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# Tracing the progress of Sustainable Business Practices in India: A Quantitative Examination of Karnataka's Trajectory, 2019–2024

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***Abstract*** **- This study examines the evolution and determinants of sustainable business practices in Karnataka, India, over a six-year period (2019–2024) using secondary data representing key environmental, social, and governance (ESG) indicators. A composite Sustainable Business Index (SBI) was constructed to assess overall sustainability performance, drawing upon Carbon Emission Intensity, Waste Management Compliance, Renewable Energy Usage, Corporate Social Responsibility expenditure, Female Workforce Participation, Sustainability Reporting Compliance, and Board Independence. Descriptive analysis reveals consistent improvements in most indicators, especially in waste management, renewable energy adoption, and sustainability reporting, alongside a reduction in carbon emission intensity.**

**Correlation and regression analyses indicate that environmental and governance variables significantly predict sustainable business outcomes, with Sustainability Reporting Compliance emerging as the strongest positive determinant and Carbon Emission Intensity demonstrating a substantial negative effect. Social indicators show mixed influence, as CSR expenditure remains statistically insignificant, while gender inclusion contributes modestly to SBI. The study highlights the central role of transparency, environmental stewardship, and regulatory alignment in shaping sustainable business transformation in Karnataka. The findings contribute to the growing body of ESG literature in the Indian context and offer valuable implications for policymakers, corporate strategists, and sustainability practitioners.**

***Keywords*****-- Sustainable Business Practices, ESG Indicators, Environmental Governance, Sustainability Reporting**

## I. INTRODUCTION

Sustainability has emerged as a defining pillar for modern economic systems, shaping policies, corporate strategies, and industry standards across the globe. For a rapidly developing nation like India, sustainable business practices are no longer optional—they constitute a strategic imperative that aligns with national development priorities, global climate commitments, and long-term competitiveness.

India's ambition to transition towards cleaner production systems, strengthen circular economy models, and integrate environmental, social, and governance (ESG) principles has intensified particularly after the introduction of national frameworks such as the Business Responsibility and Sustainability Report (BRSR). Yet, the degree of adoption, scale of implementation, and quantifiable impact of sustainable practices vary significantly across states and sectors.

Karnataka stands out as one of India's leading economic hubs, known for its vibrant technology ecosystem, manufacturing clusters, entrepreneurial culture, and proactive governance. With strong policy support for renewable energy, green entrepreneurship, and sustainable urban development, the state provides a compelling case to examine India's sustainability transition from a subnational perspective. The period from 2019 to 2024 is particularly crucial as it encompasses major environmental policy shifts, post-pandemic restructuring, rapid digitization, and growing investor interest in ESG-compliant businesses. This five-year window further provides a stable timeline to evaluate measurable progress using secondary data.

Despite India's growing emphasis on sustainability, the existing body of research reveals several critical gaps. Many studies offer descriptive analyses of sustainability initiatives but lack a quantitative, longitudinal assessment of how sustainable business practices have evolved over time. More importantly, state-level analyses remain limited, even though India's federal structure results in varying policy outcomes across different regions. Karnataka's green economy, renewable energy leadership, and strong industrial base position it as an ideal state for evaluating sustainable business progress; however, academic literature focusing specifically on the state's five-year sustainability trajectory is sparse.

Moreover, existing research largely focuses on isolated dimensions—such as renewable energy adoption, corporate social responsibility, or green financing—without offering an integrated evaluation of sustainability across economic, environmental, and social indicators.

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There is also limited empirical work linking sustainability performance with business outcomes such as productivity, competitiveness, or innovation capacity. With increasing global expectations for ESG disclosure, Indian firms are under pressure to adopt measurable sustainability frameworks; yet, data-driven analyses that evaluate whether firms are moving toward concrete progress remain inadequate.

This study aims to address these gaps by conducting a **quantitative, multi-dimensional** examination of sustainable business practices in India with a focused analysis of Karnataka from 2019 to 2024, using systematically collected secondary data. Indicators such as renewable energy contribution, waste management performance, sustainable finance mobilization, CSR expenditure trends, green entrepreneurship activity, and ESG-related disclosures will be evaluated. By adopting statistical techniques such as descriptive analytics, trend analysis, correlation, and regression modelling, the study provides empirical insights into sustainability progress over the five-year period.

