

Greenwashing Risks and Business Intelligence: An Illustrative Diagnostic Framework for Sustainability Narrative-Performance Alignment

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Abstract - Greenwashing, the practice of overstating or misrepresenting a company's sustainability efforts, has become an increasing concern as businesses face rising environmental expectations, regulatory scrutiny, and stakeholder demand for credible ESG disclosure. This paper examines how Business Intelligence (BI) tools can help create an illustrative diagnose and dashboard for surfacing potential misalignments of misleading sustainability claims by transforming ESG data into human ready insights for review. Using platforms such as Power BI, the visualizes key analytical features that signal potential greenwashing, including misalignment between qualitative narratives and quantitative performance, reporting inconsistencies, and deviations from industry benchmarks. An illustrative BI-based model is then developed and simulated to demonstrate how analytics dashboards can operationalize risk patterns while enhancing transparency and accountability in sustainability reporting. The findings highlight both the opportunities and challenges of integrating BI into ESG assurance, particularly regarding data quality, governance, and standardization. By bridging data analytics with ethical oversight, this research positions BI not only as a risk-mitigation tool, but as a value-generating mechanism that strengthens customer trust, supports informed stakeholder decision-making, and reinforces long-term corporate credibility.

Keywords: Greenwashing, Business Intelligence (BI), ESG Analytics, Narrative-Performance Alignment, Sustainability Reporting, Diagnostic Prototype, SDG 9, SDG 12, SDG 16, SDG 17

I. INTRODUCTION

Greenwashing, the deceptive practice of overstating sustainability efforts [1], erodes corporate trust amid escalating ESG (Environmental, Social, and Governance) scrutiny and regulatory pressure. Existing detection approaches fall into two largely disconnected camps: qualitative discourse analysis, which evaluates corporate narratives but rarely ties them to verified outcomes, and financial or ESG auditing, which verifies outcomes but does not systematically compare them against the narratives that accompany them. This gap leaves a persistent blind spot for green-hushing and strategic framing, in which disclosure language and capital allocation are never directly reconciled.

This paper addresses that gap with an illustrative Business Intelligence (BI) diagnostic prototype that operationalizes narrative-performance comparison as a set of visual, reproducible Key Performance Indicators (KPIs). Using

Power BI, sustainability narratives are converted into dictionary-based indices and compared, at firm level and for the same reporting period, with audited financial and operational data. We apply the prototype to a single illustrative case, BP p.l.c., not to render a judgment on the firm, but to demonstrate the methodological feasibility of the approach and to surface the assumptions, limitations, and validation steps such a tool would require before it could support any evidentiary claim. Consistent with this scope, the paper does not claim to detect or prevent greenwashing; it reports narrative-performance alignment signals that may warrant further investigation by auditors, regulators, or investors.

II. RELATED WORK

A. Greenwashing Risk and Regulatory Context

In the contemporary corporate landscape, greenwashing has generated significant reputational damage, regulatory sanctions, and legal disputes for major multinational corporations, particularly in high-impact sectors such as fossil fuels and fast fashion. Evidence from the oil and gas industry reveals a pronounced gap between corporate sustainability discourse and investment behavior: oil majors allocated on average only 1.1% of total capital expenditure to low-carbon solutions during 2019–2020 (e.g., BP: 2.3%, Chevron: 0.5%), while nearly 99% remained directed toward fossil fuel activities [2]. A comparable pattern appears in fast fashion, where Xiao's case study of H&M's *Conscious Collection* attributes greenwashing to profit pressure and competitive benchmarking, associated with post-litigation brand-loyalty losses of 15–20%, multimillion-dollar settlements, and a 12% stock-value decline following regulatory scrutiny of overstated claims [3]. Regulators have correspondingly intensified enforcement: China has introduced an Environmental Protection Tax and green-finance pilots to strengthen accountability [4], [5]; South Korea's Fair-Trade Commission fined Tesla \$2.2 million for overstating cold-weather performance; and Tesla's 2022 removal from the S&P 500 ESG Index illustrates the capital-market consequences of perceived strategic opacity [6]. These cases show that, while greenwashing may yield short-term benefit, it carries material long-term reputational and financial risk. Evidence from Chinese listed companies further suggests that environmental-tax reforms of the kind described above can measurably influence corporate greenwashing behavior [8], indicating that regulatory design itself is a relevant lever in this space.

