

How Useful are Greenwashing Metrics for Investors from Developing Countries: A Thematic Analysis

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Abstract. *The global rise of ESG (environmental, social, and governance) investing poses unique challenges for investors in emerging markets, who must navigate the pervasive risk of greenwashing without access to the sophisticated data, robust regulation, and institutional oversight available in developed countries. This study conducts a thematic analysis to critically assess the practical utility of existing greenwashing measurement methodologies in these limited contexts. The study fills a critical gap by focusing on environments where core analytical tools (e.g., Bloomberg, MSCI, Sustainalytics) are often unavailable, mandatory non-financial disclosures are lacking, and the ecosystem of NGOs and active regulators is underdeveloped. Based on a systematic review of academic literature following PRISMA guidelines, this article identifies and categorizes common greenwashing detection metrics into five thematic categories: data-driven methods, regulation-based models, and proactive analytical methods. The analysis introduces "usefulness" as a multi-dimensional analytical construct defined by data accessibility, regulatory independence, verification cost, and contextual robustness. The findings suggest that while data-driven methods dominate the literature, they possess limited direct utility for investors in emerging markets due to their reliance on inaccessible data and formal regulatory structures. Consequently, proactive analytical methods utilizing publicly available textual data offer greater practical viability.*

Keywords: greenwashing; ESG – disclosure, greenwashing detection, investors, developing countries, proactive analytical method, frequency analysis, thematic review.

Introduction

In the era of the global transition toward a sustainable economy, environmental, social, and governance (ESG) factors have become key drivers of investment decisions. However, alongside the growth of "green" investing, the practice of greenwashing – the deliberate or unintentional misrepresentation of a company's, its products', or its investment products' environmental performance – is rapidly spreading (Dangelico & Vocalelli, 2017). Greenwashing manifests in various forms and adapts to diverse contexts, making it difficult to establish a single, uncontroversial definition. Consequently, the problem has evolved into a systemic crisis of trust. According to a study presented at the Asian Financial Forum 2025, 57% of investors believe that companies in their portfolios engage in greenwashing practices. Data from the EY Institutional Investor Survey 2024 indicates that 85% of investors perceive this problem has worsened over the past five years, even though 88% are increasingly using ESG data in their decision-making.

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Furthermore, a 2021 audit by the European Commission found that 42% of companies' environmental claims were potentially false or misleading.

For developing countries, which are particularly vulnerable to climate risks and require critical green investment to modernize their economies, greenwashing poses not just an ethical dilemma, but also a significant macroeconomic and financial risk (Cartellier et al., 2025). It distorts markets and diverts capital from genuine environmental change. Compelling evidence demonstrates that investors in emerging markets face a unique set of challenges that exacerbate the effects of greenwashing. Specifically, increased information asymmetry and institutional gaps characterize these regions. With regulations and ESG disclosure standards often in their infancy, uncertainty in assessing environmental risks is at its highest. This creates an environment conducive to greenwashing, as corporate claims are difficult to verify. Consequently, emerging markets can inadvertently become a haven for high-carbon projects with greenwashing implications.

Excessive capital raising costs for responsible companies are also a consequence of greenwashing, undermining trust in ESG assets overall. Investors are unable to distinguish genuine environmental initiatives from imitation ones, forcing them to factor in the additional risk of fraud into the cost of all such investments. As a result, companies genuinely committed to sustainable development, particularly in developing countries, face higher costs of capital, which slows the transition to new environmental standards.

To effectively combat greenwashing, investors need to shift their focus from the glamorous narratives in ESG reports to verifiable quantitative and qualitative indicators. However, the methods for identifying and measuring greenwashing are currently imperfect. Currently, there is no single standard for identifying greenwashing. Researchers identify several key approaches that vary depending on the type of data analyzed and the principles of manipulation detection, such as calculating the difference (gap) between stated and actual ESG indicators, calculating the gap between a company's quantitative and qualitative statements, or calculating the gap between required and actual disclosures (Bernini et al., 2024; de Freitas Netto et al., 2020).