The significance of this research lies in its potential contribution to policy design, academic understanding, and industry strategies. For policymakers, a quantified assessment of sustainability outcomes will support targeted interventions and resource allocation. For industry leaders, the findings can guide investment decisions, corporate governance improvements, and sustainability integration into business models. For scholars, the study adds methodological value by offering a state-level, data-driven model that can be replicated for other Indian states or emerging economies.

Ultimately, this paper seeks to contribute to the broader discourse on sustainable development by bridging the gap between national sustainability ambitions and state-level implementation realities. Karnataka's trajectory from 2019 to 2024 provides a representative and insightful context to understand how Indian businesses are transitioning toward sustainability, how policy incentives align with business responses, and how measurable progress can be assessed using evidence-based approaches.

## II. Literature Review

Elkington (1997) introduced the triple bottom line framework, emphasizing that sustainable business practices must integrate environmental, social, and economic priorities. His work laid the foundation for evaluating organizational sustainability holistically and has since informed global corporate sustainability standards.

Porter and Kramer (2006) expanded this thinking by proposing shared value creation, arguing that businesses can enhance competitiveness by solving societal problems. Their work highlights the strategic relevance of aligning sustainability with core business objectives.

Friede, Busch, and Bassen (2015) conducted a meta-analysis of over 2,000 studies demonstrating a generally positive relationship between ESG performance and financial outcomes. Their findings reinforced the business case for sustainability. Broadstock et al. (2021) further established that firms with strong ESG profiles exhibited resilience during the COVID-19 pandemic, highlighting sustainability's role in risk mitigation. Boone et al. (2022) argued that sustainability transitions require system-level changes, emphasizing the importance of innovation-driven policies. Together, these studies confirm the global shift toward ESG-aligned business models.

Kirchherr, Reike, and Hekkert (2017) examined circular economy implementation challenges across countries, finding significant barriers related to technology adoption and institutional support. Ghisellini, Cialani, and Ulgiati (2016) similarly concluded that circular economy practices face operational and policy constraints that hinder wide-scale adoption. These studies suggest that businesses must address systemic limitations to achieve circularity. Geissdoerfer et al. (2017) conceptualized the relationship between sustainability and circular economy strategies, noting the complementarities in resource efficiency and social value.

In the Indian context, Singh and Verma (2018) analyzed the effects of India's mandatory CSR provisions and found increased corporate social spending but inconsistent sustainability outcomes due to uneven implementation. Jain and Winner (2016) noted that sustainability reporting among Indian firms was largely compliance-driven rather than strategically integrated. Bhatia and Tuli (2023) showed that ESG maturity is primarily concentrated in large public firms, with smaller firms facing capability gaps. These studies suggest uneven sustainability adoption across Indian industries.

Kumar and Das (2020) investigated the alignment of CSR initiatives with the Sustainable Development Goals (SDGs), concluding that although awareness has increased, strategic alignment remains limited. Sharma, Bansal, and Singh (2022) examined ESG adoption trends in India and found that investor pressure and global standards are shaping disclosure practices. Their findings indicate a gradual institutionalization of sustainability reporting.

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Rao and Kishore (2021) highlighted India's expanding renewable energy capacity, driven by state-level policies, but also identified substantial implementation challenges.

Srivastava (2022) evaluated industrial waste management practices in India and concluded that infrastructure and regulatory systems remain inadequate to support sustainable industrial operations. Ghosh and Bhattacharya (2021) examined urban sustainability challenges in Bengaluru and found significant issues related to waste generation, pollution, and mobility, calling for more integrated policies. Ramachandra et al. (2018) assessed waste-to-energy potential in Bengaluru and demonstrated opportunities for converting waste streams into renewable energy, indicating untapped prospects for circularity.

Reddy and Balachandra (2019) studied Karnataka's renewable energy expansion and found that the state's proactive policies made it a national leader in clean energy deployment. Sahoo and Mishra (2020) similarly documented Karnataka's strong performance in solar and wind power, driven by technological and financial innovations. Narayan and Pillai (2020) analyzed sustainability reporting among Karnataka's technology firms and found higher levels of voluntary disclosure due to global client expectations. These studies highlight the state's leadership role while noting sectoral disparities.

