are interconnected.

This approach was chosen because it provides a deeper understanding of ESG discourse by uncovering relationships between concepts. As (Hansen et el, 2011) note, network analysis is an effective tool for visualizing complex structures in large text datasets, offering stakeholders a clear map of corporate sustainability priorities.

### Summary of Analytical Models

| Model | Purpose | Reveals |
|---|---|---|
| **Frequency Analysis** | Identify prominent ESG terms across industries. | Which sectors focus most on ESG topics and which terms are emphasized. |
| **KWIC Analysis** | Explore the context of ESG terms in transcripts. | How ESG topics are framed (e.g., actionable vs. aspirational language). |
| **Sentiment Analysis** | Assess the tone of ESG discussions. | Whether firms discuss ESG positively, negatively, or neutrally; potential greenwashing. |
| **Topic Modeling (LDA)** | Uncover hidden themes in ESG discourse. | Dominant ESG topics and industry-specific themes. |
| **Semantic Network Analysis** | Visualize relationships between ESG terms. | Conceptual connections between ESG topics and how firms prioritize them. |

## 3.3.5 Justification for Methodology

The careful development of the ESG word list and associated analytical techniques ensures that the study aligns with best practices in computational linguistics and content analysis. By categorizing ESG-related terms into environmental, social, and governance dimensions, the word list provides a foundation for analyzing firms' sustainability strategies comprehensively. The inclusion of advanced techniques such as KWIC, sentiment analysis, and LDA further strengthens the study's ability to extract meaningful insights. This approach not only highlights the key areas of ESG focus across industries but also offers a replicable framework for future research in sustainability-related textual analysis.

Through this structured methodology, the study aims to enhance understanding of how firms communicate their ESG priorities and align with global sustainability goals. By analyzing the use of ESG terms, patterns, and sentiments, the research contributes to the broader discourse on corporate sustainability and its implications for stakeholders.

# 4. Results

## 4.1 Frequency Analysis

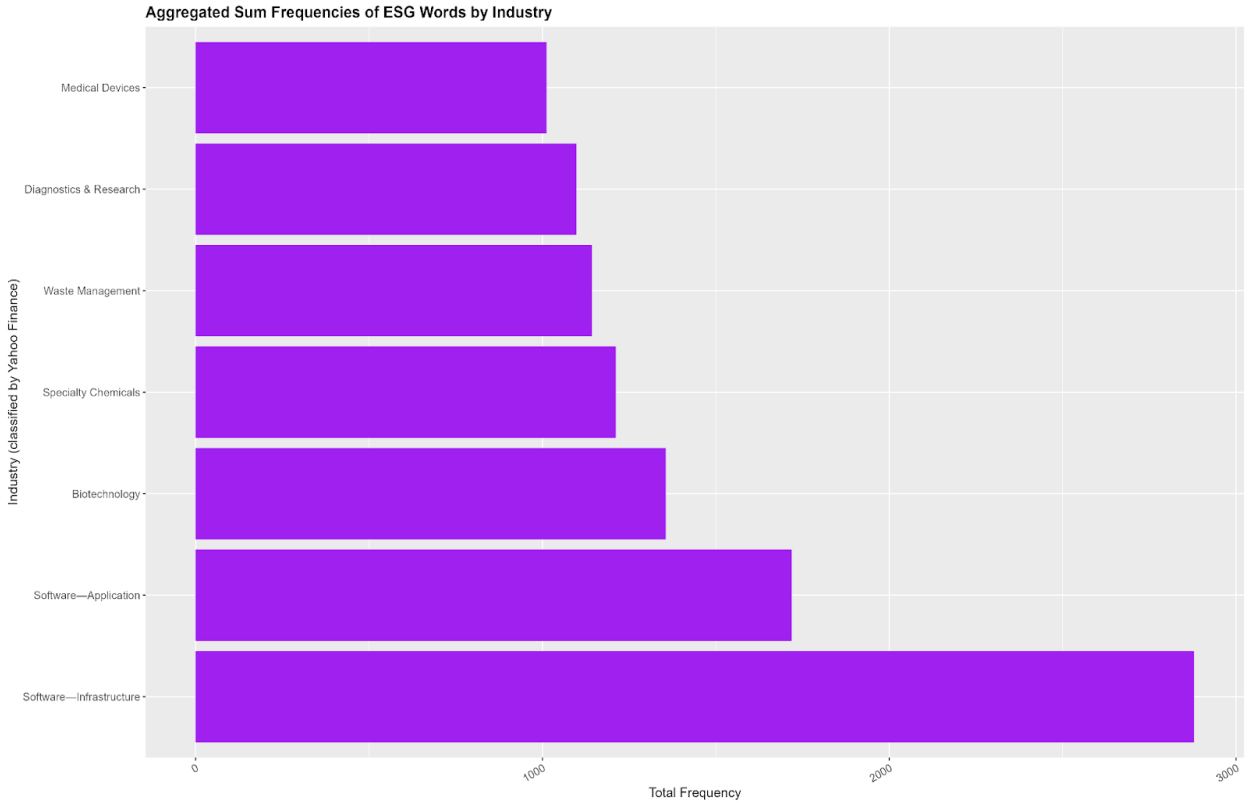


*Exhibit 4. Aggregated Sum Frequencies of ESG Words by Industry*

To assess the presence and significance of ESG-related discussions across various industries, we conducted a frequency analysis on the mentions of key ESG terms, including keywords such as "ethics," "sustainability," "governance," and "climate," within corporate earnings call transcripts. This analysis aimed to quantify the total frequency of ESG mentions in each industry and identify the sectors that are most engaged in sustainability-related discussions. Industries with higher frequencies of these terms are inferred to exhibit a stronger focus on ESG considerations.

The results of this analysis are visualized in Exhibit 4, which displays the aggregated frequencies of ESG terms across industries. Notably, the top industries with the highest total mentions of ESG terms include:

1. **Software – Infrastructure**: This industry leads in ESG discussions, reflecting its significant focus on sustainability and governance, possibly driven by regulatory compliance and stakeholder expectations in the tech sector.
2. **Software – Application**: Companies in this category exhibit strong engagement with ESG topics, particularly in areas such as data privacy and governance, which are critical for application software providers.
3. **Biotechnology**: High mentions of ESG terms indicate the sector's focus on environmental and social issues, such as health and diversity, which align with its core mission of improving societal well-being.
4. **Specialty Chemicals**: This industry emphasizes sustainability and environmental concerns, likely due to the sector's environmental footprint and the need for innovative, green solutions.
5. **Waste Management**: As expected, this sector prominently discusses ESG topics, particularly those related to waste reduction, recycling, and sustainability initiatives.

**Interpretation of Findings**

The high frequency of ESG-related terms in the aforementioned industries suggests their significant engagement with sustainability issues. For example, the technology-focused software sectors (both infrastructure and application) are likely addressing governance issues such as data security and transparency. Similarly, industries like biotechnology and specialty chemicals focus heavily on the social and environmental dimensions of ESG, reflecting their contributions to health, sustainability, and community impact.

However, frequency analysis alone may not provide the full context of ESG discussions. Mentions of ESG terms might occur in contexts unrelated to actual sustainability initiatives. To address this limitation, we extended our analysis to include **Keyword-In-Context (KWIC) analysis**, which provides insights into how ESG terms are utilized within their specific contexts. For example, KWIC allows us to assess whether mentions of "sustainability" refer to actionable strategies or are used as general references.

**Next Steps**

Building on the frequency analysis, the KWIC analysis will delve deeper into the context surrounding ESG mentions across industries. This approach aims to uncover whether industries are discussing ESG terms in meaningful ways, such as outlining strategies, assessing risks, or showcasing achievements. By combining frequency data with contextual insights, we aim to provide a more nuanced understanding of how industries are integrating ESG principles into their operations and communications. This layered approach ensures a comprehensive evaluation of ESG activity across sectors, contributing valuable insights to the broader discourse on corporate sustainability.

## 4.2 KWIC-Analysis

In the next phase of our study, we focused on analyzing the transcripts associated with the five industries that demonstrated the highest frequencies of ESG-related terms. The process began with the extraction of relevant transcripts, followed by tokenization to break the text into individual words. These tokens were then used to construct a KWIC (Keyword-In-Context) data frame, which was designed to include ten words before and after each mention of ESG-related terms, such as "sustainability," "diversity," and "governance."