B. BI and NLP for ESG Narrative-Performance Comparison

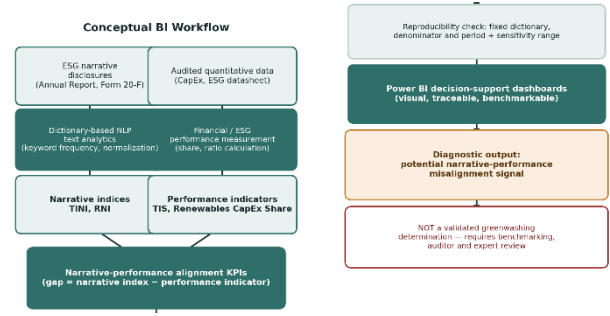
Traditional financial auditing relies on standardized, historical quantitative data, while greenwashing assessment must additionally contend with qualitative corporate narratives, creating a persistent “subjectivity gap” [7] that lets practices such as green-hushing or strategic framing evade conventional audit scrutiny. Embedding narrative analysis within structured, auditable BI data models allows sustainability claims to be evaluated alongside verified financial and operational metrics rather than in isolation, moving assessment from descriptive interpretation toward data-driven verification [9], [10]. Natural Language Processing (NLP) and cognitive-mapping techniques allow narrative disclosures to be systematically decomposed and compared against observable investment and operational outcomes. Building on recent advances in NLP-based quantification of ESG disclosures, including large-scale text-classification approaches trained on millions of corporate documents [11], this study implements narrative-alignment KPIs as illustrative BI dashboards that compare sustainability discourse with verified financial and energy data. As shown in Sections IV–V, these indicators are designed to function as consistency-check and transparency-support tools rather than as standalone greenwashing scores — a distinction the study returns to explicitly in Section VI.

III. CONCEPTUAL FRAMEWORK

Fig. 1 summarizes the conceptual workflow used to operationalize narrative-performance alignment as a BI diagnostic. Two parallel data streams are processed: (i) qualitative ESG narrative disclosures, drawn from a firm’s Annual Report and Form 20-F, converted into narrative indices through dictionary-based NLP text analytics; and (ii) audited quantitative performance data, drawn from the same firm and the same reporting period, converted into performance indicators through standard financial-ratio calculation. The two streams are combined into narrative-performance alignment KPIs, computed as the difference between a narrative index and its corresponding performance indicator, and visualized through Power BI dashboards that support traceability to source data and comparison over time or across benchmarks.

Two features of this framework distinguish it from a scoring or detection system. First, a documented reproducibility check accompanies each index: the underlying dictionary, denominator, and reporting period are fixed and reported (Section IV-C), and a bounding sensitivity range is estimated where the underlying data permit it (Section IV-F). Second, the output is explicitly framed as a diagnostic signal of potential misalignment rather than a validated greenwashing determination; converting that signal into an evidentiary claim would require the benchmarking, calibration, and expert review discussed in Section VI.

Figure 1. Conceptual BI workflow for narrative-performance alignment.



IV. METHOD

This study employs a mixed qualitative–quantitative methodology grounded in Business Intelligence (BI) principles to surface potential narrative-performance misalignment. The approach integrates structured text analytics of sustainability disclosures with verified financial and operational data and operationalizes the results using reproducible BI dashboards. The methodology is designed as a diagnostic framework, emphasizing transparency, reproducibility, and comparability rather than absolute sustainability scoring.

A. Research Design

The research follows a descriptive, single-case design, using BP p.l.c. as an illustrative example to demonstrate the methodological feasibility of BI-based narrative-performance alignment indicators. Consistent with Section III, the case is used to validate the *feasibility and reproducibility* of the method, not to render a firm-specific greenwashing judgment. The analytical process is modular and scalable, allowing replication across firms, sectors, and reporting periods; extending it to multiple firms for comparative benchmarking is identified in Section VII as a priority for future work.