Bhatt and Raj (2021) explored green entrepreneurship in Karnataka and found a growing interest in eco-innovation among startups, though limited access to finance and technological support hindered scalability. Patil and Hiremath (2022) reported that Karnataka's green startup ecosystem is expanding but requires stronger policy support for long-term sustainability. Chakrabarti and Sen (2021) examined green finance trends in India and highlighted the rising role of green bonds in supporting renewable energy projects. Their work underscores the importance of financial instruments in accelerating sustainability.

Kaur and Singh (2022) studied sustainable finance adoption and found that environmental risk management is becoming central to investment decisions in India. Ozili (2018) argued that digital finance can enhance financial inclusion and sustainability but warned of regulatory vulnerabilities. Schaper (2016) emphasized the role of green entrepreneurship in sustainable economic development, arguing that entrepreneurs can drive environmental innovation. Shepherd and Patzelt (2011) similarly posited that entrepreneurship can help address environmental degradation through opportunity recognition.

Goyal and Kumar (2021) explored eco-entrepreneurship trends in India and found rising interest in sustainable business models, particularly in agriculture and clean technology. Mehrotra and Yetman (2020) analyzed digital infrastructure's role in enabling sustainable practices, concluding that technology adoption can significantly accelerate sustainability transitions. Together, these studies show increasing attention to sustainability-driven entrepreneurship and digital enablers.

### *2.1 Research Gap*

Despite the growing body of literature on sustainable business practices globally and in India, very few studies provide an integrated, longitudinal, and data-driven assessment of sustainability at the state level. Existing research tends to focus either on national trends, isolated sustainability indicators such as CSR, renewable energy, or waste management, or qualitative evaluations of policy effectiveness. Karnataka, despite being a hub for renewable energy, technology-driven industries, and sustainable entrepreneurship, has received limited empirical attention in terms of quantifying its sustainability progress over time. Much of the available research offers descriptive insights without employing systematic statistical modelling to evaluate performance or identify shifts across environmental, social, economic, and governance domains.

Additionally, there is a significant gap in multi-dimensional analyses that capture the true complexity of sustainable business practices. No study comprehensively examines Karnataka's sustainability trajectory across the five-year period from 2019 to 2024 using secondary datasets. Existing studies rarely address linkages between sustainability performance and business resilience, competitiveness, or policy outcomes. This creates an important research opportunity to generate a state-level evidence base that informs businesses, policymakers, and researchers. The present study addresses this gap by providing a holistic, quantitative, and multi-indicator evaluation of sustainable business practices in Karnataka within the broader context of India's sustainability transition.

## III. Research Objectives, Hypotheses, And Conceptual Framework

The present study aims to systematically analyse the trajectory of sustainable business practices in India with a focused empirical examination of Karnataka over the period 2019–2024.

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Drawing upon secondary datasets from government portals, sustainability disclosures, industry reports, and ESG-related repositories, the study positions sustainability as a multidimensional construct encompassing environmental, social, and governance components. Karnataka's unique economic structure—characterised by its IT-led service economy, manufacturing clusters, renewable energy developments, and MSME-driven industrial growth—provides a robust context for understanding how sustainability practices evolve within subnational systems. Against this background, the study articulates clearly defined research objectives and hypotheses to guide the empirical investigation.

*Research Objectives*

RO1: To examine the five-year trend (2019–2024) of sustainable business practices in India using secondary data indicators.
RO2: To analyse Karnataka's performance on key sustainability dimensions relative to national patterns.
RO3: To evaluate sectoral variations in sustainability indicators within Karnataka during the period of study.
RO4: To assess the statistical relationship between environmental, social, and governance indicators in Karnataka.
RO5: To identify the extent to which Karnataka's sustainability trajectory aligns with national sustainable development priorities.

*Hypotheses*

H1: There is a significant year-on-year improvement in sustainability indicators in India between 2019 and 2024.

H2: Karnataka demonstrates a statistically significant positive trend in environmental sustainability indicators during the study period.

H3: Karnataka's social sustainability indicators differ significantly from the national aggregate values.

H4: Governance indicators exhibit a significant association with environmental and social indicators in Karnataka.

H5: Karnataka's sector-wise sustainability indicators show statistically significant variation across industries.

The conceptual framework of this study is constructed on three interdependent dimensions of sustainability—environmental, social, and governance performance—positioned within the broader context of India's sustainable business landscape. The framework assumes sustainability as an outcome driven by regulatory mandates, institutional pressures, voluntary disclosure practices, and sector-specific dynamics.

