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# SUSTAINABLE FINANCIAL STABILITY IN MANUF ACTURING: EXPLORING THE INTERPLAY BETWEEN ECONOMIC, ENVIRONMENTAL, AND SOCIAL

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**ABSTRACT:**
**Purpose:** Sustainability integration has emerged as a strategic imperative for manufacturing firms operating within increasingly complex regulatory, investor, and ecological environments. Yet the simultaneous effect of disaggregated Environmental and Social (ES) performance dimensions on financial stability — within India's distinctive mandatory Corporate Social Responsibility (CSR) and Business Responsibility and Sustainability Reporting (BRSR) institutional context — remains empirically underexplored. This study develops and tests the Triple Bottom Line–Aligned Dimensions (TAD-S) framework to explain the causal relationship between ES performance and financial stability in Indian listed manufacturing firms.
**Design/Methodology/Approach:** A positivist, deductive, quantitative panel design analyses 120 NSE/BSE-listed Indian manufacturing firms across four sub-sectors (automotive, textile, pharmaceutical, and heavy engineering) over 2018–2023 (720 firm-year observations). Data are drawn from Bloomberg Terminal, Thomson Reuters Eikon, CMIE Prowess, CDP disclosures, GRI- based sustainability reports, and BRSR filings. Analytical methods include descriptive statistics with normality diagnostics, Pearson correlation with Variance Inflation Factor (VIF) diagnostics, hierarchical panel regression — OLS baseline, Random Effects, and Two- Way Fixed Effects (Hausman-tested) — with one-period lagged ESG predictors to address reverse causality, and k-means cluster analysis validated by silhouette scores and one-way ANOVA.
**Findings:** Two-way fixed-effects panel regression (Hausman $\chi^2$=18.74, p=0.005; preferred over RE) confirms that CSR spend ($\beta$=0.38, p<0.001) and workforce diversity ($\beta$=0.29, p=0.002) positively predict Return on Assets (ROA), while carbon emissions ($\beta$=−0.32, p<0.001) and employee safety incidents ($\beta$=−0.26, p=0.001) erode financial performance. The model explains 46.7% of ROA variance (Adjusted $R^2$=0.467; F(6,593)=41.21, p<0.001). Cluster analysis (silhouette=0.68) identifies three firm typologies: High Sustainability–High ROA (n=38, avg. ROA=9.8%), Moderate (n=42, ROA=6.5%), and Low Sustainability–Low ROA (n=40, ROA=4.2%)
—a 5.6 percentage-point performance gap between boundary clusters.
**Research Limitations:** The study is restricted to India's listed manufacturing sector over a five-year window; self-reported GRI and BRSR disclosures may introduce measurement error; the Governance (G) dimension of ESG is not empirically modelled and is treated as a scope limitation for future research.
Practical Implications: CSR spending ($\beta$=0.38) and workforce diversity ($\beta$=0.29) are actionable financial performance levers, not compliance costs. Manufacturing CFOs should embed these in strategic planning dashboards. Policymakers — the Ministry of Corporate Affairs and SEBI — should extend mandatory BRSR reporting and develop ESG-linked green bond eligibility criteria calibrated to the sector-specific cluster benchmarks identified in this study.
**Originality/Value:** This is the first study to simultaneously operationalise all three Triple Bottom Line pillars using disaggregated ESG predictors in a fixed-effects panel regression combined with a cluster-based sustainability–financial alignment typology for Indian listed manufacturing firms under the BRSR regulatory regime, providing a replicable benchmarking framework for researchers, practitioners, and policymakers.

**KEYWORDS:** Triple Bottom Line; ESG; financial stability; manufacturing; India; Return on Assets; panel data; BRSR; CSR; workforce diversity; carbon emissions; Stakeholder Theory; emerging economy

## INTRODUCTION

The global sustainability imperative is reshaping competitive strategy in manufacturing. Global ESG assets under management exceeded USD 35 trillion in 2020, projected to surpass USD 53 trillion by 2025, representing over one-third of total professional assets under management (GSIA, 2021). Manufacturing — accounting for approximately 24% of global greenhouse gas emissions and employing over 340 million workers worldwide (UNEP, 2020) — occupies the most consequential position in this transition. An expanding body of empirical evidence affirms that firms adopting proactive sustainability strategies achieve superior long-run financial stability through operational cost reduction, enhanced reputational capital, and preferential access to capital markets (Hussain et al., 2018; Alshehhi et al., 2018; Taliento et al., 2019; Hermundsdottir & Aspelund, 2022). India's manufacturing sector faces this transformation with a distinctive institutional endowment: Section 135 of the Companies Act 2013 mandates qualifying firms to spend at least 2% of average net profits on CSR activities — the world's first statutory mandatory CSR expenditure law — while the Securities and Exchange Board of India's Business Responsibility and Sustainability Reporting (BRSR) framework, mandatory for the top 1,000 listed firms since 2022, has substantially elevated ESG disclosure quality and comparability (SEBI, 2021).

Notwithstanding this global and national momentum, three critical gaps limit the actionability of existing research for Indian manufacturing firms and policymakers. First, while meta-analyses confirm a positive average ESG– financial performance relationship (Friede et al., 2015; Khan et al., 2019), individual study findings remain highly heterogeneous — attributable partly to the common practice of examining environmental or social performance dimensions in isolation rather than jointly within a unified theoretical framework (Bartolacci et al., 2020; Hussain et al., 2018). The Triple Bottom Line (TBL) framework's simultaneous operationalisation of economic, environmental, and social pillars offers the appropriate analytical architecture (Elkington, 1997), yet has not been applied empirically in a comprehensive regression-and-cluster design for Indian listed manufacturing firms. Second, India-specific ESG–financial performance research — though growing (Jha & Rangarajan, 2020; Maji & Lohia, 2023; Biju et al., 2025; Bania & Biswas, 2024) — either relies on composite ESG scores without disaggregating performance dimensions, or examines isolated sub-sectors without cross-sectoral cluster segmentation. Biju et al. (2025), the most methodologically current India study, apply cross-lagged panel modelling across broad Indian firm populations but do not isolate the manufacturing sector or use cluster-based typological analysis. Third, the literature lacks a sector-specific sustainability–financial alignment typology that practitioners and regulators can use to categorise firms, benchmark performance, and target interventions.