The methodology consists of four sequential stages: (1) data collection and preprocessing, (2) narrative quantification, (3) measurement of quantitative performance, and (4) BI-based integration, visualization, and reproducibility/sensitivity checking of alignment KPIs.

B. Data Collection and Sources

Two categories of data were used, both drawn from BP p.l.c. and both covering fiscal year 2024, to ensure internal consistency, auditability, and a *shared unit of analysis* between the narrative and quantitative sides of each KPI. Narrative data were extracted from BP’s audited Annual Report and Form 20-F 2024 [16], focusing on sections addressing corporate strategy, sustainability, capital allocation, and energy transition. These documents constitute BP’s official regulated disclosure and are the sole source for narrative quantification.

Quantitative data were obtained from BP’s own audited financial disclosures for the same fiscal year: total cash capital expenditure of \$16.237 billion, and capital expenditure attributable to BP’s low-carbon energy business of \$1.596 billion, both reported in BP’s Fourth Quarter and Full-Year 2024 Results [22], consistent with the capital-allocation figures in BP’s ESG Datasheet 2024 [17]. Restricting both the narrative and the quantitative side to the same firm, the same fiscal year, and the same

category of measurement (capital allocation) corrects a methodological limitation identified in an earlier version of this analysis, in which one alignment KPI had compared firm-level narrative discourse with a system-level (global) primary-energy benchmark drawn from a different year and a different unit of analysis — a mismatch resolved in this revision (Section V-B).

C. Narrative Quantification

Qualitative sustainability discourse was transformed into structured indicators using a dictionary-based text-analysis approach, applied to the strategy, sustainability, capital-allocation, and energy-transition sections of the source document. Text was lower-cased and tokenized, and boilerplate legal and glossary language was excluded from the counted sections to reduce distortion. Two narrative indices were constructed:

1. Transition Investment Narrative Index (TINI): measures the intensity of discourse related to financial commitment toward transition activities, using the fixed dictionary {investment, capital allocation, capex, funding, transition investment, low-carbon investment}, counted case-insensitively including simple morphological variants (e.g., invest*, fund*).
2. Renewables Narrative Index (RNI): captures the prominence of renewable-energy discourse using the fixed dictionary {renewable, wind, solar, renewable electricity}, counted on the same basis.

Each index is defined as the count of dictionary-term occurrences divided by the total count of thematically related terms within the same sections (capital-related discourse for TINI; energy-related discourse for RNI), rather than by overall document length, to reduce distortion from generic sustainability language elsewhere in the report. This contextual-normalization choice is consistent with prior research on impression management and symbolic sustainability communication [13].

D. Quantitative Performance Measurement

Quantitative performance was assessed using two normalized, firm-level indicators derived from BP's audited FY2024 data:

1. Transition Investment Share (TIS): the ratio of transition-related capital expenditure (renewables, bioenergy, hydrogen, EV-charging infrastructure, and carbon capture and storage) to total capital expenditure.
2. Renewables CapEx Share: the ratio of capital expenditure attributable to BP's low-carbon energy business to BP's total capital expenditure for the same fiscal year [22]. This indicator replaces the system-level renewable-energy-share measure used in an earlier version of this analysis; it is constructed on the same capital-allocation basis, the same firm, and the same reporting period as TIS and as the narrative indices, so the resulting alignment KPI compares like with like.

Both indicators reflect investor-oriented assessments of transition credibility that prioritize capital allocation over symbolic commitment [14].

E. Alignment KPI Construction

Potential misalignment was operationalized using alignment KPIs that capture the discrepancy between narrative emphasis and quantitative performance:

Narrative–Investment Alignment KPI = TINI – TIS

Narrative–Renewables Alignment KPI = RNI – Renewables CapEx Share

Because both terms in each subtraction are unitless proportions, normalized to a comparable range, and drawn from the same firm and reporting period, the difference is directionally interpretable: positive values indicate that narrative emphasis exceeds observable performance, values near zero indicate relative alignment, and negative values indicate that capital allocation exceeds narrative emphasis. This subtraction is used strictly as a *heuristic screening signal, not a calibrated distance metric*: no independently validated greenwashing-risk threshold currently classifies a given gap magnitude as concerning, and none is proposed here. Section VI returns to this limitation and to what would be required to establish such a threshold.