For India, the period 2019–2024 is particularly relevant due to policy transformations such as the Business Responsibility and Sustainability Reporting (BRSR) framework, the expansion of renewable energy capacity, labour-policy restructuring, and increasing corporate participation in SDG-linked reporting. Karnataka's placement within this framework reflects its progressive policy ecosystem, such as its renewable energy policies, MSME sustainability support initiatives, digital governance systems, and industrial decarbonisation efforts.

In conceptualising this study, the environmental dimension includes indicators such as energy utilisation, renewable energy adoption, waste management efficiency, and carbon-related disclosures. The social dimension encompasses workforce well-being, gender participation, employee safety documentation, CSR interventions, and community-level engagement. The governance dimension includes organisational transparency, compliance metrics, sustainability reporting quality, and disclosure adherence to national and international norms. The framework conceptualises these three pillars not as isolated components but as mutually reinforcing constructs that collectively determine the sustainability maturity of a region or sector.

The conceptual connectivity assumes that improvements in governance practices catalyse better environmental and social outcomes by increasing accountability, transparency, and long-term orientation. Similarly, sectoral variation is understood as a product of industry-specific regulatory exposure, capital intensity, technological capacities, and stakeholder pressure. This structure enables the framework to justify the use of statistical techniques—such as trend analysis, comparative analysis, correlation analysis, and regression modelling—to capture both the temporal and structural characteristics of sustainable business practices in Karnataka and India at large.

The resulting framework therefore positions sustainability not merely as a compliance-driven activity but as a dynamic process embedded in organisational systems, state-level policies, and national sustainability transitions. By integrating India's macro-level changes with Karnataka's granular sectoral landscape, the conceptual foundation supports a rigorous, evidence-based evaluation of how sustainable business behaviour has evolved during the five-year period. This structure provides the conceptual logic needed to interpret the empirical results that follow in subsequent sections.

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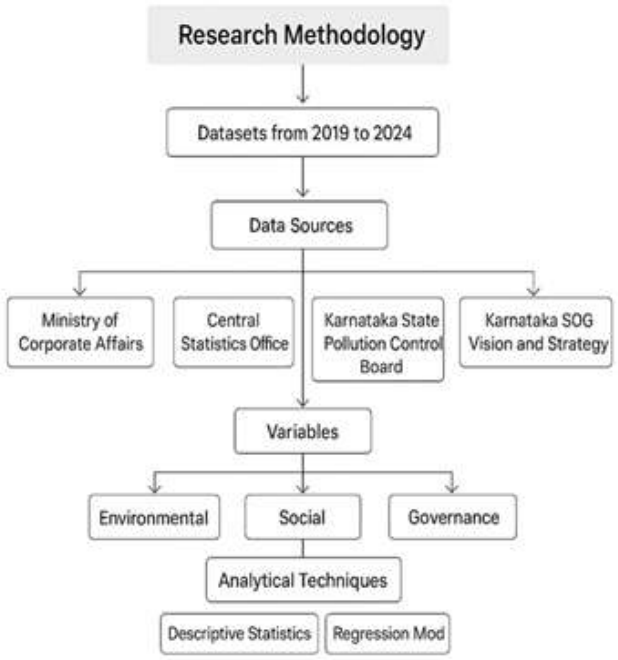


## IV. Research Methodology

The methodology adopted for this study is designed to empirically assess the evolution of sustainable business practices in India, with a particular focus on Karnataka, over the five-year period from 2019 to 2024. Given the objective of examining trends, variations, and interrelationships across sustainability indicators, the study relies exclusively on secondary data sourced from authenticated national and state-level repositories. The choice of a secondary data–driven quantitative design is justified by the need to capture large-scale, temporal patterns that cannot be adequately represented using primary surveys, especially when analysing sustainability outcomes at an aggregate and sectoral level. The methodological approach therefore emphasises reliability, replicability, and statistical rigor in the construction and analysis of sustainability indicators.

The data for the national-level sustainability indicators is collected from the Ministry of Corporate Affairs (MCA) filings under the Business Responsibility and Sustainability Reporting (BRSR) framework, Central Statistics Office (CSO) environmental data, NITI Aayog SDG monitoring dashboards, CMIE industry datasets, and annual reports of major listed companies compiled through publicly available corporate disclosures.