To gain a deeper understanding of the context in which these terms were used, we applied part-of-speech (POS) tagging to the KWIC data frame. This allowed us to extract key nouns and verbs associated with ESG discussions, providing insights into how firms articulate their sustainability initiatives and concerns. Additionally, we created word clouds for the five industries, visualizing the most frequently mentioned terms and identifying context-specific patterns. During this step, custom stopwords were detected and removed to enhance the clarity of the analysis.

Subsequently, we conducted separate KWIC analyses of all the industries and for each of the top two industries to uncover industry-specific ESG narratives. The findings are presented in the following sub-sections, accompanied by word clouds that highlight the unique ways in which each industry engages with ESG topics. These visualizations and analyses offer valuable insights into the contextual nuances of ESG discussions across sectors, revealing industry priorities and the depth of their sustainability commitments.

## 4.3 Word Cloud Analysis: ESG Discussions Across All Industries


*Exhibit 5. Word Cloud across all industries*

The aggregated word cloud analysis, depicted in Exhibit 5, provides a comprehensive visualization of the ESG-related themes discussed across various industries. Prominent terms such as "commitments," "governance," "community," "safety," and "growth" dominate the visualization, reflecting the core priorities and focal points of firms when addressing ESG considerations in their corporate communications and strategies.

**Key Insights from the Word Cloud**

1. **Governance as a Central Theme**: The prominence of terms such as **"governance," "ratings,"** and **"leader"** highlights the critical importance of governance in corporate

ESG strategies. These terms reflect the emphasis on transparency, regulatory compliance, and accountability. Companies are increasingly focusing on building robust governance frameworks to foster trust and meet the growing demands of investors and stakeholders.

2. **Commitments to Community and Social Responsibility**: Words like **"community," "safety," "diversity,"** and **"benefit"** underscore the social dimensions of ESG. These terms indicate a commitment to inclusivity, employee well-being, and community engagement. For example, "safety" reflects the importance of providing secure and supportive working environments, while "community" signals active efforts to positively impact society beyond organizational boundaries.

3. **Environmental Sustainability and Climate Focus**: Frequently mentioned terms such as **"environment," "climate," "emissions,"** and **"greenhouse"** demonstrate industries' commitment to addressing environmental challenges. These words reflect efforts to reduce carbon footprints, adopt greener technologies, and align with global sustainability objectives, such as transitioning to low-carbon economies.

4. **Growth and Strategic Development**: The appearance of words like **"growth," "development," "results,"** and **"management"** emphasizes that ESG strategies are increasingly integrated into companies' broader business goals. These terms suggest that firms view ESG not just as a compliance requirement but also as a driver of long-term profitability, innovation, and competitiveness.

### 4.3.1 Software – Infrastructure industry


*Exhibit 6. Word Cloud for the Software-Infrastructure industry*

The wordcloud for the Software – Infrastructure industry (Figure 6) reveals prominent terms such as "security," "customer," "management," "technology," and "capabilities," which highlight the industry's focus on addressing critical infrastructure challenges. These terms provide insights into the industry's priorities, particularly in enhancing cybersecurity, improving technology management, and meeting customer demands.

A key observation from the wordcloud is the centrality of "security," reflecting the industry's significant emphasis on cybersecurity solutions. Terms like "protection," "compliance," "network,"

and "transformation" further underscore the industry's focus on safeguarding systems and addressing evolving security needs. Additionally, "customer" and "management" emphasize the industry's commitment to providing tailored solutions that align with client requirements and operational priorities.

**Example Context: Security and Efficiency**

An illustrative sentence extracted from the transcripts exemplifies this focus:

*"As customers increasingly look to rationalize spend, we believe Rapid7 is incredibly well-positioned to accelerate customers' path to consolidate security spend and increase their efficacy by utilizing our Insight platform to help solve their most urgent security needs."*

This sentence highlights several key aspects of the Software – Infrastructure industry's engagement with ESG themes:

1. **Customer-Centric Solutions**: The emphasis on addressing "customers' path to consolidate security spend" reflects a strategic focus on providing efficient, cost-effective cybersecurity solutions tailored to client needs.
2. **Cybersecurity Innovation**: The mention of the "Insight platform" showcases the industry's reliance on innovative technologies to address urgent security challenges, aligning with the increasing demand for advanced cybersecurity infrastructure.
3. **Operational Efficiency**: The industry's role in helping clients "rationalize spend" and "increase their efficacy" reflects its broader commitment to driving operational efficiency and value creation.

### 4.3.2 Software – Application


*Exhibit 7. Word Cloud for the Software-Appliance industry*

Through an examination of the word cloud generated for the Software - Application industry (Exhibit 7), we analyzed two key ESG dimensions: **governance** and **social**. The wordcloud reveals prominent terms such as "technology," "governance," "clients," "security," and "reducing," which highlight the industry's priorities in addressing these ESG themes.

**Governance Perspective**

Focusing on the **governance** dimension, terms like "governance," "strategy," and "policies" emphasize the industry's commitment to implementing robust governance frameworks. These efforts aim to ensure compliance, accountability, and ethical practices. A sentence extracted from the transcripts underscores this focus:

*"An AI strategy plan identifying priority projects, providing resources to help structure and implement AI projects, and then ensure proper governance and policies are applied and monitored."*

This sentence demonstrates how companies in this sector actively incorporate governance considerations into their AI and technological advancements, ensuring that innovation is paired with accountability and compliance.

**Social Perspective**

On the **social** dimension, terms like "reducing," "impact," and "clients" reflect the industry's role in leveraging technology to create broader societal benefits. These include reducing environmental impacts and enhancing social well-being through scalable software solutions. The following example sentence illustrates this commitment:

*"Our software can have an enormous effect by reducing the environmental impact of our clients as they produce, transport, and distribute their products, and to this end, ESG is part of our annual environmental, social, and governance report***."**

This sentence highlights the industry's focus on integrating social and environmental considerations into its operations, showcasing how software solutions contribute to ESG goals by supporting clients in achieving sustainability objectives.

## 4.4 Sentiment Analysis of ESG Discussions Across Industries

To understand how companies perceive and discuss ESG topics, a sentiment analysis was conducted across various industries. This analysis utilized the Loughran-McDonald (LM) dictionary, which is tailored for financial sentiment analysis, to compute average positive and

negative sentiment scores. By evaluating sentiment scores, we aim to discern whether firms address ESG topics positively or negatively and identify trends over time.