F. Reproducibility and Sensitivity Check

To support reproducibility, the dictionaries, denominators, source sections, and reporting period used for TINI and RNI are fully specified in Section IV-C — not only the resulting index values — so that an independent analyst working from the same source document could recompute both indices. Because the narrative-side dictionaries were not re-processed against the source text within this revision, a full empirical sensitivity analysis of the narrative indices under alternative keyword lists is identified as a specific, named limitation and priority for future work (Section VII) rather than reported as an executed result.

On the quantitative side, where BP's own disclosures support more than one defensible definition of “transition” capital expenditure, the Narrative–Renewables Alignment KPI is reported in Section V-B under both a narrow, low-carbon-segment definition and, as an actual, sourced bounding check, under the broader transition-investment definition already used for TIS. This is a real comparison of two disclosed figures, not a simulated sensitivity test, and it illustrates concretely how sensitive the alignment signal is to scope choices in defining “transition” or “low-carbon” spending — a robustness consideration recommended for the narrative side as well once full-text reprocessing is performed.

V. RESULTS

A. Narrative–Investment Alignment KPI

Transition-related capital expenditure has become an increasingly relevant strategic lever for firms seeking to offset compliance costs from environmental regulation and carbon taxation [5], while also supporting long-term profitability, innovation, and market competitiveness. However, “narrative asymmetry” — the gap between symbolic communication and substantive action — can allow firms to market a green reputation while capturing ESG-related commercial benefits without a matching capital commitment [6]. A quantitative, evidence-based comparison between rhetoric and allocation is therefore

useful for preserving reporting transparency for customers, investors, and regulators.

On the narrative side, the Transition Investment Narrative Index (TINI) was constructed from BP's Annual Report and Form 20-F 2024 following the dictionary and procedure specified in Section IV-C. On the performance side, the Transition Investment Share (TIS) was calculated as the ratio of transition-related capital expenditure (\$3.70 billion — renewables, bioenergy, hydrogen, EV charging, and carbon capture and storage) to BP's total FY2024 capital expenditure (\$16.20 billion), equal to 22.84%.

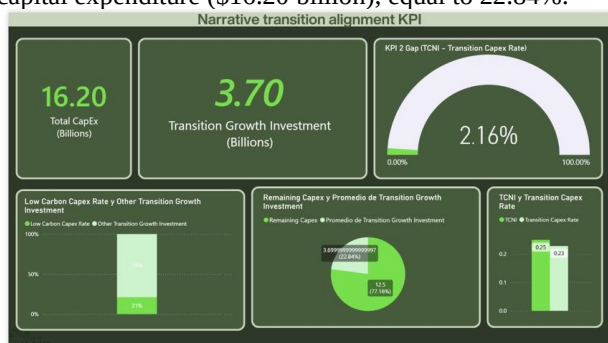


Figure 1. Narrative-Investment Alignment Dashboard.

The dashboard reports a narrative-investment index of approximately 0.25 against a Transition Investment Share of approximately 0.23, yielding a Narrative-Investment Alignment KPI of 2.16% — a small positive gap indicating that transition-related discourse modestly exceeds the corresponding share of invested capital, within the range this study treats as reflecting relative alignment between communication and investment behavior (Section IV-E). This indicator is not a standalone performance measure; its interpretive relevance depends on benchmarking against industry peers, and sector-level evidence suggests that oil and gas companies generally have made limited progress in reallocating capital toward low-carbon activities since 2021 [15].

B. Narrative-Renewables Alignment KPI

This study also assesses the alignment between BP's discourse on renewable energy and BP's own renewable/low-carbon capital allocation, using a Narrative-Renewables Alignment KPI corrected, in this revision, to compare firm-level narrative with firm-level, same-period performance data (Section IV-D). The Renewables Narrative Index (RNI), derived from the same dictionary-based analysis of BP's Annual Report and Form 20-F 2024, was 0.19. The corresponding Renewables CapEx Share — capital expenditure attributable to BP's low-carbon energy business (\$1.596 billion) divided by BP's total FY2024 capital expenditure (\$16.237 billion) — was 9.83% (0.0983) [22].