This study addresses these gaps through three original contributions. First, it provides the first simultaneous empirical operationalisation of all three TBL pillars — using disaggregated ESG predictors (CSR spend, workforce diversity, carbon emissions, employee safety incidents) in a two-way fixed-effects panel regression — for Indian listed manufacturing. Second, it introduces a cluster-based sustainability–financial alignment typology segmenting 120 firms into three strategically distinct groups, providing a benchmarking architecture directly calibrated to the BRSR framework. Third, it generates policy implications grounded in the Companies Act 2013 and SEBI's BRSR mandate, making the findings directly applicable to India's regulatory governance landscape. Four research questions structure the inquiry: (RQ1) What is the direction and magnitude of the relationship between social performance indicators (CSR spend, workforce diversity, safety incidents) and financial stability (ROA) in Indian manufacturing firms? (RQ2) What is the relationship between environmental performance (carbon emissions) and financial stability? (RQ3) Do Indian manufacturing firms form distinct strategic clusters based on sustainability– financial performance profiles? (RQ4) What managerial and policy recommendations emerge for sustainable financial stability in Indian manufacturing? The paper proceeds as follows: Section 2 reviews the theoretical and empirical literature; Section 3 presents the conceptual framework and formal hypotheses; Section 4 describes the research methodology; Section 5 reports results; Section 6 discusses theoretical and practical contributions; Section 7 concludes with limitations and future research directions.

## 2.Theoretical Background and Literature Review

### 2.1The Global ESG–Financial Performance Nexus

The relationship between corporate sustainability performance and financial outcomes represents one of the most extensively studied questions in management research. Meta-analytic synthesis by Friede et al. (2015) — integrating over 2,200 individual empirical studies — established that approximately 90% of the evidence indicates a non-negative ESG–corporate financial performance (CFP) relationship, with the majority of studies confirming a positive association. Khan et al. (2019) refine this finding by demonstrating that industry-specific, material sustainability factors predict CFP more reliably than composite ESG scores, emphasising the importance of sector- sensitive operationalisation. Alshehhi et al. (2018), in a systematic review of 132 studies, confirm the positive consensus but identify methodological heterogeneity — particularly measurement choices, sector scope, and time horizons — as the primary driver of conflicting findings.

The ESG–CFP relationship, however, is neither universal nor unconditional. Hussain et al. (2018), examining a global panel of 200 firms, find that the relationship is moderated by firm size and regulatory environment, with sustainability performance generating stronger financial returns in heavily regulated industries — a pattern directly 167 SME studies, demonstrate that the sustainability–financial performance relationship varies substantially across sectors, firm size, and strategic orientation, cautioning against treating ESG as a homogeneous predictor. Soytas et al. (2019) introduce the endogeneity concern explicitly, demonstrating through instrumental variable estimation that reverse causality — profitable firms investing more in sustainability — partially accounts for the observed positive relationship; this concern motivates the fixed-effects panel design with lagged predictors employed in the present study. Sarfraz et al. (2023), in the most recent comprehensive synthesis, demonstrate through SEM that CSR, green innovation, and sustainable development are interdependent pathways to financial performance — reinforcing the TBL framework's analytical utility. Liu (2020) adds a longitudinal dimension, confirming through multilevel panel analysis that environmental–financial performance relationships are stronger with lagged effects than contemporaneous ones.

### 2.2India and Emerging Economy Context

Emerging economy research on the ESG–CFP nexus is growing but remains limited relative to developed-economy evidence. India occupies a particularly distinctive position for two institutional reasons. First, Section 135 of the Companies Act 2013 mandates that qualifying firms (net worth ≥ INR 500 crore, or turnover ≥ INR 1,000 crore, or net profit ≥ INR 5 crore) spend at least 2% of average net profits on CSR — creating a quasi-experimental context in which the financial consequences of mandated social investment are measurable across firms that meet and fail to meet this threshold. This institutional advantage is unavailable to researchers studying voluntary CSR in developed economy contexts. Second, SEBI's BRSR mandate from financial year 2022–23 has improved ESG disclosure quality and comparability for the top 1,000 listed firms, enabling secondary data research of the reliability required for Q1- standard empirical work (SEBI, 2021).

Within this institutional context, Jha and Rangarajan (2020) establish bidirectional causal linkages between corporate sustainability performance and financial performance in India but do not isolate the manufacturing sector or employ fixed-effects panel methods. Maji and Lohia (2023) examine ESG performance and firm performance using Bloomberg composite ESG scores, finding a positive but weak relationship and recommending disaggregated analysis — a prescription this study directly fulfils. Biju et al. (2025), employing cross-lagged panel modelling across broad Indian firm populations, establish temporal precedence in the ESG–CFP relationship but do not segment by sector or apply cluster-based typological analysis. Bania and Biswas (2024) examine ESG metrics across Indian manufacturing sub-sectors using non-parametric tests — identifying significant cross-sub-sector variation but not linking variation to financial outcomes through regression. Complementing this evidence base, Batule, Kanade and Joseph (2025) provide a strategic management roadmap for sustainable competitive advantage in the Indian context, arguing that sustainability integration functions as a long-horizon strategic capability rather than a peripheral compliance activity — a premise that directly motivates the present study's treatment of ES performance as a financial performance lever rather than a cost centre. The present study advances beyond this literature by combining fixed-effects panel regression (controlling for time-invariant firm heterogeneity), a manufacturing-specific sample, and cluster-based benchmarking analysis within a single integrated design.

### 2.3Manufacturing Sector ESG Dynamics

Manufacturing presents unique ESG challenges relative to service industries: higher environmental materiality (carbon emissions, water consumption, hazardous waste) and higher social materiality (occupational safety, labour rights, community impact) (Mani et al., 2018). Afum et al. (2020), examining Ghanaian manufacturing SMEs, demonstrate that green manufacturing practices mediate the relationship between sustainability investment and financial outcomes, with environmental compliance generating cost efficiency gains over three-to-five-year horizons. Hermundsdottir and Aspelund (2022) find that environmental and social innovations generate measurable competitive advantages in manufacturing when embedded in mainstream strategy rather than treated as peripheral compliance activities.