Despite the existence of recent systematic literature reviews on greenwashing, the topic remains relevant. Several robust systematic literature reviews have already addressed the categorization of various approaches to identifying greenwashing, predominantly focusing on the activities of large, publicly traded corporations (e.g., Fan et al., 2025; Yu et al., 2020; Persakis et al., 2025; Janik et al., 2025). However, given the escalating relevance of this topic, new methodologies for detecting and quantifying greenwashing continue to emerge, thereby creating a need for updated synthesis and review. Furthermore, few studies explicitly evaluate these methodologies through the lens of an investor operating under the constraints of an emerging market.

This study aims to systematize approaches to measuring greenwashing used in contemporary research and analyze their usefulness from an investor perspective. The goal is to identify the most practical methods that will help investors avoid investing in companies engaging in greenwashing. Unlike previous studies, this research examines the strengths and weaknesses of each approach specifically from the perspective of an emerging market investor. The research method employed is a thematic literature review using the PRISMA methodology, alongside frequency and comparative analysis.

Background and Literature Context

The global surge in sustainable finance and the incorporation of ESG factors into investment decisions have created a multi-trillion-dollar market for "green" assets. However, this rapid growth has been shadowed by the equally rapid proliferation of greenwashing – the act of disseminating misleading information to create an undeserved perception of environmental responsibility (Huang et al., 2020). High-profile scandals, such as Volkswagen's "Dieselgate" (Fracarolli Nunes & Lee Park, 2016), demonstrate the severe financial and reputational risks greenwashing poses to investors. While this is a global challenge, the context for investors in developing countries is critically distinct and significantly more problematic.

These investors operate within a constellation of systemic constraints that fundamentally alter the utility and applicability of conventional greenwashing metrics (Diener & Habisch, 2022). First, there is a profound data and information asymmetry. They often lack access to the sophisticated, subscription-based analytical platforms (e.g., Bloomberg, MSCI, Sustainalytics) that are standard in developed markets. Second, the regulatory and institutional environment is typically underdeveloped. Mandatory, standardized non-financial reporting is rare, and dedicated regulatory bodies with strong enforcement powers to combat misleading green claims are frequently absent. The result is a market where vague terms like "eco-friendly" and "green" are used without legal consequence, and where even the definition of what constitutes a "green" financial instrument, such as a bond, can be ambiguous and contested (Dumrongvute & Tengaumnay, 2025).

Third, the behavioral and market dynamics are unique. Consumer and investor awareness of sustainability issues may be in earlier stages of development, leading to a "greenness learning effect" where market participants take time to discern genuine sustainability from greenwashing. This delay creates a fertile ground for greenwashes to operate temporarily without detection. Furthermore, academic research using game-theoretical models suggests that in such emerging market conditions, a certain level of regulatory leniency might, paradoxically, maximize social welfare in the short term, complicating the regulatory calculus (Huang et al., 2020).

Methodology

Research Design and Search Strategy

This study employs a systematic thematic literature review guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology. The review focuses on empirical studies published between January 2020 and December 2025, a period selected to capture the most recent evolution of greenwashing metrics following the global surge in sustainable finance regulations (fig.1).

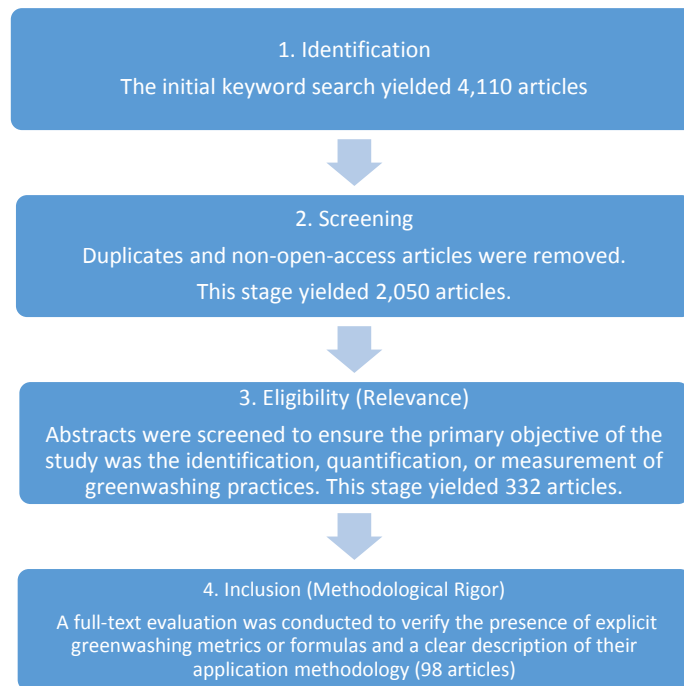


Figure 1. Screening and selection process

The primary data source was the Google Scholar database, chosen for its multidisciplinary coverage and accessibility, which aligns with the study's focus on resources available to investors in emerging markets. The search strategy utilized a combination of keywords related to the core constructs: ("greenwashing" OR "greenwashing metrics") AND ("measurement" OR "index" OR "score"). To ensure relevance, the search was limited to peer-reviewed journal articles and working papers published in English. The article selection was conducted over a five-year period from 2020 to 2025.