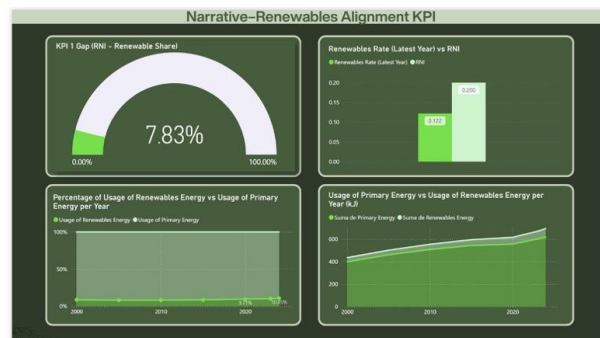


Figure 2. Narrative-Renewables Alignment Dashboard.

The corrected Narrative-Renewables Alignment KPI is therefore $0.19 - 0.0983 = 0.0917$ (9.17%). The dashboard in Fig. 3 visualizes the general KPI construct using values from an earlier stage of this analysis (RNI = 0.200, renewables rate = 0.122, gap = 7.83%), computed before the firm-level correction described in Section IV-D; the validated, same-period, firm-level figures reported here (0.19 and 0.0983) supersede the values shown in that dashboard and should be used for interpretation.

As a sensitivity check (Section IV-F), if “transition” capital is instead defined using BP's broader transition-investment figure already used for TIS in Section V-A (\$3.70 billion, 22.84% of total CapEx) rather than the narrower low-carbon-energy-segment figure, the KPI becomes $0.19 - 0.2284 = -0.0384$ (−3.84%) — a sign reversal that illustrates how materially the alignment signal depends on how “transition” or “low-carbon” spending is scoped, and underscores why this study treats the KPI as a heuristic screening signal rather than a calibrated score (Section IV-E). Both figures fall within a modest range around zero under either definition, which this study interprets only as an indication that BP's renewable-energy narrative and its renewable/low-carbon capital allocation are not grossly divergent — not as evidence for or against greenwashing.

VI. DISCUSSION

A. Interpreting the Alignment Signal

The alignment KPIs reported in Section V should be read as descriptive comparison signals, not as greenwashing determinations. A positive gap indicates that narrative emphasis exceeds measured performance under the specific dictionary, denominator, and performance definition used; it does not, by itself, establish that a disclosure is misleading, that any accounting or legal standard has been breached, or that the underlying intent was deceptive. Prior review of this work correctly noted that no calibration or interpretive threshold currently distinguishes an unremarkable gap from one that should be treated as a genuine misalignment concern. Establishing such a threshold — for example, through comparison against a distribution of same-sector peer firms, or through structured expert judgment — is a necessary next step before this type of indicator could support any evidentiary or regulatory use, and is identified as a priority in Section VII.

B. Drawbacks of Using BI for Greenwashing Risk Screening

Beyond the calibration gap above, a BI-based approach of this kind carries several general drawbacks. *Data availability and comparability*: sustainability disclosures are not fully standardized across firms or jurisdictions, which complicates cross-firm dictionary application and benchmarking. *Context-blindness*: dictionary-based NLP cannot reliably distinguish forward-looking aspiration from realized commitment, cannot detect negation or hedging (“we do not currently plan to...”), and can be inflated by boilerplate or legal disclaimer language if section selection is not carefully controlled. *Not a substitute for audit*: the approach is a screening tool, not a substitute for financial or forensic audit, on-site verification, or supply-chain assurance; it can flag a pattern worth investigating but cannot itself confirm or refute it. *False positives and negatives*: an ambitious but sincere transition strategy that has not yet translated into capital allocation can trigger a false positive, while a firm whose disclosure language is deliberately calibrated to avoid simple keyword-based signals — a form of “green-hushing” — can produce a false negative. *Perceived objectivity*: presenting these signals through polished BI dashboards carries a communication risk, since visual, quantified outputs can convey a degree of objectivity and rigor that the underlying method, as currently validated, does not yet support — which is precisely why this paper reframes its own contribution as an illustrative diagnostic prototype rather than a greenwashing detector.