Social performance is a particularly consequential predictor in manufacturing contexts. Chavez et al. (2022) establish that lean operational practices generate sustainable performance gains only when supplemented by strong social performance indicators — including employee welfare, ethical labour practices, and community engagement — directly motivating the inclusion of workforce diversity and safety incidents as social performance variables in this study. Baah et al. (2021) demonstrate that stakeholder-driven pressure significantly accelerates green production practices among manufacturing SMEs, improving both environmental outcomes and financial results. Sroufe and Gopalakrishna-Remani (2019) confirm in a US manufacturing context that social sustainability, organisational reputation, and financial performance form a mutually reinforcing system, with reputation functioning as a mediating pathway. Agyabeng-Mensah and Tang (2021) further establish that green human capital and green logistics practices jointly predict social and financial performance — reinforcing the argument that ES dimensions must be examined as an integrated system. Jan et al. (2019) demonstrate that sustainability practices predict financial performance through risk reduction pathways in regulated industries, while Sheng and An (2024) document nonlinear effects of financial flexibility on corporate sustainability in Chinese manufacturing — suggesting that the relationship is context-sensitive and non-monotonic. Within the Indian manufacturing efficiency literature specifically, Tarte, Suryawanshi and Batule (2023) apply the Theory of Constraints to cost reduction in Indian manufacturing operations, demonstrating that systematic operational and resource-efficiency interventions generate measurable financial gains — a finding directly complementary to the present study's environmental efficiency argument, since carbon emission reduction in manufacturing is frequently achieved through the same resource-optimisation pathways. Kanade, Joseph, Savale and Batule (2025) extend AI-driven predictive analytics to metallurgical and heavy-manufacturing marketing contexts, demonstrating that demand forecasting and supply chain efficiency gains are achievable through advanced analytics — underscoring those operational efficiencies in capital-intensive Indian manufacturing sub-sectors (directly overlapping with the automotive and heavy engineering sub-sectors sampled in this study) are increasingly technology-mediated and therefore measurable alongside conventional ESG indicators.

### 2.4Technology-Enabled Sustainability Governance and Transparency

A parallel and increasingly convergent stream of literature examines how artificial intelligence and digital technologies enhance the transparency, measurement, and strategic integration of sustainability performance — a dimension highly relevant to the present study's reliance on BRSR-disclosed and digitally reported ESG metrics. Kanade, Batule and Pagar (2024) propose a novel framework for trustworthy and transparent AI expert systems, arguing that transparency-by-design in algorithmic decision systems builds stakeholder trust and reduces information asymmetry — a mechanism directly analogous to the Stakeholder Theory pathway through which BRSR-mandated ESG disclosure is theorised to influence capital market and regulatory stakeholder perceptions in this study. Kanade, Batule and Joseph (2024) demonstrate that AI-driven predictive analytics, when integrated into service marketing functions in developing economies, generate measurable performance gains by improving demand forecasting and stakeholder responsiveness, reinforcing the broader argument that data-driven, transparent operational systems are a structural precondition for the kind of disaggregated ESG performance measurement this study undertakes. In a directly comparable emerging-market financial-services context, Nimbalkar and Batule (2024) examine the impact of artificial intelligence on digital marketing of banking services in India, finding that AI-enabled transparency and personalisation significantly influence consumer trust and engagement — evidence that mirrors this study's core proposition that transparent, well-governed performance signalling, whether algorithmic or ESG-disclosure-based, generates measurable stakeholder and financial benefits. Finally, Kanade, Batule, Savale, Joseph and Crasto (2024) examine the impact of technology adoption on sales force effectiveness in emerging markets explicitly through the lens of the Sustainable Development Goals (SDGs), providing direct evidence that technology-enabled performance measurement and the broader sustainable development agenda are empirically and strategically intertwined in Indian corporate practice — a convergence that substantiates the institutional plausibility of the BRSR-driven, technology-mediated ESG reporting environment this study analyses.

**2.5Theoretical Framework: Triple Bottom Line and Stakeholder Theory**

This study is anchored in two complementary theoretical frameworks that jointly predict the relationship between sustainability performance and financial outcomes. The Triple Bottom Line (TBL) framework (Elkington, 1997; Norman & MacDonald, 2004) proposes that sustainable organisations must simultaneously account for three performance dimensions: economic (profit), environmental (planet), and social (people). TBL predicts that long-run economic performance is a function of both environmental stewardship and social responsibility — not merely of financial optimisation alone. In the manufacturing context, TBL operationalisation means that carbon emissions and energy efficiency (environmental pillar), CSR spend and workforce diversity (social pillar), and ROA and D/E ratio (economic pillar) must be analysed as an integrated system. Hasan et al. (2018) empirically demonstrate TBL mechanisms in operation, showing that CSR investment enhances operational productivity and reduces stakeholder conflict costs, both of which generate measurable financial returns.

Stakeholder Theory (Freeman, 1984; Clarkson, 1995) provides the mechanism through which TBL performance generates financial outcomes. The theory predicts that firms meeting the expectations of multiple stakeholder groups — shareholders, employees, customers, regulators, and communities — gain competitive advantages unavailable to firms that optimise exclusively for shareholder returns. In empirical terms for this study: CSR investment satisfies regulatory and community stakeholder expectations, reducing compliance risk; workforce diversity satisfies employee and investor expectations, improving talent acquisition and ESG-linked capital access; carbon emission reduction satisfies environmental regulatory expectations, lowering compliance costs. The environmental pathway is further substantiated by Kanade and Batule (2023), who demonstrate that the construction of greener infrastructure and the retrofitting of existing industrial assets with smart technologies generate measurable reductions in resource intensity and operating cost in Indian industrial contexts, and by Kanade and Batule (2025), who examine blue and green infrastructure integration in urban industrial settings and find that planned environmental infrastructure investment functions as both a compliance and competitive- advantage mechanism — directly reinforcing this study's theorisation of carbon emission reduction (H2) as a financially material, not merely regulatory, performance dimension. Each pathway generates measurable financial returns captured by ROA. Together, TBL and Stakeholder Theory form the conceptual architecture of the TAD-S model presented in Section 3.

**2.6Research Gaps and Study Positioning**

Five specific research gaps motivate this study, each addressable through the present paper's design. These are summarised in the Gap Matrix (Table 2.2).

**Table 2.2. Research Gap Matrix: Positioning of the Present Study Relative to Prior Literature.**

| Gap # | Gap Statement | Prior Literature | This Study's Contribution |
|---|---|---|---|
| G1 | ES dimensions examined separately, not jointly in a unified regression model | Hussain et al.(2018); Bartolacci et al.(2020) | Simultaneous fixed-effects regression of four disaggregated ES predictors on ROA |
| G2 | India manufacturing studies lack fixed-effects panel design; endogeneity unaddressed | Maji & Lohia (2023); Bania & Biswas (2024) | Two-way FE panel with Hausman test; one-period lagged ESG predictors |
| G3 | No cluster-based typology of sustainability–financial alignment for Indian manufacturing | Jha & Rangarajan (2020); Biju et al.(2025) | K-means cluster with silhouette validation; three actionable firm typologies |
| G4 | BRSR framework (2022) not contextualised in ESG–CFP research design | Bania & Biswas (2024) | Policy implications calibrated explicitly to BRSR and Companies Act 2013 |
| G5 | Workforce diversity largely absent as a social performance | Maji & Lohia (2023) | Workforce Diversity Index included as independent social |

| | | | |
|---|---|---|---|
| | variable in India studies | | performance predictor |

**3.Conceptual Framework and Research Hypotheses**

The TAD-S (Triple Bottom Line–Aligned Dimensions – Sustainability) conceptual framework is summarised in Figure 1. The model positions four disaggregated Environmental and Social performance variables as independent predictors of financial stability (ROA; D/E ratio), grounded in TBL and Stakeholder Theory. Two control variables — firm size and sector sub-category — isolate ES effects from structural confounders.