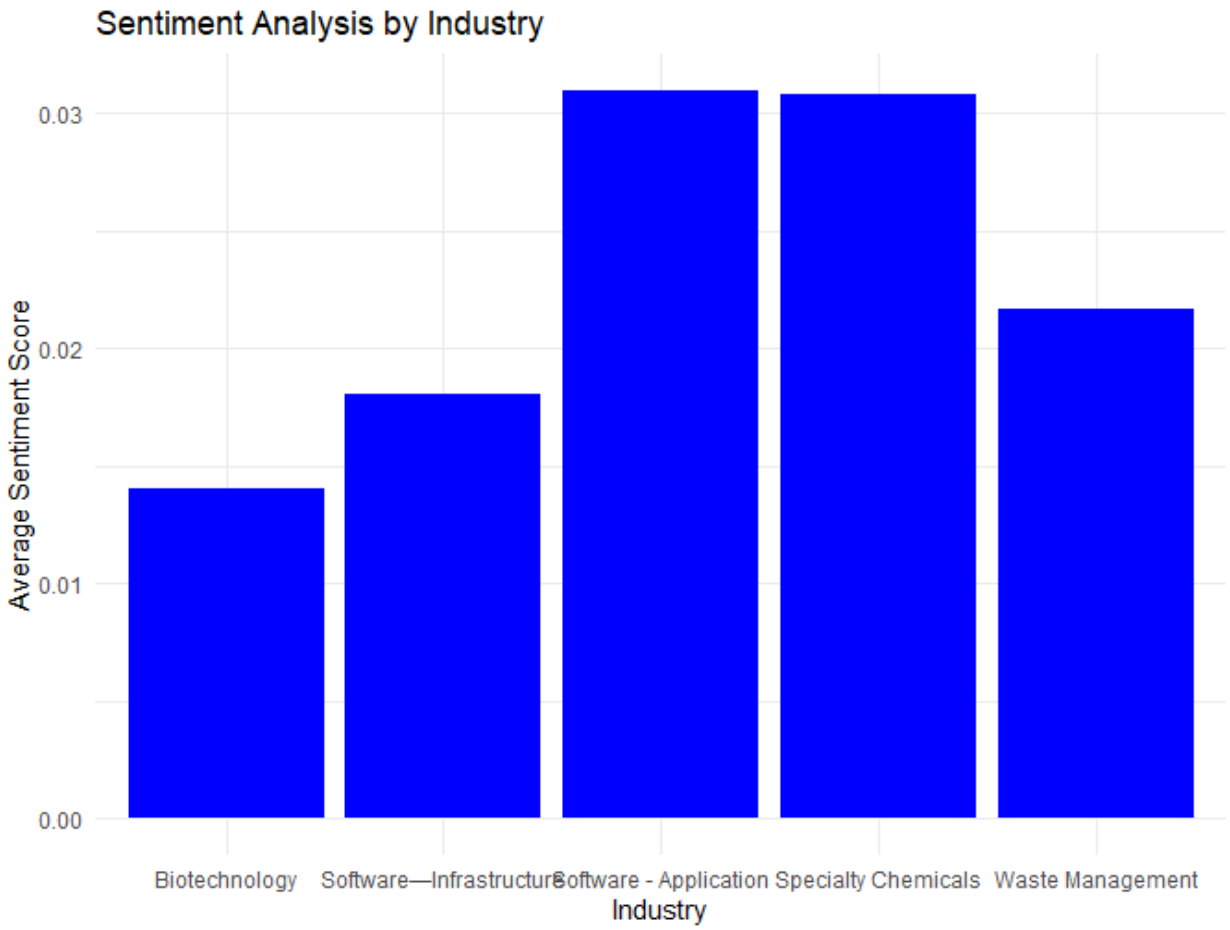


*Exhibit 8 Sentiment Analysis by Industry*

Industry-Level Sentiment Analysis

Exhibit 8. depicts the average sentiment scores across the five industries with the most frequent mentions of ESG-related terms. This analysis highlights how industries vary in their approach to ESG topics, yet all maintain positive net sentiment scores.

Industry Sentiment Highlights:

- Software – Application and Specialty Chemicals recorded the highest positive sentiment scores. This reflects optimistic discussions, emphasizing ESG as a source of competitive advantage, particularly in innovation and sustainable practices.

- Waste Management also demonstrates strong positive sentiment, aligning with its inherent focus on environmental sustainability and resource optimization.
- Software – Infrastructure and Biotechnology, while showing slightly lower sentiment scores, still reflect positive discussions around ESG, often emphasizing governance and social responsibility.

The consistently positive sentiment across industries suggests that ESG is viewed as an opportunity rather than a liability, with companies emphasizing its potential for growth, compliance, and stakeholder engagement.

**Temporal Trends in Sentiment**

Exhibit 9 illustrates the temporal evolution of sentiment scores, comparing average positive and negative sentiments over time. This analysis sheds light on how the sentiment around ESG discussions shifts in response to external factors, such as market trends, regulatory changes, or public sustainability commitments.

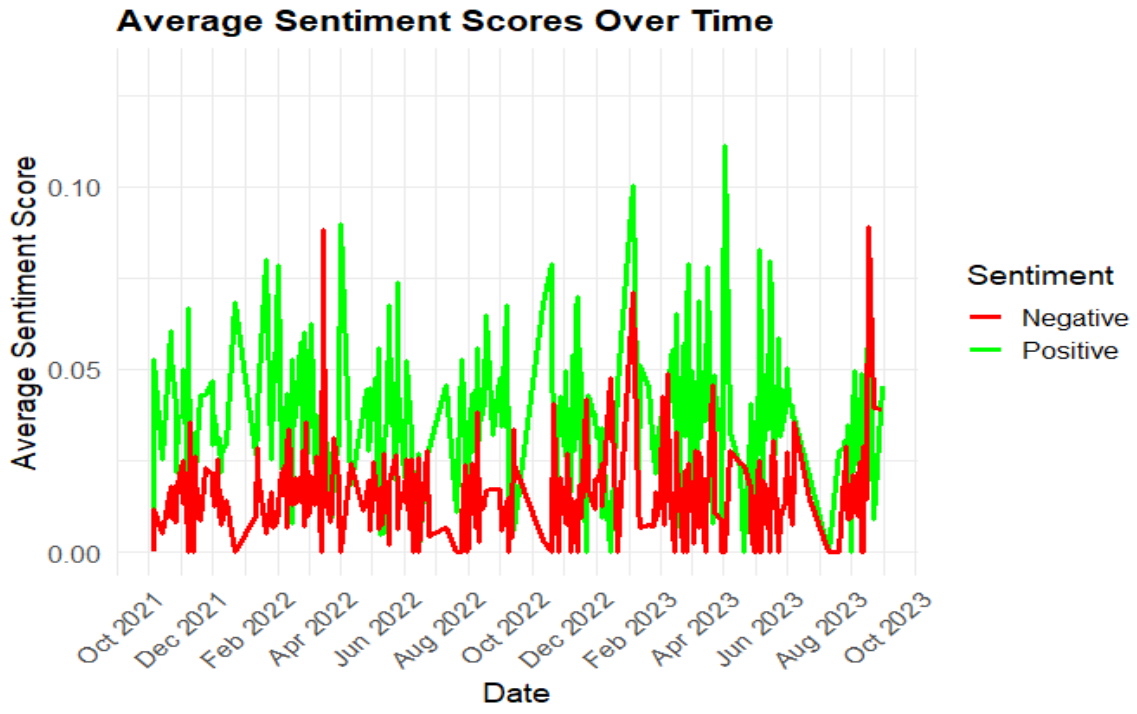


*Exhibit 9. Average Sentiment Scores Over Time*

**Key Temporal Patterns**:

- **Positive Sentiment Dominance**: Positive sentiment consistently outweighs negative sentiment across the time series, indicating that companies largely view ESG topics favorably.
- **Periodic Spikes**: Peaks in positive sentiment likely coincide with quarterly reporting cycles, significant ESG announcements, or achievements related to sustainability goals.
- **Negative Sentiment Presence**: Occasional upticks in negative sentiment suggest challenges, such as the costs of implementation or concerns around regulatory burdens. However, these remain minimal compared to positive discussions.

This temporal analysis indicates that companies' perspectives on ESG are not static but adapt to external and internal changes, reflecting the evolving nature of sustainability in corporate strategy.

**Insights and Context**

The positive sentiment trends align with the findings from the **KWIC analysis**, where industries primarily discussed ESG in the context of growth opportunities, innovation, and operational efficiency. Negative sentiments, though present, likely reflect practical challenges rather than outright resistance to ESG initiatives.

For example:

- A representative statement from the **Waste Management** sector highlights the optimism: *"Our efforts in reducing landfill waste and increasing recycling rates demonstrate our commitment to sustainability while creating long-term value for stakeholders."*
- Conversely, a statement from the **Software – Infrastructure** sector illustrates a challenge: *"Adapting governance structures to meet new regulatory standards has required significant investment, but we remain committed to achieving compliance."*

These examples demonstrate how companies balance opportunities and challenges within ESG discussions.