C. What a Validated Detector Would Require

Turning this prototype into a validated detection or prevention tool would require, at minimum: (i) benchmarking the alignment KPIs against a peer set of same-sector firms to establish a normal or expected range, rather than relying on a single-firm illustration; (ii) structured expert or auditor judgment to calibrate an interpretive threshold; (iii) a labeled dataset of confirmed greenwashing and non-greenwashing cases against which detection accuracy could be measured; and (iv) longitudinal tracking of the same firm across multiple reporting periods to distinguish a persistent pattern from a single-year artifact. None of these four elements is present in this study; each is named explicitly, rather than implied, in Section VII and reprised in the Conclusion.

External resources already exist that could support requirement (i) without building a peer benchmark from scratch. The World Benchmarking Alliance publishes an Oil and Gas Benchmark using a documented ACT-based methodology that scores companies on climate alignment, low-carbon investment, and social transition indicators [18], [19], including a BP-specific profile [20], and CDP similarly reports sector-wide evidence that most oil and gas companies have yet to establish credible fossil-fuel phase-out plans [21]. Incorporating such existing third-party frameworks as external reference points is a more tractable near-term step than constructing a fully custom peer benchmark, and is recommended as a starting point for the future work identified in Section VII. Complementary forensic-accounting approaches to detecting greenwashing and ESG data manipulation [12] offer a further

methodological precedent for the auditor-calibration step described above, and could be combined with the BI framework proposed here in future work.

VII. LIMITATIONS

This study has several specific limitations, additional to the general drawbacks discussed in Section VI-B.

Single-firm, single-period scope: the study relies on one illustrative firm (BP) and one reporting period (FY2024); no cross-firm peer benchmarking (e.g., against Shell or Chevron) was performed in this revision. This is identified as the most important direction for future work, since interpreting any single-firm KPI value depends on a comparative baseline that does not yet exist here.

No validated threshold or ground truth: no independently validated greenwashing-risk threshold or labeled-outcome data was used or is proposed; the alignment KPIs are diagnostic signals, not detection-accuracy-tested classifiers.

No expert calibration: no structured expert-judgment or auditor calibration of the indices was performed.

Narrative-side sensitivity not re-executed: the dictionary, denominator, and preprocessing procedure for the narrative indices (TINI, RNI) are fully specified for reproducibility (Section IV-C), but an empirical sensitivity analysis re-testing these indices under alternative keyword lists was not re-executed against the source text within this revision. The sensitivity check reported in Section V-B is instead a real, sourced bounding check on the quantitative side only (alternative definitions of transition capital expenditure).

No longitudinal analysis: this is a cross-sectional, single-year illustration; no analysis tracks whether an observed gap persists, narrows, or widens over time.

Dictionary-method limits: the method inherits the general drawbacks discussed in Section VI-B, including context-blindness and sensitivity to disclosure-section selection.

These limitations directly bound the claims made in this paper: the BI prototype is shown to be methodologically feasible and reproducible in its data sourcing and calculation, but it is not validated as a greenwashing detection or prevention system.

VIII. CONCLUSION

This paper presented an illustrative Business Intelligence diagnostic prototype that compares sustainability narratives with verified financial data to surface potential narrative-performance misalignment, motivated by the material strategic and financial risk that greenwashing now represents amid growing regulatory pressure and investor scrutiny. Implemented through Power BI and applied to a single illustrative case (BP p.l.c.), the prototype converts qualitative ESG disclosures into reproducible narrative indices and compares them, at firm level and for the same reporting period, against corresponding performance indicators, correcting a unit-of-analysis inconsistency identified in an earlier version of this work.

The resulting alignment KPIs are, by design, diagnostic screening signals rather than validated greenwashing determinations: treating them as evidence of actual greenwashing would require the peer benchmarking, expert calibration, labeled-outcome validation, and

longitudinal analysis identified in Sections VI and VII as this work's most important next steps. Positioned honestly within those bounds, the findings suggest that BI can provide a transparent, traceable, and reproducible structure for visualizing sustainability narrative-performance comparisons — a useful complement to, but not a substitute for, financial audit, regulatory review, and domain-expert judgment in sustainability assurance.

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