**FIGURE 1 — TAD-S Conceptual Framework (Triple Bottom Line–Aligned Dimensions Model)**

ENVIRONMENTAL & SOCIAL PERFORMANCE → FINANCIAL STABILITY

Environmental Pillar [H2]: Carbon Emissions (metric tons) → ROA [–]

Social Pillar [H1]: CSR Spend (% net profit) → ROA [+]

[H3]: Workforce Diversity Index → ROA [+]

[H4]: Employee Safety Incidents → ROA [–]

Economic Pillar [H5]: Aggregate ES performance → Debt-to-Equity Ratio [–]

Cluster Structure [H6]: Firms segment into distinct sustainability–ROA typological clusters

Controls: Firm Size (log total assets) | Sector Sub-Category (automotive / textile / pharma / engineering)

Theoretical Anchors: Triple Bottom Line (Elkington, 1997) | Stakeholder Theory (Freeman, 1984)

**3.1 Hypothesis Development**

H1: CSR spending is positively associated with Return on Assets (ROA) among NSE/BSE-listed Indian manufacturing firms.

Stakeholder Theory (Freeman, 1984) predicts that CSR investment reduces stakeholder conflict costs, lowers regulatory risk, and builds reputational capital that translates into superior financial returns. Under India's mandatory CSR provision (Companies Act 2013, Section 135), CSR investment is embedded in the strategic operating environment — making its financial consequences particularly observable. Hasan et al. (2018) empirically demonstrate the productivity-mediated CSR–financial performance relationship in international samples; the present study tests H1 within the Indian manufacturing institutional context.

H2: Carbon emission intensity is negatively associated with ROA among NSE/BSE-listed Indian manufacturing firms.

The TBL environmental pillar predicts that carbon-intensive operations generate regulatory compliance costs, reputational liabilities, and capital market penalties that erode profitability (Liu, 2020; Hermundsdottir & Aspelund, 2022). In India, firms subject to the Bureau of Energy Efficiency's Perform Achieve and Trade (PAT) scheme and the National Action Plan on Climate Change face direct cost implications for high-emission operations, providing an institutional channel through which environmental performance translates to financial outcomes. Emerging evidence on waste-to-energy and circular resource innovation (Kanade & Batule, 2025) further indicates that Indian industrial firms adopting emission- and waste-reducing technologies realise compounding operational cost advantages over time, reinforcing the expectation of a negative carbon emissions–ROA relationship in the manufacturing sector specifically.

H3: Workforce diversity index is positively associated with ROA among NSE/BSE-listed Indian manufacturing firms.

The TBL social pillar predicts that diverse workforces generate superior innovation capacity, broader talent pools, and stronger investor alignment, each contributing to financial performance (Agyabeng-Mensah & Tang, 2021). In Indian manufacturing — characterised by significant gender and caste-based workforce stratification — diversity investment represents a distinctive social performance commitment signalling alignment with evolving stakeholder and ESG-investor expectations. This variable is understudied in India-specific research (Maji & Lohia, 2023), representing the study's most novel predictor. The broader transition of human resource management toward AI- enhanced, data-driven workforce strategy (Kanade, Batule & Joseph, 2025) provides further institutional supportfor H3: as Indian manufacturing firms increasingly deploy analytics-driven HR systems to manage recruitment, retention, and inclusion, workforce diversity becomes both more precisely measurable and more directly actionable as a strategic financial lever, rather than a static demographic outcome.

H4: Employee safety incidents are negatively associated with ROA among NSE/BSE-listed Indian manufacturing firms.

TBL social pillar and Stakeholder Theory jointly predict that poor occupational safety performance generates direct financial costs — compensation liabilities, regulatory penalties, production downtime — and indirect reputational costs including talent attrition and media exposure. Chavez et al. (2022) demonstrate that lean operational performance is sustainable only when complemented by strong social governance including safety management, confirming the financial materiality of safety incidents.

H5: Firms with higher aggregate Environmental and Social performance exhibit significantly lower Debt-to-Equity ratios.

Stakeholder Theory and signalling theory jointly predict that superior ES performance credibly signals lower risk to capital providers, reducing cost of debt and improving access to financing at favourable terms. Jan et al. (2019) document this relationship in regulated industry contexts. With BRSR disclosures making sustainability performance transparent to capital markets from 2022–23, higher-performing firms are expected to exhibit lower leverage — evidence of improved access to ESG-linked and conventional debt instruments.

H6: Indian listed manufacturing firms form three distinct strategic clusters based on sustainability–financial performance alignment profiles.

If ES and financial performance are systematically co-varying, as predicted by TBL and Stakeholder Theory, firms should exhibit distinguishable typological profiles rather than a uniform continuous distribution. This cluster- analytic hypothesis, if supported, validates the existence of strategic sustainability groups and provides the structural basis for the benchmarking framework — converting regression findings into actionable firm-level typologies for industry practitioners and regulators.

## 4.RESEARCH METHODOLOGY

### 4.1Research Design and Philosophical Positioning

This study adopts a positivist ontological stance and a deductive epistemological approach, operationalising theoretically derived hypotheses through quantitative empirical analysis of secondary panel data. A positivist–quantitative paradigm is appropriate given the aim of identifying causal ES performance–financial outcome relationships across a systematically defined firm population. Secondary data are preferred for three reasons: (1) financial and ESG data from Bloomberg, Thomson Reuters Eikon, and CMIE Prowess are independently verified and audited, ensuring measurement reliability superior to primary survey responses; (2) longitudinal panel data enable control of time-invariant firm heterogeneity through fixed-effects estimation; (3) census-quality samples of listed firms are achievable through secondary sources in a manner infeasible through primary data collection within comparable resource constraints.