This query returned 4,110 articles (fig.1). The second stage involved screening open-access articles, which yielded 2,050 articles. The third stage involved screening abstracts of articles that clearly stated the objective of identifying and measuring greenwashing practices, which yielded 332 articles. The fourth stage involved a full-text evaluation of the materials, based on the availability of greenwashing metrics and a description of their application methodology. . Studies not directly related to greenwashing measurement were excluded. This stage yielded 98 articles, which were analyzed as part of this thematic frequency and comparative analysis.

Clustering and Classification Framework

To address the heterogeneity of the selected studies, the 98 papers were categorized based on the underlying methodological logic of their proposed metrics. Unlike previous reviews that group studies broadly by topic, this study clusters papers by the specific formulaic approach used to detect greenwashing.

Initial analysis identified 15 distinct metric formulations. While some formulations share theoretical underpinnings (e.g., disclosure-performance gaps), variations in data sources (e.g., Bloomberg vs. Sino database) and normalization techniques (e.g., Z-scores vs. simple differences) constitute distinct methodological clusters. To resolve inconsistencies in prior categorizations, this study recognizes 15 distinct clusters corresponding to the unique metric structures identified in the

sample. These 15 clusters are subsequently aggregated into five broader thematic categories for analysis: (1) Disclosure-Performance Gap Methods, (2) Disclosure Quality and Verifiability, (3) Symbolic and Selective Disclosure, (4) Linguistic and Tone Analysis, and (5) Behavioral and Binary Indicators. This two-tiered classification (15 specific clusters within 5 thematic categories) ensures both granular accuracy and high-level conceptual clarity.

Analytical Construct: Defining "Usefulness"

A critical contribution of this study is the operationalization of "usefulness" as an analytical construct tailored to the context of emerging markets. In developed markets, usefulness is often equated with statistical significance or correlation with financial performance. However, for investors in developing countries, usefulness is defined by practical applicability under constraints.

We assess the usefulness of each metric based on four criteria derived from the institutional gaps identified in the background literature:

1. Data Accessibility: Does the metric rely on free, publicly available data (e.g., annual reports) or proprietary, subscription-based databases (e.g., Bloomberg, MSCI)?
2. Regulatory Independence: Can the metric be applied in jurisdictions with weak or non-existent mandatory ESG disclosure laws?
3. Verification Cost: Does the metric require sophisticated technical skills (e.g., advanced NLP, Python coding) or can it be applied using standard financial analysis tools?
4. Contextual Robustness: Is the metric sensitive to local market conditions, or does it rely on standardized global benchmarks that may not reflect emerging market realities?

By applying this framework, the study moves beyond a simple cataloging of metrics to a critical assessment of their viability for investors facing information asymmetry and institutional voids.

Results

Overview of Metric Clusters

The frequency analysis identified 15 distinct methodological clusters across the 98 selected papers. **Table 1** presents these clusters, their underlying formulas or logic, the representative papers, and the frequency of use within the sample.

Table 1. Clusters of papers with different greenwashing metrics

Metrics	Number
Disclosure and Performance Gap $GW = \left[\frac{ESG_{dis} - \overline{ESG}_{dis}}{\sigma_{dis}} \right] - \left[\frac{ESG_{per} - \overline{ESG}_{per}}{\sigma_{per}} \right]$ Where ESG_{dis} is ESG score form Bloomberg database of the company $\overline{ESG}_{dis}$ is the mean of ESG scores form Bloomberg database of the companies in the sample ESG_{per} is ESG score of the company from Asset 4 of other database $\overline{ESG}_{per}$ is the mean of ESG score form Asset 4 (or other) database of the companies in the sample σ – variance	50
Disclosure and Performance Gap for peers $GW = [(D - \bar{D})/\sigma_D] - [(P - \bar{P})/\sigma_P]$ where D is ESG score from Bloomberg database $\bar{D}$ is the mean of ESG score from Bloomberg database for peers (peer is industry)	1