## 4.5 Network Graph with Bigram

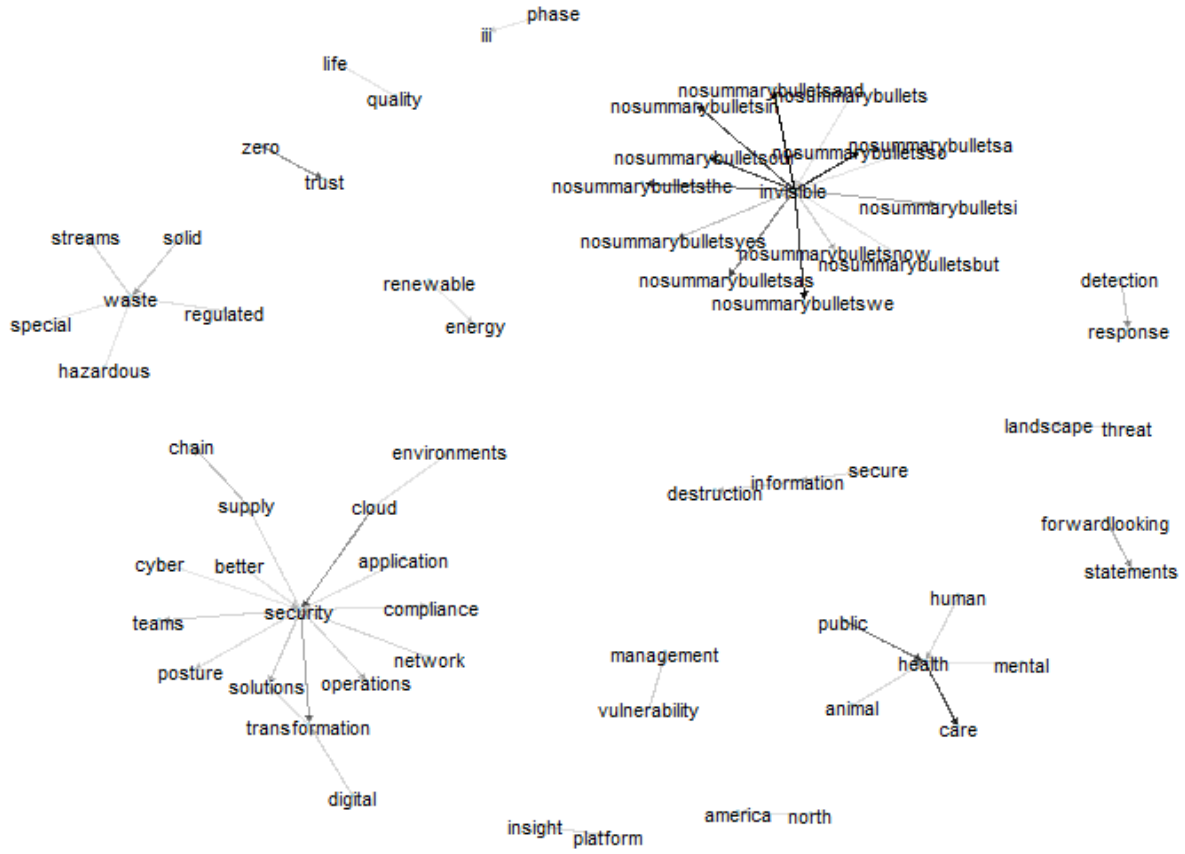


*Exhibit 8. Customize Network Graph with Bigram*

The network graph in Exhibit 8 demonstrates the interconnectedness of ESG terms and provides a visual framework for understanding how companies address sustainability, governance, and social issues in their communications. The identified clusters—such as those related to security, renewable energy, and public health—highlight the multidimensional nature of ESG discussions and reflect the diverse priorities across industries. By visualizing co-occurrence patterns, the graph reveals key relationships and thematic groupings that offer contextual depth, enabling us to uncover nuanced narratives that go beyond simple frequency analysis. This approach is particularly valuable for identifying dominant themes within ESG discussions, such as the

emphasis on cybersecurity and compliance in governance, the focus on renewable energy in environmental initiatives, and the attention to health and care in social domains.

This method offers distinct advantages over traditional techniques by providing a holistic and contextualized view of ESG themes. Its ability to highlight relationships between terms, group related concepts into clusters, and handle large datasets ensures that even subtle patterns are captured effectively

The network reveals distinct clusters of related terms, which represent specific themes or contexts. For example:

- **Security and Compliance Cluster**: Terms like "security," "compliance," "cyber," and "operations" appear closely linked, reflecting the governance aspect of ESG. This cluster emphasizes companies' focus on cybersecurity, compliance frameworks, and secure operational strategies, which are critical in highly regulated industries.
- **Renewable Energy and Sustainability Cluster**: Words like "renewable," "energy," "solid," "streams," and "hazardous" form a distinct cluster, highlighting discussions related to environmental sustainability, resource management, and the transition to renewable energy sources.
- **Health and Public Care Cluster**: Terms such as "health," "mental," "animal," and "care" indicate the social dimension of ESG, particularly in industries addressing public welfare and employee well-being.
- **Digital Transformation Cluster**: Connections between terms like "digital," "platform," and "transformation" point to the role of digital tools and innovation in advancing ESG initiatives.

The graph also highlights outliers, such as phrases like "nosummarybullets," which may require further preprocessing to ensure the inclusion of only meaningful terms in future analyses.

## 4.6 Addressing Drawbacks of Aggregated Frequency Analysis in ESG Terminology Research

In previous sections, our analysis and models have largely relied on aggregated frequency sums of ESG-related terminology across industries. However, this approach has revealed several notable drawbacks and biases that warrant further discussion. Specifically, aggregated sums can overemphasize the prevalence of certain ESG themes in industries that inherently use specific terminology as part of their core business operations, rather than as a reflection of genuine ESG emphasis.

**Industry-Specific Biases in Aggregated Frequency Analysis**

One clear example of this phenomenon is the software industry, where terms like "security" may appear frequently. While "security" can relate to social or governance aspects of ESG (e.g., cybersecurity or data protection policies), in the context of this industry, its usage often pertains to business-specific or technical concerns, rather than broader ESG-focused initiatives. Similarly, industries like waste management may rank high due to their inherent association with sustainability-related terms, yet this prominence may not accurately reflect a nuanced commitment to ESG principles beyond their operational context.

**Shifting Focus: Mean Frequencies and Industry Selection**

To mitigate these biases and gain a more generalizable understanding of ESG trends, we have shifted our focus to industries that are less directly tied to specific ESG-related terminology. This allows us to explore a broader, more representative picture of how ESG principles are integrated across diverse sectors. The selected industries for deeper analysis include:

- **Banks-Diversified**: Representing the financial sector, this industry provides insights into how ESG is embedded in areas such as sustainable investment, ethical lending practices, and corporate governance.

- **Packaging and Container**: This industry offers a perspective on ESG considerations in logistics, infrastructure, and urban planning, where sustainability and operational efficiency intersect.
- **Residential**: The residential sector sheds light on ESG integration in housing and construction, particularly in areas such as energy efficiency, social impact (e.g., affordable housing), and environmental considerations.
- **Telecom Services**: This industry highlights how technology-driven sectors address ESG challenges, including digital inclusion, governance, and environmental impacts of network operations.

By focusing on these industries, we aim to counteract the overrepresentation of ESG terminology in sectors where such language is embedded in day-to-day operations. Instead, our analysis prioritizes industries that offer a more balanced view of general ESG trends.