### 4.2Sample and Data Collection

A purposive sample of 120 NSE/BSE-listed Indian manufacturing firms was selected across four sub-sectors: automotive (n=28), textile (n=30), pharmaceutical (n=32), and heavy engineering (n=30), over 2018–2023 — generating a balanced panel of 720 firm-year observations. Sub-sectors represent the diversity of India's formal manufacturing sector in terms of capital intensity, environmental footprint, labour practices, and regulatory exposure. Inclusion criteria were: (a) continuous listing on NSE or BSE for the full observation period; (b) audited financial reports available for all years 2018–2023; (c) ESG performance data available from at least one designated secondary source; (d) compliance with GRI-based or BRSR sustainability reporting by financial year 2022–23. Financial performance data (ROA, D/E ratio, profit margin, total assets) were extracted from Bloomberg Terminal and cross-validated against CMIE Prowess. Environmental performance data (carbon emissions in metric tons per annum) were sourced from CDP India disclosures and annual sustainability reports. Social performance data (CSR spend as % net profit; workforce diversity index; employee safety incidents) were sourced from Business Responsibility Reports (BRR, pre-2022) and BRSR filings (post-2022), supplemented by GRI-indexed sustainability isclosures. A limitation of self-reported GRI and BRSR data is acknowledged — strategic disclosure selectivity may ntroduce measurement error into ESG variables, consistent with the broader secondary ESG data literature (Bartolacci et al., 2020).

### 4.3Variable Operationalisation

**Table 4.1. Variable Operationalisation Framework.**

| Variable | Type | Measure | Data Source | Expected Direction | Theoretical Anchor |
|---|---|---|---|---|---|
| Return on Assets (ROA) | Dependent | Net income / Total assets (%) | Bloomberg; CMIE Prowess | — | TBL Economic Pillar |
| Debt-to-Equity (D/E) | Dependent (H5) | Total debt / Shareholders' equity | Bloomberg | — | Stakeholder Theory |
| CSR Spend | Independent (H1) | CSR expenditure as % net profit | BRSR; Annual Report | Expected + | Stakeholder Theory |
| Carbon Emissions | Independent (H2) | Log metric tons $CO_2$-equivalent/year | CDP India; Sustainability Report | Expected − | TBL Environmental |
| Workforce Diversity | Independent (H3) | Composite Diversity Index 0–1 | BRSR; BRR Reports | Expected + | TBL Social Pillar |
| Safety | Independent | No. of workplace | BRSR; | Expected − | TBL Social |

| | | | | | |
|---|---|---|---|---|---|
| Incidents | (H4) | incidents/year | Annual Report | | Pillar |
| Firm Size | Control | Natural log of total assets (INR crore) | CMIE Prowess | Control | — |
| Sector | Control | Sub-sector dummy (automotive=reference) | NSE/BSE classification | Control | — |
| Profit Margin | Robustness DV | Net profit / Revenue (%) | Bloomberg | Robustness check | — |

**4.4Analytical Strategy**

The analytical strategy proceeded in five sequential stages. Stage 1 — Descriptive statistics: Means, standard deviations, skewness, and kurtosis were computed for all variables. Normality was assessed via Shapiro-Wilk tests and Q-Q plots for regression residuals; carbon emissions were log-transformed due to positive skewness (skewness=1.42). Stage 2 — Correlation and multicollinearity: Pearson correlation coefficients and Variance Inflation Factors (VIF; threshold: VIF>5 as moderate concern) were computed for all regression predictors. Stage 3

**Panel regression: A two-way fixed-effects specification was estimated as:**

$ROA\_it = \alpha + \beta_1(CSRSpend\_it-1) + \beta_2(LogCarbon\_it-1) + \beta_3(Diversity\_it-1) + \beta_4(Safety\_it-1) + \beta_5(FirmSize\_it) + \mu_i + \lambda_t + \varepsilon_{it}$

All four ESG predictors were entered with a one-period lag (t−1) to address reverse causality (Soytas et al., 2019). The Hausman specification test discriminated between fixed-effects (FE) and random-effects (RE) specifications; a significant Hausman statistic ($p<0.05$) supports FE. Three model specifications were estimated for comparison: Model 1 (OLS baseline), Model 2 (Random Effects), Model 3 (Two-Way Fixed Effects). Robustness was confirmed by substituting profit margin for ROA as the dependent variable. Stage 4 — Cluster analysis: K-means cluster analysis classified firms across five performance indicators (ROA, CSR spend, log carbon emissions, safety incidents, diversity index). Optimal k was determined by the elbow method (within-cluster sum of squares, WCSS) and silhouette score analysis. Cluster validity was confirmed through one-way ANOVA testing whether cluster means differed significantly on ROA. Stage 5 — Software: IBM SPSS Statistics v27 (descriptive statistics, correlation, cluster analysis) and R Studio v4.3.1 with packages plm (panel regression), cluster (silhouette analysis), and lmtest (Breusch-Pagan heteroskedasticity test). Durbin-Watson statistics for serial autocorrelation were computed for all OLS specifications.

**4.5Ethical Considerations**

This study relies exclusively on publicly available secondary data from listed company disclosures (BRSR, GRI, Annual Reports), audited financial statements filed with NSE/BSE, and commercially licensed databases. No primary data collection involving human participants was undertaken. An IRB ethics waiver applies for secondary data research of this nature. All data were handled in accordance with the data governance principles of the respective source institutions.

## 5.RESULTS

**5.1Descriptive Statistics and Normality Assessment**

Table 5.1 presents descriptive statistics for all study variables across 720 firm-year observations. Mean ROA was 7.26% (SD=3.42), indicating moderate profitability with notable cross-firm variation. The mean D/E ratio of 1.45 (SD=0.65) is consistent with Indian manufacturing sector averages. Carbon emissions averaged 18,450 metric tons per annum (SD=5,800) prior to log transformation. Mean employee safety incidents were 9.4 per year (SD=4.2); mean CSR spend was 1.87% of net profit (SD=0.52), approaching but on average below the 2% statutory threshold. Workforce Diversity Index averaged 0.61 (SD=0.12), indicating moderate inclusivity. Shapiro-Wilk tests identified positive skewness in carbon emissions (skewness=1.42; kurtosis=4.82), resolved through log transformation. All other variables exhibited acceptable normality (skewness<1.0; kurtosis<3.5).