Metrics	Number
P is ESG score from other database $\bar{P}$ is the mean of ESG score from other database for peers (peer is industry) σ – variance	
Disclosure and Performance Gap $GW = \left[\frac{ESG_{dis} - minESG_{dis}}{maxESG_{dis} - minESG_{dis}} \right] - \left[\frac{ESG_{per} - minESG_{per}}{maxESG_{per} - minESG_{per}} \right]$ ESG_{dis} is ESG score form Bloomberg database of the company ESG_{per} is ESG score of the company from Sino database	1
Verifiability of reports $GW = (\text{Number of qualitative disclosures} - \text{Number of quantitative disclosures}) / \text{Number of disclosures}$ Where: Number of disclosures is the total number of disclosed items related to environmental liabilities and environmental performance and governance Number of qualitative disclosures refers to the number of these items disclosed in text form. Number of quantitative disclosures refers to the number of these items disclosed in numerical form.	18
Talk manipulations $Greenwashing = \sqrt{(\text{Selective} \times \text{Symbolic})}$ where $\text{Selective} = 100 \times (1 - EID1/EID2)$, EID1 represented the number of EID (Environmental Information Disclosure) items disclosed by the firm, and EID2 was the total number of items to be disclosed. $\text{Symbolic} = 100 \times (EID3/EID1)$, EID3 represented the number of descriptive and qualitative items.	8
Talk manipulations $GWL = \sqrt{GWLS \times GWLE}$, where $GWLE = 100 \times \text{symbolic disclosure items} / \text{disclosed items}$, symbolic disclosures - vague, non-verifiable statements) compared to all disclosed items. GWLS is selective disclosure measured as $GWLS = 100 \times (1 - \text{disclosed items} / \text{total items})$	5
$GWL = \sqrt{GWLS \times GWLE}$, Where GWLS is selective disclosure: This is when companies only report the good environmental news and hide the bad. It was measured by looking at what information was not disclosed compared to what should have been disclosed $GWLS = 100 \times (1 - \text{disclosed items} / \text{total items}) + 1$ GWLE is expressive manipulation: This is when companies use more general, positive language about the environment without providing specific, verifiable details. $GWLE = 100 \times (\text{symbolic disclosure items} / \text{disclosure items}) + 1$	1
Talk manipulations Greenwashing (Tone) index = $(\text{Positive Words} - \text{Negative Words}) / \text{Total Number of Words in Environmental Protection report}$	5
$GW = \frac{\sum_{i=1}^8 X_i}{\sum_{i=1}^8 Y_i + 1}$ where X_i is symbolic behavior (yes=1, no=1) among one of the eight items (environmental protection investment expenditure or borrowing, environmental protection funding subsidies or reduction or exemption of incentive income, type and quantity of pollutants discharge compliance, whether to	3

Metrics	Number
implement the past certification, environmental protection measures and improvement, policy impact, environmental management objectives, and other environmental-related income and expenditure) Y_i is substantive behavior (yes=1, no=1) among one of the eight items	
$GWI = \frac{(GCI - \overline{GCI})}{\sigma_{GCI}} - \frac{(GPI - \overline{GPI})}{\sigma_{GPI}}$ where GCI is a green communication index and GPI is a green practice index, derived from sustainability reports by content analysis	1
Comparing “talk” and “walk” with FinBERT model To measure greenwashing, authors operationalize the “talk” dimension by calculating the length, positive tone, and forward-looking vagueness of carbon and non-carbon disclosures in CSR reports using FinBERT model. For “walk” they scale the firm’s Scope 1+2 GHG (for carbon) and pollution and waste output (for non-carbon) by total assets, and multiply the values by -1, so that higher values denote better environmental performance (e.g., lower carbon intensity). For each “talk” and “walk” measure, companies are ranked annually within their country and sector, and the rankings are converted into percentiles. Each “walk” percentile is then subtracted from its corresponding “talk” percentile, yielding three greenwashing sub-measures for carbon and three for non-carbon. Higher values of these sub-measures reflect greater disparity between disclosure and performance, i.e., more greenwashing. Finally, they calculate composite carbon (non-carbon) greenwashing as the simple average of the three carbon (non-carbon) sub-measures.	1
$GW = \begin{cases} 1 & \text{if } ESG_{talk} = 5Top \text{ and } ESG_{funds} < median \\ 0 & \text{if not} \end{cases}$	1
$GW = \begin{cases} 1 & \text{if } CDP > 94 \text{ and } CI < median \\ 0 & \text{if not} \end{cases}$ Where CDP is CDP (Carbon Disclosure Project) disclosure score in CDP database; CI is a carbon intensity calculated as Scope 1 GHG emissions divided by the total revenues (in thousands of US dollars) of the company	1
GW as the ratio of the positive communication about ESG performance from firm ESG reports to standardized ESG scores provided by Refinitiv	1
Survey based method	1
Total	98