**Observations from the Aggregated Mean Frequency Graph**

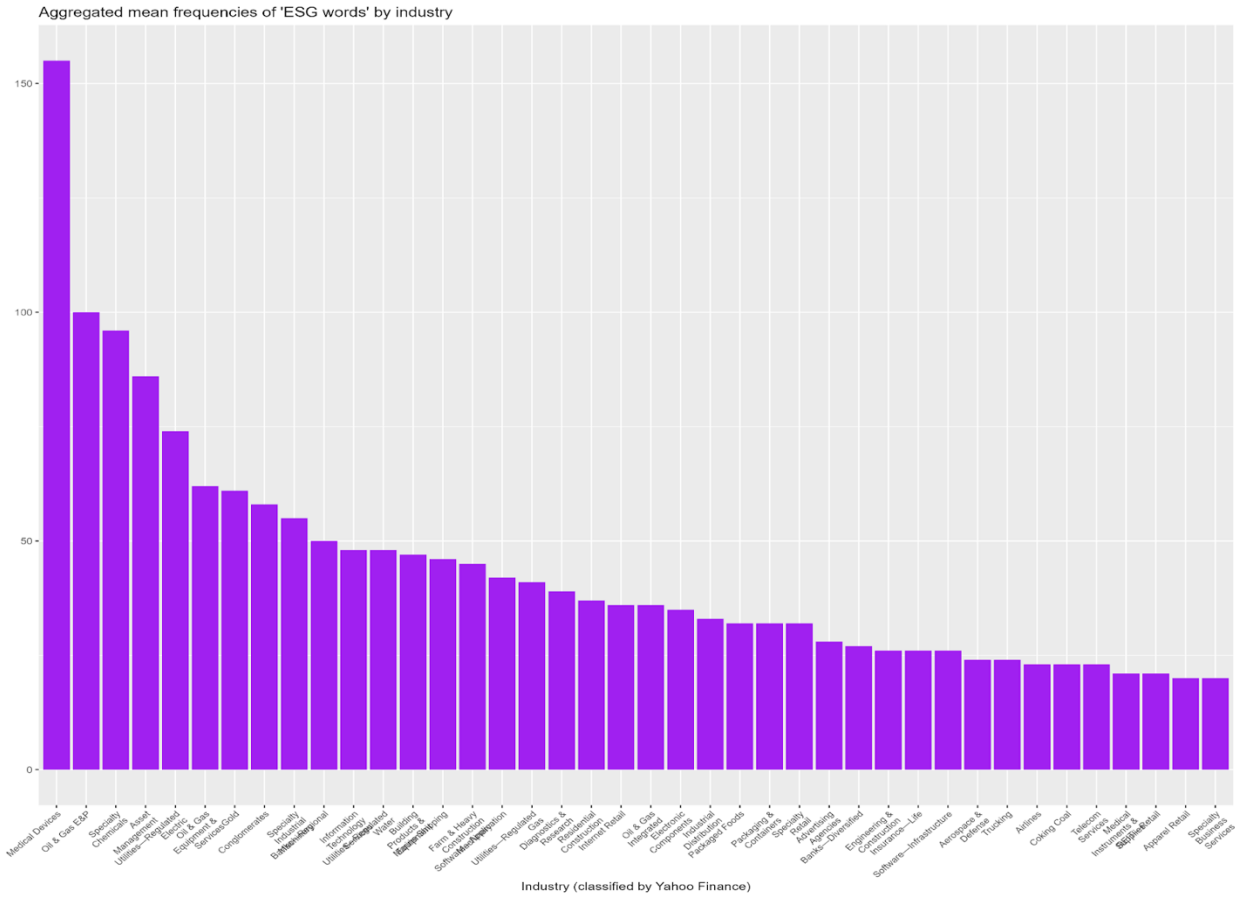


*Exhibit 9: Aggregated mean frequencies "ESG Words" by industries*

The aggregated mean frequency graph(Exhibit 9) further supports this approach. The industries chosen for analysis—Banks-Diversified, Parking and Container, Residential, and Telecom Services—fall within a range of moderate mean ESG term frequencies, indicating they are neither outliers nor excessively skewed by industry-specific jargon. This middle-ground positioning suggests that the selected industries reflect a general trend of ESG emphasis, making them ideal candidates for examining overarching patterns and themes.

### 4.6.1 Word Cloud with KWIC analysis on targeted industry

Same as before we have used KWIC to separate or find the relevant documents fragments then make word could for our four chosen industries.


*Exhibit 10. Word Cloud Banks-Diversified, Packaging and Container, Residential, and Telecom Services.*

To further address the biases identified in aggregated frequency-based ESG terminology analysis, we utilized the Key Word in Context (KWIC) method to extract relevant document fragments. This approach allowed us to focus on the context in which ESG-related terms are used, ensuring that the analysis captures the true essence of ESG discourse, rather than terminology driven by industry-specific jargon. The extracted fragments were then used to generate word clouds for the four selected industries: **Banks-Diversified**, **Packaging and Container**, **Residential**, and **Telecom Services**.

**Insights from the Word Cloud Analysis**

The word cloud generated from the extracted ESG-related fragments provides a clear visualization of the dominant themes across these industries. Terms such as **sustainability**, **capital**, **believe**, **including**, and **innovation** emerge as central, reflecting broad ESG principles rather than sector-specific terminology. The presence of these words across diverse industries highlights the general applicability of ESG concepts in areas such as sustainable practices, stakeholder belief in long-term value creation, and innovative solutions to global challenges.

Additionally, terms like **communities**, **environment**, **emissions**, and **greenhouse** underscore the focus on environmental and social dimensions of ESG. The relative uniformity of these themes across industries like Banks-Diversified and Telecom Services—which are not inherently associated with environmental concerns—suggests that ESG discourse is becoming more generalized and less tied to specific operational contexts. This observation reinforces the idea that the selected industries represent broader ESG trends rather than being skewed by terminology unique to their core business operations.

**Why These Findings Are More General to ESG**

Compared to industries like software or waste management—where ESG-related terms like **security** or **waste** are embedded in their day-to-day operations—the selected industries offer a more balanced perspective on ESG integration. For instance:

- **Banks-Diversified** reflects the financial sector's focus on sustainable investing, ethical lending, and corporate governance, which are applicable across many industries.
- **Packaging and Container** represents a sector where operational efficiency intersects with ESG goals, such as reducing emissions and enhancing infrastructure sustainability.
- **Residential** highlights ESG themes relevant to housing, including energy efficiency and community development, which have universal implications.
- **Telecom Services** showcases the application of ESG principles in technology-driven sectors, emphasizing digital inclusion and environmental considerations.

The word cloud analysis reinforces this general trend, with the prominence of words like **sustainability**, **capital**, and **communities** indicating a broad focus on ESG values across the

chosen industries. These terms are not overly tied to specific operational contexts, making the findings more representative of ESG discourse as a whole.

### 4.6.2 Network Graph

To uncover deeper insights into how ESG-related terminology is discussed in industry-specific earnings calls, we utilized a **network graph analysis**. This visualization highlights the intricate connections between ESG and other key terms, revealing not just the frequency of these terms but also the broader context in which they are used.

**ESG at the Center of Industry Conversations**

The network graph (Exhibit 11) clearly positions **ESG** as a central node, connecting with a wide array of terms that reflect its multifaceted nature. This interconnectedness underscores the broad and dynamic scope of ESG discourse across industries. Key insights from the network graph include:

- **Core Connections**: ESG connects prominently with terms like **sustainability**, **governance**, **communities**, **emissions**, and **capital**, indicating its strong association with environmental, social, and governance priorities. These connections reflect the integrated approach companies are adopting to address diverse stakeholder expectations.