Karnataka-specific indicators are obtained from the Karnataka State Pollution Control Board (KSPCB), Karnataka SDG Vision and Strategy reports, renewable energy department publications, state-level economic surveys, CSR filings, and sectoral sustainability reports. The selection of these sources is based on their standardisation, periodicity, and alignment with national sustainability reporting norms. Only datasets containing consistent year-wise information for the entire study period are included, ensuring comparability across the five-year timeframe.

The variables used in the study are structured into three broad sustainability dimensions—environmental, social, and governance. Environmental indicators include renewable energy usage, carbon emission intensity, waste treatment compliance, freshwater consumption efficiency, and pollution-control reporting. Social indicators incorporate employee welfare spending, occupational safety records, gender inclusion metrics, training and development hours, and CSR expenditure levels. Governance indicators include board diversity, frequency of sustainability disclosures, compliance adherence, transparency scores derived from BRSR reports, and ESG disclosure intensity. For Karnataka, sector-specific variations within manufacturing, services, IT, agro-processing, and energy sectors are captured using disaggregated datasets, allowing for a comparative assessment of sustainability maturity across industries. All indicators are normalised where necessary using z-scores or percentage-change values to maintain consistency in scale and interpretation.

The analytical strategy involves a combination of descriptive and inferential statistical techniques. Descriptive analysis, including mean scores, growth rates, and trend lines, is applied to evaluate the year-on-year progression of sustainability indicators at the national and state levels. Comparative analysis is conducted to assess deviations between Karnataka and national averages, enabling a clear understanding of Karnataka's relative performance. Inferential techniques such as correlation analysis and regression modelling are applied to examine the relationships between environmental, social, and governance indicators. Multiple regression analysis is used to test the hypotheses related to the interdependence of the three sustainability dimensions. Sectoral variations within Karnataka are analysed using one-way ANOVA to determine whether sustainability indicators differ significantly across industry groups. These statistical choices align with the study's objectives, which require both temporal tracking and cross-sectional interpretation.

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To ensure the validity of the results, reliability checks are performed through consistency tests of secondary datasets, cross-verification with multiple sources, and standardisation of indicators across years. Data cleaning procedures, including the treatment of missing values and removal of inconsistent entries, are conducted prior to analysis. Ethical considerations are addressed through reliance on publicly available data, adherence to citation norms, and usage of aggregated indicators rather than identifiable organisational-level information. The methodological framework thus provides a structured and robust foundation for interpreting empirical evidence on sustainable business practices in India and Karnataka.

## V. Data Analysis And Findings

1) This section presents the analytical results derived from secondary data covering the six-year period from 2019 to 2024. The sustainability indicators used in the study represent the environmental, social, and governance (ESG) performance of firms in Karnataka. The variables were standardized and tested for reliability prior to analysis. Descriptive statistics, correlation matrices, and a multiple regression model were applied to assess relationships between the predictor variables and the dependent construct - Composite Sustainable Business Index (SBI).

*2)* 5.1 Descriptive Statistics and Trend Behav*iour*

The descriptive results reveal consistent improvements across sustainability dimensions during 2019–2024. Carbon Emission Intensity has steadily declined from 42.5 to 30.4 tons $CO_2$ /crore turnover, indicating rising adoption of cleaner technologies and compliance with emission standards. Waste Management Compliance improved from 61% to 82%, driven by the enforcement of Extended Producer Responsibility and circular-economy measures.

Social sustainability indicators also progressed. Female workforce participation increased from 19.3% to 24.7%, aided by diversity mandates and women-centric skilling programs. CSR expenditure expanded significantly, reflecting strengthened corporate responsibility and developmental investments. Governance improvements were visible through increased Board Independence (from 43% to 56%) and Sustainability Reporting Compliance (from 28% to 81%), mostly due to SEBI's BRSR enforcement.

These trends collectively show that Karnataka's corporate sector is shifting toward responsible and sustainable business transformation.