Source: Authors' own research.

Analysis of Methodological Families

The first section is the most substantive and frequently encountered in the sample studied; the formula used is a standardized indicator (Z-score) for comparing the "gap" between ESG disclosure (Disclosure) and actual performance (Performance). The basic idea is sound and is indeed widely used in empirical ESG research. We have seen that the specific formula used can vary. Some authors use a simple difference ($ESG_dis - ESG_perf$), while others employ more sophisticated approaches such as regression residuals.

The second and third clusters of studies use almost the same formula as the first, but with minor variations. The second cluster is deliberately drawn from a study by Yu, Luu, and Chen (2020), as this methodology has become a recognized standard by eliminating many of the shortcomings associated with the formula used in the first case. First, the method eliminates industry biases—comparisons are made only within a single industry, as disclosure requirements and performance indicators vary significantly across sectors. Second, it improves the comparability

of the results. Using Z-scores allows for comparison of the "gap" between companies of different sizes and in different countries within a single study.

The fourth cluster is based on measuring greenwashing, based on a different fundamental approach: the formula measures not the "gap" between words and actions, but rather the "bias" in the way information is presented within a single communication channel. It evaluates the quality of communication by measuring the degree of transparency and detail in reporting. More quantitative data usually means greater verifiability, which may indirectly reduce the potential for greenwashing, but there is no direct link.

The fifth, sixth, and seventh clusters of studies use different formulas but a similar approach to measuring greenwashing, which is fundamentally different from the previous ones. The key logic of the formula is that a company is highly likely to be greenwashing if it simultaneously conceals a lot (Selective ↑) and what it reveals is vague and symbolic (Symbolic ↑). The geometric mean shows that both conditions must be met simultaneously to achieve a high overall indicator. This formula is the next logical step in greenwashing research. While earlier approaches looked for the consequence (the discontinuity), this approach seeks to identify the mechanism (the strategy) itself in a company's reporting. However, its main limitation remains the need for manual or semi-automated content analysis and the development of a reference list of disclosures (EID2) for each industry.

Eighth cluster, represented by the Greenwashing (Tone) Index formula, applied in the study by Fan et al. (2025), refers to linguistic methods for identifying greenwashing through sentiment analysis. The formula $(\text{Positive Words} - \text{Negative Words}) / \text{Total Words}$ measures the shift in sentiment toward positivity. A higher value indicates potential greenwashing. This is a labor-intensive process that begins with defining a text corpus and identifying all sections related to environmental topics from company reports. Next, a dictionary is selected and adapted, emphasizing the use of specialized dictionaries for financial or ESG reporting. For non-English-speaking markets (e.g., China), custom dictionaries are often created, as in the study on the tone of sustainability reports. After this, text processing and calculations occur. Automated counting of words classified into positive and negative categories and calculation of the final index.

Fan et al.'s (2025) approach logically complements existing methodologies by focusing on style rather than content or results. Its strength lies in its ability to analyze large text arrays and detect subtle manipulations. Its main weakness is the difficulty of separating genuine enthusiasm from strategic embellishment, which requires careful control of variables.

In the ninth cluster of studies, greenwashing is measured as the difference between symbolic and substantive behavior of the company. Its main difference is that the areas in which a company's behavior is examined are in some way related to its investments. The primary principle for identifying symbolic behavior is the absence of investments in environmental protection. A similar approach is used in the studies of the tenth cluster. In this study, the company's green practices are also strictly defined from the outset, reducing the subjectivity of the research approach.