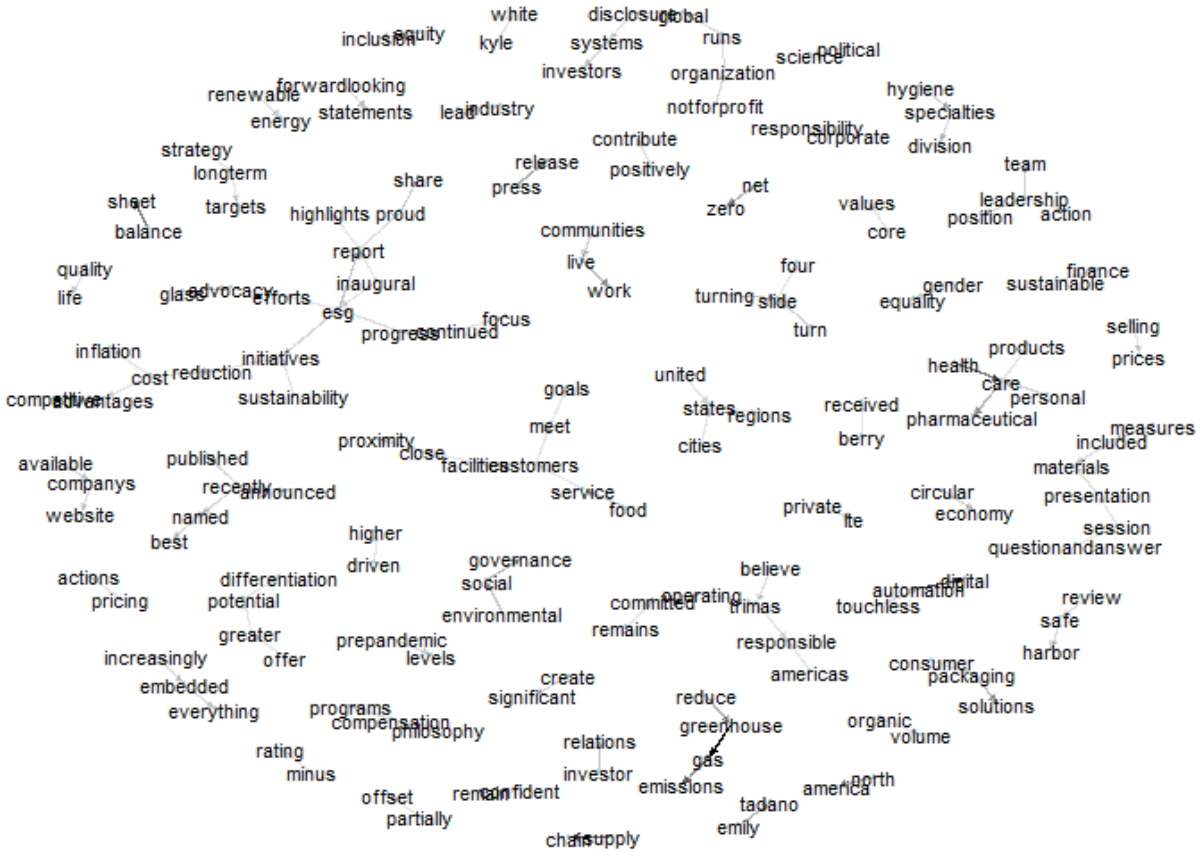


*Exhibit 11. Network Graph*

- **Sector-Specific Contexts**: The specific terms linked to ESG vary by industry. For example:
    - In **Banks-Diversified**, ESG is closely associated with terms like **capital**, **returns**, and **investment**, reflecting a focus on sustainable finance and ethical investment practices.
    - In **Residential**, ESG connects strongly with **energy efficiency**, **communities**, and **greenhouse**, highlighting themes of housing sustainability and environmental impact.

    - In **Telecom Services**, ESG links to terms like **infrastructure**, **inclusion**, and **technology**, emphasizing digital access and operational sustainability.
    - In **Packaging and Container**, ESG's connections to terms like **logistics**, **efficiency**, and **emissions** showcase efforts to optimize infrastructure while minimizing environmental impact.

- **Emerging Themes and Priorities**: The graph also reveals emerging ESG themes. For instance, terms like **circularity**, **renewable energy**, and **equity** are closely linked with ESG, demonstrating how companies are evolving their narratives to include more innovative and inclusive approaches to sustainability and governance.

**Why the Network Graph is Meaningful**

Unlike frequency analysis or word clouds, the network graph emphasizes relationships, showing how ESG-related language is constructed and prioritized. The connections in the graph demonstrate that ESG is not a standalone concept but rather a framework that companies integrate into their operations and strategies in diverse ways.

For example:

- The link between **ESG**, **greenhouse**, and **goals** reflects a growing emphasis on measurable environmental commitments, such as reducing carbon footprints.
- The connection between **ESG**, **communities**, and **values** highlights a strong social focus, with companies aligning their ESG strategies with stakeholder engagement and equity.
- The intersection of **ESG**, **capital**, and **returns** shows that governance and sustainability are being tied to long-term financial performance, reflecting the economic value of ESG principles.

## 4.7 Topic modeling

For the preparation of the topic model, a Document-Term Matrix (DTM) was constructed on the whole dataset to represent the bigram frequencies in a structured format suitable for topic modeling. Each document in the DTM corresponded to a combination of Industry and Year, identified through a unique document ID (e.g., *"Energy_2021"*). The matrix stored bigram counts

as term frequencies within these documents. To reduce sparsity and improve model efficiency, terms with a sparsity greater than 99% (appearing in less than 1% of documents) were removed. This step eliminated rare bigrams that could introduce noise while retaining significant word pairs relevant for topic extraction.

To determine the optimal number of topics for the analysis, the Latent Dirichlet Allocation (LDA) model was evaluated using multiple metrics. A common heuristic suggests setting the

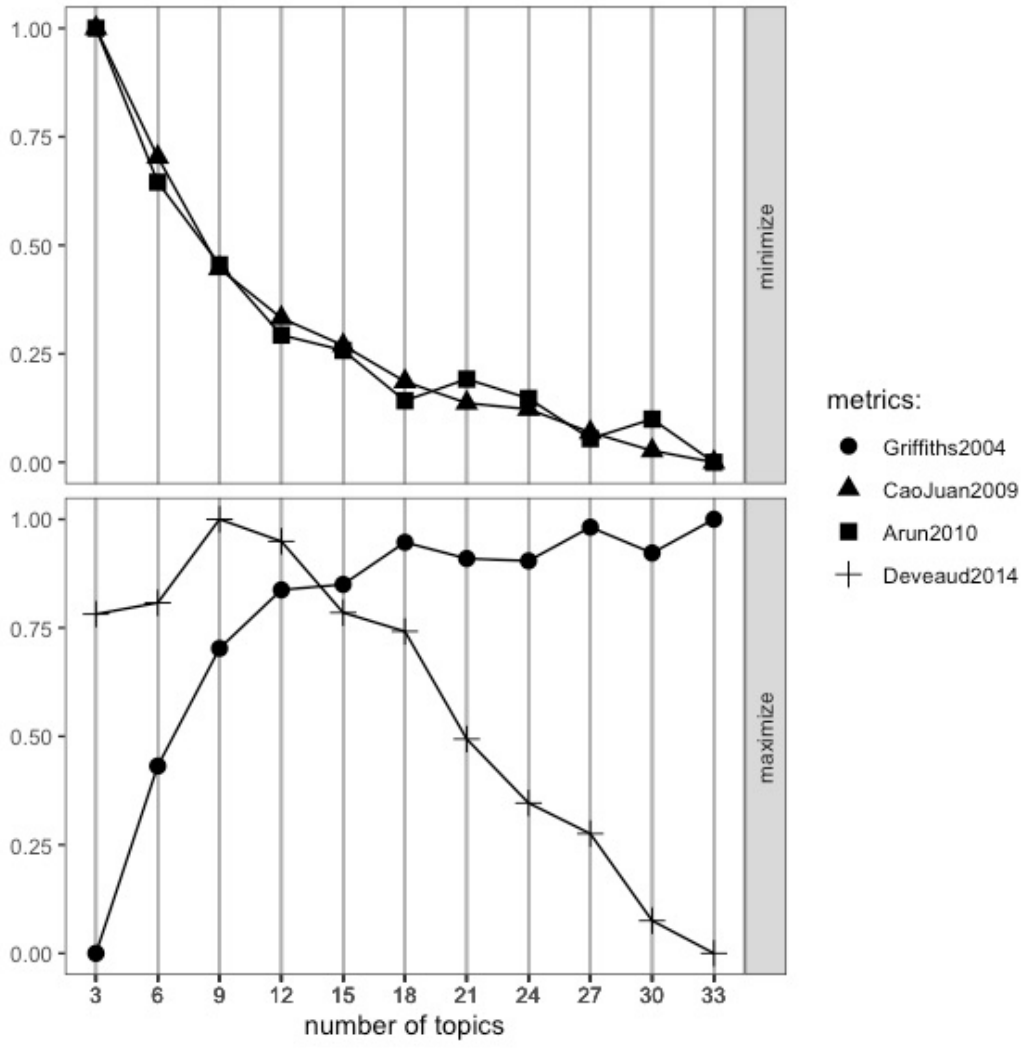


*Exhibit 12: find optimal topic for Topic Modeling*

number of topics (kk) within 1% to 10% of the dataset size, ensuring that topics are neither too broad nor overly granular. But because of computational power, we tested with a smaller range to test whether optimal k can be found. To determine the optimal number of topics for Latent Dirichlet Allocation (LDA) modeling, the topic numbers were systematically varied from **3 to 33 in**

**increments of 3**. Metrics such as **topic coherence** (a measure of semantic similarity among the terms within a topic) and **granularity** (the balance between overly broad and overly fragmented topics) were evaluated to ensure the model's robustness.

By analyzing these metrics, a balance between **topic interpretability and granularity** was achieved. The results were visualized to assess the relationship between coherence and the number of topics, leading to the identification of **15 topics** as the most appropriate for the final analysis. This selection ensured that the model produced meaningful and coherent themes without excessive overlap or redundancy.

Once the optimal number of topics was determined, the LDA model was implemented, and the **top 5 terms** for each of the 15 topics were extracted for further inspection. The table above illustrates these key terms, reflecting the dominant themes within each topic.