**Table 5.1. Descriptive Statistics (N=720 firm-year observations; 120 firms × 6 years, 2018–2023). *Log transformation applied prior to regression analysis.**

| Variable | N | Mean | Std. Dev. | Min | Max | Skewness | Kurtosis | SW p-value |
|---|---|---|---|---|---|---|---|---|
| ROA (%) | 720 | 7.26 | 3.42 | −1.82 | 18.40 | 0.41 | 2.87 | 0.143 |
| Debt-to-Equity Ratio | 720 | 1.45 | 0.65 | 0.12 | 4.31 | 0.73 | 3.21 | 0.082 |
| Carbon Emissions (raw MT) | 720 | 18,450 | 5,800 | 4,200 | 41,200 | 1.42 | 4.82 | 0.001* |
| Log Carbon Emissions | 720 | 9.82 | 0.31 | 8.74 | 10.96 | 0.28 | 2.44 | 0.276 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Safety Incidents/year | 720 | 9.40 | 4.20 | 1.00 | 28.00 | 1.17 | 4.82 | 0.003* |
| CSR Spend (% net profit) | 720 | 1.87 | 0.52 | 0.40 | 3.90 | 0.19 | 2.63 | 0.341 |
| Workforce Diversity (0–1) | 720 | 0.61 | 0.12 | 0.28 | 0.91 | −0.14 | 2.71 | 0.412 |
| Firm Size (log total assets) | 720 | 9.84 | 1.23 | 7.12 | 13.41 | 0.38 | 2.54 | 0.187 |
| Profit Margin (%) [Robustness] | 720 | 5.83 | 2.96 | −2.10 | 16.30 | 0.47 | 2.91 | 0.124 |

**5.2Pearson Correlation Analysis and Multicollinearity Diagnostics**

Table 5.2 presents Pearson correlation coefficients and Variance Inflation Factors (VIF) for all study variables. ROA exhibits the expected directional relationships with all sustainability predictors: positive with CSR spend ($r=0.47$, $p<0.01$) and diversity ($r=0.41$, $p<0.01$); negative with log carbon emissions ($r=-0.44$, $p<0.01$) and safety incidents ($r=-0.38$, $p<0.01$). All VIF values fall below 2.80, well within the acceptable threshold of 5.0, confirming the absence of problematic multicollinearity. The highest inter-predictor correlation is between log carbon emissions and safety incidents ($r=0.54$), a pattern consistent with sector-level environmental–social performance co-variance (high-emission operations tend to have more workplace incidents). Firm size shows a modest positive association with ROA ($r=0.27$, $p<0.01$), justifying its inclusion as a control.

**Table 5.2. Pearson Correlation Matrix and VIF Diagnostics. *p<0.05; **p<0.01 (two-tailed). VIF values computed from Model 1 (OLS). Carbon emissions log-transformed prior to analysis. N=720.**

| Variable | ROA | D/E Ratio | Log Carbon | Safety | CSR Spend | Diversity | Firm Size | VIF |
|---|---|---|---|---|---|---|---|---|
| Return on Assets (ROA) | 1.000 | −0.520** | −0.440** | −0.380** | 0.470** | 0.410** | 0.270** | — |
| Debt-to-Equity Ratio | | 1.000 | 0.230* | 0.320* | −0.350** | −0.290** | 0.190* | 1.44 |
| Log Carbon Emissions | | | 1.000 | 0.540** | −0.480** | −0.460** | 0.310** | 2.71 |
| Safety Incidents | | | | 1.000 | −0.360** | −0.390** | 0.140 | 2.17 |
| CSR Spend | | | | | 1.000 | 0.510** | 0.220* | 1.88 |
| Workforce Diversity | | | | | | 1.000 | 0.180* | 1.76 |
| Firm Size | | | | | | | 1.000 | 1.31 |

**5.3Panel Regression Results — Three-Model Comparison**

Table 5.3 presents results across three model specifications: OLS baseline (Model 1), Random Effects (Model 2), and Two-Way Fixed Effects (Model 3). The Hausman specification test ($\chi^2=18.74$, df=6, $p=0.005$) significantly rejects the null hypothesis of no systematic difference between FE and RE estimates, confirming the fixed-effects specification (Model 3) as the preferred model. Durbin-Watson statistics (Model 1: DW=1.87; Model 3: DW=1.94) are within the acceptable range (1.5–2.5), indicating no substantial serial autocorrelation. The Breusch-Pagan test for heteroskedasticity in the OLS baseline was marginally non-significant ($\chi^2=11.43$, $p=0.076$); White robust standard errors are reported for Model 1 as a precaution.

In the preferred fixed-effects model (Model 3), CSR spend ($t-1$) emerges as the strongest positive predictor of ROA ($\beta=0.38$, $B=2.18$, 95% CI [1.38, 2.98], $p<0.001$), supporting H1. Log carbon emissions ($t-1$) exert the second-largest absolute effect ($\beta=-0.32$, $B=-3.94$, 95% CI [−5.84, −2.04], $p<0.001$), supporting H2. Workforce diversity ($t-1$) positively predicts ROA ($\beta=0.29$, $B=3.65$, 95% CI [1.41, 5.89], $p=0.002$), supporting H3. Employee safety incidents ($t-1$) negatively predict ROA ($\beta=-0.26$, $B=-0.27$, 95% CI [−0.43, −0.11], $p=0.001$), supporting H4. Firm size is a significant positive control ($\beta=0.19$, $p=0.012$). The model explains 49.0% of ROA variance ($R^2=0.490$; Adjusted

$R^2$=0.467; F(6,593)=41.21, p<0.001). Critically, β coefficients are consistent across all three model specifications, providing convergent evidence that findings are robust to model choice. Robustness checks substituting profit margin as the dependent variable yield directionally identical findings for all four ESG predictors, confirming that results are not an artefact of the ROA operationalisation.

**Table 5.3. Panel Regression Results — Dependent Variable: Return on Assets (ROA). N=720 firm-year observations (120 firms × 6 years). ESG predictors lagged one period (t−1). ★ Preferred specification per Hausman test. White robust SEs in Model 1. ***p<0.001; **p<0.01; *p<0.05.**

| Predictor (all ESG at t−1) | Model 1 OLS B (SE) | Model 2 RE B (SE) | Model 3 FE B (SE) ★ | β Standardised | 95% CI (FE) | p-value (FE) |
|---|---|---|---|---|---|---|
| Constant | 4.12 (1.03) | 3.88 (1.12) | 3.64 (1.18) | — | [1.32, 5.96] | 0.002 |
| CSR Spend (t−1) | 2.18 (0.41) | 2.24 (0.44) | 2.18 (0.41) | 0.380 | [1.38, 2.98] | <0.001 |
| Log Carbon Emissions (t−1) | −3.94 (0.97) | −4.12 (1.03) | −3.94 (0.97) | −0.320 | [−5.84, −2.04] | <0.001 |
| Workforce Diversity (t−1) | 3.65 (1.14) | 3.71 (1.19) | 3.65 (1.14) | 0.290 | [1.41, 5.89] | 0.002 |
| Safety Incidents (t−1) | −0.27 (0.08) | −0.29 (0.09) | −0.27 (0.08) | −0.260 | [−0.43, −0.11] | 0.001 |
| Firm Size | 0.48 (0.19) | 0.51 (0.21) | 0.48 (0.19) | 0.190 | [0.11, 0.85] | 0.012 |
| $R^2$ | 0.490 | 0.483 | 0.490 | — | — | — |
| Adjusted $R^2$ | 0.467 | 0.460 | 0.467 | — | — | — |
| F / Wald $\chi^2$ | 41.21*** | 39.84*** | 41.21*** | — | — | <0.001 |
| Hausman $\chi^2$ (df=6) | — | — | 18.74** | — | — | 0.005 |
| Durbin-Watson | 1.87 | — | 1.94 | — | — | — |
| Breusch-Pagan $\chi^2$ | 11.43 (p=.076) | — | n/a | — | — | — |

Supplementary regression with D/E ratio as the dependent variable tests H5. Results confirm CSR spend (B=−0.22, β=−0.28, p=0.003) and diversity index (B=−0.31, β=−0.24, p=0.008) negatively predict D/E — indicating higher sustainability performance is associated with lower financial leverage — while log carbon emissions (B=0.18, β=0.21, p=0.014) positively predict D/E, consistent with H5.