The eleventh cluster applies comparison between "talk" and "walk". The main difference is a more complex linguistic analysis of report texts using with FinBERT model.

The studies we've divided into clusters twelve, thirteen, and fourteen use a mixed methodology: some of the information for calculating greenwashing is obtained from text analysis of company reports, while others are based on real-world quantitative metrics, such as carbon intensity.

And the final cluster is represented by a study in which greenwashing is measured through interviews.

Discussion

Comparison with Existing Literature

The findings of this review align with recent systematic literature reviews by Bernini et al. (2024) and de Freitas Netto et al. (2020), which also identify the disclosure-performance gap as the dominant methodology in academic literature. However, this study diverges by critically evaluating these methods through the lens of investor utility in resource-constrained environments. While Bernini et al. (2024) focus on methodological rigor and validity, this study highlights that methodological rigor does not necessarily equate to practical usefulness in emerging markets. For instance, while the Disclosure-Performance Gap (Cluster 1) is the most cited method (50 papers), it relies heavily on proprietary databases like Bloomberg and Asset4. As noted by Diener and Habisch (2022), this creates a barrier for investors in developing countries who lack institutional subscriptions.

Furthermore, this study expands on the work of Yu et al. (2020) by categorizing the evolution from simple gap analysis to more nuanced textual and behavioral metrics. The shift towards linguistic analysis (Clusters 8-9) observed in this sample supports the findings of Janik and Ryszko (2025), who note a growing trend in using NLP for sustainability reporting analysis. However, this review adds the critical dimension of verification cost, suggesting that while NLP methods are data-accessible, they may require technical skills unavailable to the average investor in developing regions.

Implications for Investors in Developing Countries

The operationalization of "usefulness" reveals a significant mismatch between academic popularity and practical utility. The most common approach (Cluster 1) scores low on Data Accessibility and Regulatory Independence. Conversely, the Disclosure Quality (Cluster 4) and Symbolic/Selective (Clusters 5-7) methods score higher on Accessibility as they rely on publicly available annual reports. However, they score lower on Verification Cost due to the need for content analysis.

In an environment of underdeveloped regulation, the most reliable approach appears to be a comprehensive one combining multiple methods, such as the Greenwashing Assessment Framework, which includes diagnostic questions on hidden tradeoffs, vagueness, and mislabeling. This approach does not require numerical ESG data and relies on publicly available communications, making it flexible and comprehensive. The result is a qualitative assessment rather than a numerical index. It requires expert judgment and is subjective. It also relies on content analysis of reporting (the GWLS + GWLE approach). It analyzes the completeness of disclosure and manipulative language in corporate reports. This will help identify tactics of omission and manipulation, but it is labor-intensive. However, it will still be necessary to start with a "discontinuity" analysis based on available information sources.

Natural language processing (NLP) techniques to detect greenwashing in sustainability report text, such as using the ClimateBERT model, help generate labels for greenwashing risk based on climate attributes. However, it must be recognized that there are limitations; studies often use perception-based measures, which may lead to subjective interpretations rather than objective assessments. For investors in developing countries, less common but more accessible approaches based on textual analysis of company reports using language models or simple word frequency

analysis of ESG vocabulary words can be proposed as a viable alternative to expensive database subscriptions.

Conclusion

The purpose of this work was to conduct a thematic scoping review and analyze the strengths and weaknesses of various approaches to measuring greenwashing. The results of research suggest that the most common approach to identifying and quantifying greenwashing in the academic literature is calculating the gap between ESG disclosure and ESG performance using databases such as Bloomberg and Asset4. Despite its prevalence, this approach appears to be of limited practical use for investors in emerging markets, where access to such databases is typically severely limited.

Therefore, for these categories of investors, less common but more accessible approaches based on textual analysis of company reports using language models or simple word frequency analysis of ESG vocabulary words may offer greater utility. These findings imply that investors in developing countries should shift from passive data consumption to active research and verification, including narrative and textual analysis of annual reports, sustainability statements, and media coverage to identify ambiguities, contradictions, and exaggerations. Future research should focus on developing simplified, open-source tools that operationalize these proactive analytical methods for non-expert users in emerging markets.