Upon closer analysis of the topics, it was observed that **Topics 1, 5, 9, 12, 13, and 15** are most closely related to **Environmental, Social, and Governance (ESG)** themes. These topics include terms such as:

- **Topic 1**: "sustainability report," "greenhouse gas," "sustainability goals," "carbon footprint," "safety performance."
- **Topic 5**: "carbon capture," "natural gas," "low carbon," "clean energy," "energy transition."
- **Topic 9**: "safety profile," "safety efficacy," "safety tolerability," "safety data," "efficacy safety."
- **Topic 12**: "board directors," "leadership team," "eric green," "equity inclusion," "management team."
- **Topic 13**: "leadership team," "board directors," "press release," "chief executive," "executive officer."
- **Topic 15**: "green hydrogen," "elyse greenspan," "next question," "first question," "wells fargo."

These topics predominantly highlight discussions on **environmental sustainability** (e.g., carbon reduction, clean energy), **governance-related themes** (e.g., leadership and board directors), and **social issues** (e.g., safety performance and equity inclusion).

This structured approach to topic modeling ensures that the ESG-related discussions are objectively identified and categorized, enabling further analysis of corporate priorities and stakeholder communication strategies.

Then we analyzed the **temporal evolution** of ESG (Environmental, Social, and Governance) discussions in corporate earnings calls across various industries. By applying topic modeling and calculating changes in ESG importance, we identify the industries that have demonstrated the largest increases and decreases over the time. These findings offer critical insights into industry-specific ESG priorities and their evolution in response to external factors such as market forces, regulatory pressures, and investor expectations.

### 4.7.1 Industries with the Largest ESG Importance Changes

The analysis highlights significant variations in ESG importance across industries, with both upward and downward trends observed. Leading the increase in ESG emphasis are industries such as **Insurance** and **Specialty**, which demonstrated the highest growth in ESG importance. This rise likely reflects a proactive response to climate-related risks, governance expectations, and increasing regulatory pressures. The **REIT - Specialty** sector also showed a notable increase, underscoring the real estate industry's commitment to sustainability through energy-efficient initiatives and reduced carbon footprints. Similarly, **Drug Manufacturers** exhibited positive trends, driven by their continued emphasis on health and safety, while the **Railroad** industry reported gradual but consistent improvements, highlighting its alignment with environmental priorities like carbon emissions reduction and sustainable transportation practices.

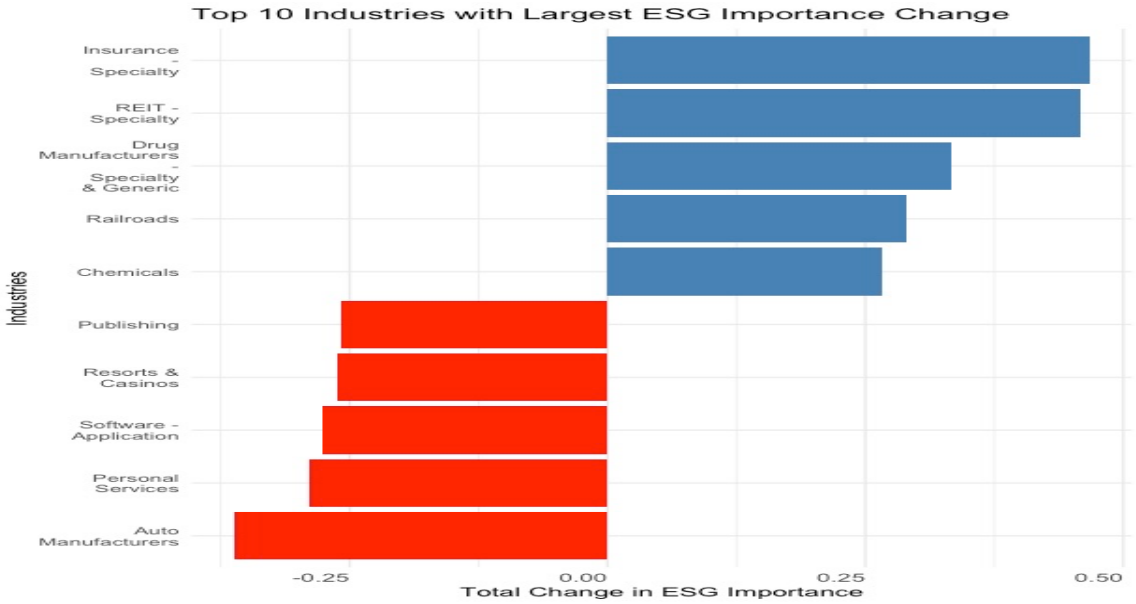


*Exhibit 13: Industries by Change in ESG Importance*

On the other hand, industries such as **Auto Manufacturers** and **Personal Services** reported the largest declines in ESG discussions. The persistent downward trend in the **Auto Manufacturers** sector could be attributed to competing priorities, such as operational challenges and supply chain disruptions, which may have deprioritized sustainability efforts. The **Publishing** industry experienced a decline but showed a modest recovery in recent periods, signaling renewed attention to governance and social themes. Similarly, **Resorts & Casinos** and **Software - Application** sectors displayed consistent decreases, suggesting a temporary shift in focus away from ESG priorities as these industries navigated broader economic challenges and recovery efforts.

### 4.7.2 Temporal Trends

A year-over-year analysis of ESG importance for the top five increasing and decreasing industries reveals distinct temporal patterns. Among the industries with increasing ESG focus, **Insurance** and **Specialty** demonstrated a steady upward trajectory, reflecting sustained commitments to integrating sustainability and governance into corporate strategies. These trends align with increasing investor expectations and regulatory mandates, particularly in sectors heavily impacted

by climate and financial risks. **REIT - Specialty** showed sharp increases in ESG importance, highlighting the growing emphasis on energy-efficient property management and environmental performance. While **Drug Manufacturers** exhibited some year-to-year fluctuations, their overall positive trajectory reflects the sector's focus on health and safety initiatives. The **Railroad** industry displayed gradual but consistent growth, emphasizing its role in advancing sustainable logistics and reducing environmental impact.