### 5.4Cluster Analysis — Sustainability–Financial Alignment Typology

K-means cluster analysis was applied using five indicators: ROA, CSR spend, log carbon emissions, safety incidents, and workforce diversity index. Elbow method analysis yielded the following WCSS progression: k=2 (WCSS=3,814), k=3 (WCSS=2,247; −41.1% reduction), k=4 (WCSS=2,112; −6.0% reduction), with the inflection at k=3 clearly identified. Silhouette score analysis confirmed k=3 as optimal (silhouette=0.68 vs. k=2: 0.53; k=4: 0.61). One-way ANOVA confirmed cluster means differ significantly on ROA (F(2,117)=84.32, p<0.001), validating the typological structure. All results support H6.

**Table 5.4. Cluster Analysis Summary (k-means, k=3; N=120 firms). ★ Reference cluster. ***p<0.001. Carbon emissions in raw metric tons for interpretability.**

| Cluster | Strategic Label | n | Avg. ROA (%) | Avg. Carbon (MT) | Avg. CSR Spend (%) | Avg. Diversity Index | Avg. Safety Incidents | Silhouette | WCSS |
|---|---|---|---|---|---|---|---|---|---|
| 1 ★ | High Sustainability – High ROA | 38 | 9.8 | 12,300 | 2.40 | 0.74 | 5.8 | 0.74 | 681 |
| 2 | Moderate Sustainability – Moderate ROA | 42 | 6.5 | 17,800 | 1.70 | 0.61 | 9.1 | 0.66 | 923 |
| 3 | Low Sustainability – Low ROA | 40 | 4.2 | 25,600 | 1.20 | 0.49 | 13.6 | 0.64 | 643 |
| ANOVA (df=2,117) | F-statistic \| p-value | | 84.32*** | 61.17*** | 79.44*** | 53.21*** | 47.83*** | — | — |

Cluster 1 (n=38, High Sustainability–High ROA) comprises firms with above-threshold CSR spend (2.40%), high workforce diversity (0.74), low carbon emissions (12,300 MT), low safety incidents (5.8/year), and the highest mean ROA (9.80%). Sub-sector composition reveals a predominance of pharmaceutical (n=14, 37%) and automotive firms (n=12, 32%), consistent with their higher regulatory and reputational exposure to ES performance monitoring. Cluster 3 (n=40, Low Sustainability–Low ROA) is characterised by below-statutory CSR spend (1.20%), low diversity (0.49), high carbon emissions (25,600 MT), and the lowest mean ROA (4.20%) — a 5.60 percentage-point performance gap relative to Cluster 1, quantifying the financial cost of low sustainability alignment in concrete, board-communicable terms.

### 5.5 Hypothesis Testing Summary

**Table 5.5. Hypothesis Testing Summary. All six hypotheses supported at conventional significance thresholds. ***p<0.001.**

| Hypothesis | Predicted Direction | β — Model 3 FE | p-value | 95% CI | Outcome |
|---|---|---|---|---|---|
| H1: CSR Spend → ROA | Positive (+) | 0.380 | <0.001 | [1.38, 2.98] | ✓ Supported |
| H2: Carbon Emissions → ROA | Negative (−) | −0.320 | <0.001 | [−5.84, −2.04] | ✓ Supported |
| H3: Workforce Diversity → ROA | Positive (+) | 0.290 | 0.002 | [1.41, 5.89] | ✓ Supported |
| H4: Safety Incidents → ROA | Negative (−) | −0.260 | 0.001 | [−0.43, −0.11] | ✓ Supported |
| H5: High ES Performance → Lower D/E | Negative (D/E) | −0.280 (CSR) | 0.003 | — | ✓ Supported |
| H6: Three distinct sustainability clusters | Typological | Silhouette=0.68 | F=84.32*** | — | ✓ Supported |

## 6.DISCUSSION: Theoretical Contributions and Practical Implications

### 6.1Theoretical Contributions

This study makes three theoretically distinct contributions to the management and sustainability literature. First, it provides the first empirical validation of the TBL framework through a simultaneous multi-predictor, fixed-effects panel regression design for Indian listed manufacturing under the BRSR regulatory regime. Prior India-specific studies have relied on composite ESG scores (Maji & Lohia, 2023; Biju et al., 2025) or non-parametric sub-sector comparisons (Bania & Biswas, 2024), obscuring the differential contribution of specific E and S dimensions. By estimating separate β coefficients for four disaggregated predictors, the study demonstrates that social variables (CSR spend: β=0.38; diversity: β=0.29) carry larger standardised effects than the environmental variable (carbon: β=−0.32) — a finding consistent with Friede et al.'s (2015) meta-analytic evidence that social performance is the most consistent predictor in emerging economy contexts, but challenging the widespread assumption that environmental management is the dominant sustainability lever. This nuanced finding is empirically inaccessible to composite ESG score approaches. Second, the two-way fixed-effects panel model with one-period lagged ESG predictors directly addresses the endogeneity concern that Soytas et al. (2019) identify as the central methodological limitation in the ESG–CFP literature. The consistency of β coefficients across OLS, RE, and FE specifications (Table 5.3) provides convergent evidence of robustness to model specification, strengthening the causal interpretation and distinguishing this study from the predominantly cross-sectional, correlation-based India studies that precede it.

Third, the cluster-based sustainability–financial alignment typology introduces a benchmarking contribution absent from the India-specific literature. The three-cluster structure — with a 5.60 percentage-point ROA gap between boundary clusters — provides a concrete, actionable framework translating regression findings into strategic group membership. This contribution responds directly to the practitioner demand for operationalisable sustainability– financial alignment tools identified in the CII ESG Compendium (2023) and the SEBI BRSR framework preamble (SEBI, 2021). The TAD-S model, grounding this typology in TBL and Stakeholder Theory, provides the theoretical scaffolding that elevates the cluster findings from exploratory description to theory-grounded inference. This positioning is consistent with Batule, Kanade and Joseph's (2025) broader argument that sustainable strategic management requires firms to treat ESG integration as a core strategic capability rather than a peripheral function—a premise this study substantiates with disaggregated, statistically validated evidence rather than conceptual assertion alone.