This study is subject to several limitations that define the scope of its findings. First, the literature search was conducted primarily using Google Scholar, which ensures broad interdisciplinary coverage but may not fully capture studies indexed exclusively in specialized databases such as Scopus or Web of Science, potentially leading to the underrepresentation of some niche or highly technical contributions. Second, the keyword strategy was intentionally focused on terms such as “greenwashing metrics” and “measurement”, which may have excluded relevant studies addressing greenwashing indirectly, for example through ESG controversies, disclosure quality, or sustainability assurance, without explicitly using these terms. Third, the review is limited to publications from 2020 to 2025 in order to capture recent methodological developments; however, this choice may overlook earlier foundational research that contributed to the development of current approaches. Additionally, only English-language publications were included, which may introduce a language bias, particularly in the context of emerging markets where relevant research is often published in local languages. Finally, while the study applies a systematic approach to classification, the thematic clustering of greenwashing metrics involves an element of researcher interpretation, and alternative classification frameworks may yield different analytical groupings. These limitations do not undermine the validity of the findings but rather delineate the boundaries within which the results should be interpreted and highlight avenues for future research.

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During the preparation of this work, the authors utilized ChatGPT 4 to enhance readability and language clarity. Following the use of this tool, the authors meticulously reviewed and revised the content as necessary and assumes full responsibility for the final content of the publication.

References

- Bernini, F., Giuliani, M., & La Rosa, F. (2024). Measuring greenwashing: A systematic methodological literature review. *Business Ethics, the Environment & Responsibility*, 33(4), 649–667. <https://doi.org/10.1111/beer.12378>
- Cartellier, F., et al. (2025). Can investors curb greenwashing? *Journal of Economic Dynamics and Control*, 105, 195.
- Dangelico, R. M., & Vocalelli, D. (2017). “Green Marketing”: An analysis of definitions, strategy steps, and tools through a systematic review of the literature. *Journal of Cleaner Production*, 165, 1263-1279.
- de Freitas Netto, S. V., Sobral, M. F. F., Ribeiro, A. R. B., & Soares, G. R. D. L. (2020). Concepts and forms of greenwashing: A systematic review. *Environmental Sciences Europe*, 32(1), 19. <https://doi.org/10.1186/s12302-020-00353-w>
- Diener, J., & Habisch, A. (2022). Sustainability improvement or impact washing? Assessing ethical investment policies of SRI fund providers from an impact perspective. *Assessing Ethical Investment Policies of SRI Fund Providers from an Impact Perspective* (May 18, 2022).
- Dumrongvute, P., & Tengaumnay, T. (2025). The ESG Illusion: Greenwashing and the challenge of legal gaps in corporate sustainability in Thailand. *European Corporate Governance Institute-Law Working Paper*, (858).
- Fan, X., Li, Y., & Wang, H. (2025). Ownership concentration and corporate greenwashing in China’s capital markets: Based on a multi-actors perspective. *Pacific-Basin Finance Journal*, 89, 102600. <https://doi.org/10.1016/j.pacfin.2024.102600>
- Fracarolli Nunes, M., & Lee Park, C. (2016). Caught red-handed: The cost of the Volkswagen Dieselgate. *Journal of Global Responsibility*, 7(2), 288-302.
- Huang, H., Xing, X., He, Y., & Gu, X. (2020). Combating greenwashers in emerging markets: A game-theoretical exploration of firms, customers, and government regulations. *Transportation Research Part E: Logistics and Transportation Review*, 140, 101976.
- Huang, R., & Huang, Y. (2020). Does internal control contribute to a firm’s green information disclosure? Evidence from China. *Sustainability*, 12(8), 3197.
- Janik, A., & Ryszko, A. (2025). Greenwashing in sustainability reporting: A systematic literature review of strategic typologies and content-analysis-based measurement approaches. *Sustainability*, 18(1), 17. <https://doi.org/10.3390/su18010017>
- Persakis, A., Nikolopoulos, T., Negkakis, I. C., & Pavlopoulos, A. (2025). Greenwashing in marketing: A systematic literature review and bibliometric analysis. *International Review on Public and Nonprofit Marketing*, 22(4), 957–992. <https://doi.org/10.1007/s12208-025-00345-7>
- Yu, E. P. Y., Van Luu, B., & Chen, C. H. (2020). Greenwashing in environmental, social and governance disclosures. *Research in International Business and Finance*, 52, 101192.