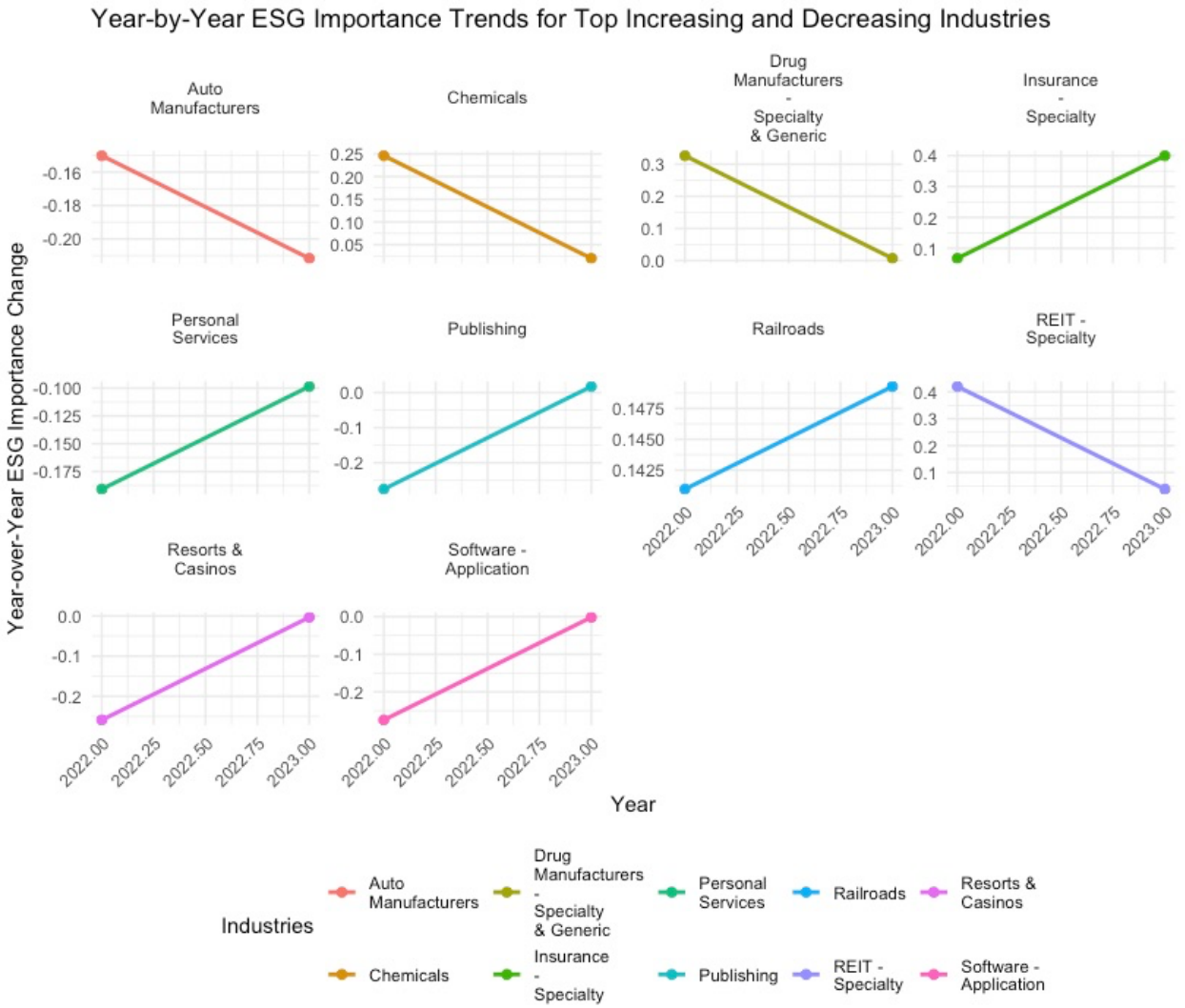


*Exhibit 13: ESG Trend of Industries*

Conversely, industries with declining ESG importance showed more concerning trends. **Auto Manufacturers** experienced a persistent decline in ESG focus, possibly driven by economic pressures and shifting priorities toward financial recovery and operational efficiency. Similarly, **Personal Services** and **Publishing** reported notable decreases in ESG discussions, although the latter showed some recovery in the most recent period. The **Resorts & Casinos** and **Software - Application** industries followed a similar downward trajectory, indicating reduced emphasis on ESG priorities amidst post-pandemic recovery challenges and evolving corporate strategies. These findings highlight the need for industries with declining ESG importance to reassess their sustainability commitments and align more closely with stakeholder expectations and global ESG trends.

### 4.7.4 Key Insights and Implications

The analysis provides several notable insights:

1. **Industries Leading ESG Discussions**: Sectors such as **Insurance**, **Specialty**, and **REIT - Specialty** have emerged as leaders in ESG discussions, reflecting their proactive efforts to address environmental and governance challenges. These industries are likely responding to external pressures, including investor expectations, regulatory mandates, and reputational concerns.

2. **Industries Lagging Behind**: The decline in ESG importance within the **Auto Manufacturers** and **Software - Application** industries raises concerns about potential misalignment with global sustainability trends. These findings suggest a need for these sectors to reassess their ESG priorities and integrate sustainability strategies more effectively into their operations.

3. **Temporal Variability**: The year-over-year analysis highlights both consistent and fluctuating trends. Industries such as **Insurance** and **Railroads** demonstrated sustained increases, indicating a long-term commitment to ESG goals. Conversely, sectors like **Drug Manufacturers** and **Publishing** exhibited temporary declines followed by recovery, suggesting sensitivity to external factors such as regulatory changes and market demands.

# 5. Discussion

## 5.1 Limitations of the Study

While this study provides significant insights into ESG discussions in corporate earnings calls, several limitations should be acknowledged to contextualize the findings and highlight opportunities for future research.

First, the reliance on pre-defined ESG keyword lists, while systematic, introduces challenges in capturing the full breadth of ESG-related discussions. Keywords may fail to encompass emerging terminology or context-specific nuances, particularly in industries where ESG language overlaps with operational jargon. For instance, terms like "security" in the software industry may ambiguously refer to both governance concerns and core business priorities, potentially leading to misclassification.

Second, the methodology primarily leverages sentiment analysis, topic modeling, and frequency-based metrics, which, while robust, have inherent constraints. Sentiment analysis, for instance, relies on the Loughran-McDonald dictionary tailored for financial texts. This lexicon may not fully capture the nuances of ESG-related sentiment, particularly for terms that carry positive connotations in general contexts but imply risks in financial discussions. Similarly, topic modeling through Latent Dirichlet Allocation (LDA) may struggle with overlapping themes, leading to challenges in distinguishing between closely related topics such as environmental initiatives and regulatory compliance.

Third, the study's focus on textual data from earnings calls may exclude other influential channels of ESG communication, such as sustainability reports, press releases, or investor presentations. These alternative sources could provide additional context or highlight themes that are underrepresented in earnings calls, potentially offering a more comprehensive view of corporate ESG priorities.

Finally, while the dataset spans multiple industries and over 7,600 earnings calls, it is limited to a specific timeframe and geographical context. Temporal and regional factors, such as changes in regulatory environments or cultural attitudes toward sustainability, may influence the

generalizability of the findings. Additionally, the study does not explore whether ESG communication aligns with actual corporate performance or stakeholder perceptions, leaving room for further exploration of the gap between stated priorities and real-world outcomes.

These limitations underline the complexity of analyzing ESG communication and suggest that future research could refine methodologies, broaden data sources, and integrate additional performance metrics to deepen understanding of this critical topic.

## 5.2 Future Research Opportunities

This study has laid a strong foundation for understanding how ESG themes are communicated in corporate earnings calls, but there are significant opportunities to expand this work. One challenge highlighted is the difficulty in distinguishing between mentions of ESG as a core business opportunity versus genuine concerns about sustainability. For example, industries like software may often reference terms like "security," which could reflect both governance concerns and business-specific priorities. Future research could explore advanced methodologies, such as classification models, to better identify and differentiate these contexts, potentially offering deeper insights into how businesses approach ESG themes.

Another promising avenue lies in analyzing the structure of earnings calls. Future studies could examine the balance between proactive ESG discussions initiated by companies and reactive responses to questions from stakeholders. This structural approach would reveal whether ESG themes are being actively integrated into strategic priorities or merely addressed under external pressure. Such research could help stakeholders assess a company’s genuine commitment to sustainability.

Sentiment analysis has been a valuable tool in this research, but its limitations suggest further opportunities. Approaches like stance detection or argumentation mining could add nuance by uncovering the underlying motivations or justifications behind ESG mentions. For instance, identifying whether companies frame sustainability as a value-driven mission or a compliance necessity could deepen our understanding of corporate ESG narratives.

Temporal analysis is another area that warrants further exploration. Tracking how ESG themes evolve over time in response to regulatory changes or public sentiment could provide richer insights into the factors driving corporate sustainability efforts. Expanding this analysis to a global context, with cross-country comparisons, would also reveal how cultural, regulatory, and market dynamics shape ESG communication.

Finally, integrating additional data sources, such as market reactions or financial performance, could enhance the analysis. This multimodal approach would allow researchers to evaluate how ESG communication aligns with or impacts other aspects of a company's operations and reputation.

# 6.Conclusion

This research demonstrates the increasing prominence of ESG discussions in corporate earnings calls, reflecting the growing importance of sustainability in the business world. Using advanced text mining techniques, it highlights how companies across industries are engaging with ESG themes, both as opportunities and as challenges. Industries with a natural alignment to sustainability, such as waste management, emphasize environmental and social concerns, while those in technology or finance are incorporating ESG into their broader strategic narratives. Temporal analysis also reveals that ESG priorities are not static but evolve in response to external pressures and shifting market dynamics.

The study has made several contributions, from addressing biases in ESG terminology to providing actionable insights for stakeholders. However, it also acknowledges its limitations, particularly in fully capturing the context and intent behind ESG mentions. Distinguishing between genuine sustainability efforts and business-driven opportunities remains a key challenge, but one that future research can address through innovative approaches.

This work underscores the importance of transparency and consistency in corporate ESG communication. By offering a replicable framework and identifying areas for improvement, it supports the broader goal of fostering sustainable business practices. As ESG continues to shape corporate priorities, this study serves as a stepping stone for future research, encouraging deeper exploration of how businesses navigate the intersection of profitability and sustainability.

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