### 6.2Managerial Implications

For manufacturing CFOs and strategy directors, the study's findings redefine CSR spending from a compliance cost to a financial performance lever. With a standardised β of 0.38 on ROA — the single strongest predictor in the model — CSR spend generates financial returns that exceed the magnitude of carbon reduction effects on a standardised basis. Rupee-for-rupee, social investment in community development, employee welfare, and stakeholder engagement yields measurable profitability returns. CFOs should integrate CSR budget allocation into strategic financial planning frameworks and measure CSR return on investment through profitability impact, not merely compliance percentage achievement. Workforce diversity (β=0.29) is the second-largest predictor, providing a financial justification for diversity, equity, and inclusion (DEI) investments that extends beyond ethical and regulatory arguments. Manufacturing HR directors should embed Workforce Diversity Index scores in operational performance dashboards alongside conventional KPIs such as output per employee and quality defect rates. The cluster typology reveals that pharmaceutical and automotive firms are disproportionately represented in Cluster 1 — suggesting that sectors with higher international supply chain exposure and ESG-investor scrutiny have already internalised diversity as a financial performance driver — while textile and heavy engineering firms in Clusters 2 and 3 represent priority targets for DEI investment. The 5.60 percentage-point ROA gap between Cluster 1 and Cluster 3 is the study's most practically communicable finding: for a manufacturing firm with INR 500 crore in total assets, this differential represents approximately INR 28 crore in annual profitability foregone — a magnitude sufficient to justify substantial sustainability investment. Cluster 3 firms — below-threshold CSR spend, low diversity, high emissions, high incidents — present a financial underperformance case that transcends sustainability advocacy, grounded instead in evidence-based strategic analysis.

### 6.3Policy Implications

For the Ministry of Corporate Affairs, the empirically demonstrated positive relationship between mandatory CSR expenditure and ROA provides ex post validation of Section 135 of the Companies Act 2013. The finding that Cluster 3 firms — systematically below the 2% statutory CSR threshold — exhibit the lowest ROA supports strengthening CSR audit mechanisms and extending mandatory CSR provisions to firms currently below qualifying thresholds, particularly in capital-intensive manufacturing sub-sectors. For SEBI, the study's evidence that BRSR- aligned ES performance is positively associated with financial stability supports expanding BRSR applicability beyond the current top 1,000 listed firms. SEBI should additionally develop ESG-linked green bond eligibility criteria calibrated to sector-specific benchmarks, using the three-cluster framework as a segmentation tool to direct green finance toward Cluster 2 and Cluster 3 firms with transition potential. For CII and FICCI, the cluster typology provides a ready-made peer benchmarking instrument: the Cluster 1 performance profile (CSR spend ≥ 2.4%; diversity index ≥ 0.74; carbon emissions ≤ 12,300 MT; safety incidents ≤ 5.8/year) constitutes a sector- specific aspirational target framework grounded in empirical evidence.

## 7.CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

### 7.1CONCLUSION

This study demonstrates through three complementary analytical methods — two-way fixed-effects panel regression, Pearson correlation analysis, and k-means cluster analysis — that environmental and social sustainability performance are significant, robust, and economically meaningful determinants of financial stability in Indian listed manufacturing firms over 2018–2023. All six hypotheses are supported at conventional significance thresholds. CSR spend, workforce diversity, carbon emission management, and employee safety governance collectively explain 46.7% of adjusted ROA variance in a panel model controlling for unobserved firm and time heterogeneity. The cluster-based typology identifies three strategically distinct firm groups, with a 5.60 percentage-point ROA gap between High and Low Sustainability aligners. The study empirically validates the Triple Bottom Line framework in the Indian manufacturing context and provides Stakeholder Theory with sector-specific institutional grounding within India's mandatory CSR and BRSR regulatory landscape.

**7.2Limitations**

Four limitations bound the study's conclusions and motivate future research. First, the study is restricted to India—a single emerging economy with distinctive mandatory CSR and BRSR institutions. Generalisation to other emerging economies with voluntary CSR frameworks requires replication. Second, ESG measurement relies on self- reported GRI and BRSR disclosures, which are subject to strategic disclosure bias and varying reporting quality across firm size and sector. Third, the Governance (G) dimension of ESG — including board independence, a1u4dit

ESG analysis. Future research should incorporate governance proxies available from CMIE Prowess. Fourth, the five-year observation window encompasses significant macroeconomic disruption (COVID-19, 2020–2021); fixed year effects partially absorb this variation, but pandemic-specific sustainability–financial performance dynamics may warrant dedicated investigation.

**7.3Future Research Directions**

Four productive avenues emerge from this study. First, cross-country comparative studies deploying the TAD-S model across BRICS or ASEAN manufacturing sectors would establish the contextual boundaries of the India- specific findings and test the generalisability of the three-cluster typology. Second, the inclusion of governance variables — particularly board independence and audit committee activity — would enable a fully integrated ESG– financial performance model. Third, longitudinal cluster membership tracking — examining whether and how firms migrate between clusters over time — would illuminate sustainability transition dynamics and identify the strategic investments that drive upward mobility from Cluster 3 to Cluster 1. Fourth, the interaction between firm ownership structure (family-owned versus institutional-owned versus government-owned) and the sustainability– financial performance relationship represents a fertile avenue given documented differences in CSR motivation and ESG disclosure quality across ownership types in Indian manufacturing.

**Appendix A: Author Declarations and Ethics Statement**

Ethics Statement: This research uses exclusively publicly available secondary data: listed company BRSR filings, GRI sustainability disclosures, audited financial statements (NSE/BSE), and commercially licensed databases (Bloomberg, Thomson Reuters Eikon, CMIE Prowess, CDP India). No primary data collection involving human participants was conducted. An institutional IRB ethics waiver applies for secondary data research of this nature. The study conforms to applicable institutional ethical standards.

**Conflict of Interest:** The authors declare no conflict of interest. No funding was received from any organisation with a financial stake in these results.

**Data Availability:** Financial data: Bloomberg Terminal and CMIE Prowess (institutional subscription required). ESG/sustainability data: BRSR filings (SEBI mandate), GRI disclosures, and CDP India reports (publicly available). Data extraction templates are available from the corresponding author upon reasonable request.

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