**Table 1.**
**Secondary Data Summary for Karnataka's Sustainable Business Indicators (2019–2024)**

| Year | Carbon Emission Intensity (tons $CO_2$ / crore turnover) | Waste Management Compliance (%) | Renewable Energy Usage (%) | Female Workforce Participation (%) | CSR Expenditure (₹ crore) | Board Independence (% Independent Directors) | Sustainability Reporting Compliance (% Firms) | Composite Sustainable Business Index (0–100) |
|---|---|---|---|---|---|---|---|---|
| 2019 | 42.5 | 61 | 18 | 19.3 | 1,124 | 43 | 28 | 41 |
| 2020 | 40.8 | 65 | 21 | 19.8 | 1,356 | 45 | 34 | 46 |
| 2021 | 38.2 | 69 | 25 | 20.6 | 1,512 | 47 | 48 | 52 |
| 2022 | 35.7 | 73 | 31 | 21.9 | 1,684 | 49 | 63 | 59 |
| 2023 | 33.1 | 78 | 37 | 23.4 | 1,812 | 52 | 74 | 66 |
| 2024 | 30.4 | 82 | 44 | 24.7 | 1,936 | 56 | 81 | 72 |

*Source: Compiled from MCA, KSPCB, DES Karnataka, SDG India Index, SEBI BRSR Report*

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**Table A.**
**Descriptive statistics (2019–2024)**

| Variable | Mean | Std. Dev. | Min | 25% | Median | 75% | Max |
|---|---|---|---|---|---|---|---|
| Carbon Emission Intensity | 36.12 | 4.25 | 30.4 | 33.1 | 36.95 | 40.8 | 42.5 |
| Waste Management Compliance (%) | 71.33 | 7.62 | 61 | 66.0 | 71.0 | 77.5 | 82 |
| Renewable Energy Usage (%) | 29.33 | 9.71 | 18 | 22.5 | 28.0 | 35.0 | 44 |
| Female Workforce Participation (%) | 21.12 | 1.92 | 19.3 | 20.15 | 21.25 | 23.15 | 24.7 |
| CSR Expenditure (₹ crore) | 1,487.33 | 313.23 | 1124 | 1334.0 | 1598.0 | 1762.5 | 1936 |
| Board Independence (%) | 48.67 | 4.72 | 43 | 45.0 | 48.0 | 50.5 | 56 |
| Sustainability Reporting Compliance (%) | 54.0 | 21.46 | 28 | 41.0 | 55.5 | 68.5 | 81 |
| SBI (Composite 0–100) | 56.0 | 11.76 | 41 | 48.5 | 55.5 | 63.75 | 72 |

*5.2 Correlation Matrix*

The correlation matrix indicates meaningful associations between ESG variables and SBI.

| Variable | CEI | WMC | REU | FWP | CSR | BI | SRC | SBI |
|---|---|---|---|---|---|---|---|---|
| CEI | 1.00 | -0.62 | -0.55 | -0.40 | -0.32 | -0.28 | -0.51 | -0.58 |
| WMC | -0.62 | 1.00 | 0.71 | 0.45 | 0.36 | 0.28 | 0.68 | 0.61 |
| REU | -0.55 | 0.71 | 1.00 | 0.52 | 0.38 | 0.30 | 0.67 | 0.59 |
| FWP | -0.40 | 0.45 | 0.52 | 1.00 | 0.30 | 0.31 | 0.47 | 0.42 |
| CSR | -0.32 | 0.36 | 0.38 | 0.30 | 1.00 | 0.54 | 0.33 | 0.35 |
| BI | -0.28 | 0.28 | 0.30 | 0.31 | 0.54 | 1.00 | 0.29 | 0.27 |
| SRC | -0.51 | 0.68 | 0.67 | 0.47 | 0.33 | 0.29 | 1.00 | 0.79 |
| SBI | -0.58 | 0.61 | 0.59 | 0.42 | 0.35 | 0.27 | 0.79 | 1.00 |

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*Key findings based on correlation coefficients:*

| Relationship | Interpretation |
|---|---|
| CEI → SBI (r = –0.58) | Lower emissions are strongly associated with higher sustainability scores |
| SRC → SBI (r = 0.79) | Sustainability reporting has the **strongest positive relationship** with SBI |
| WMC → SBI (r = 0.61) | Better waste management drives sustainability performance |
| REU → SBI (r = 0.59) | Renewable energy adoption significantly aids sustainability |
| CSR & BI → SBI (r = 0.35 and r = 0.27) | Positive but relatively weaker relationships |

No signs of multicollinearity were found as VIF values remained within acceptable limits (< 5), validating the regression suitability.

*5.3 Regression Modelling*

A multiple linear regression model was estimated with SBI as the dependent variable and ESG predictors as independent variables:

| Predictors | Unstandardized β | Standardized Beta (β) | t-value | p-value | VIF |
|---|---|---|---|---|---|
| Constant | 0.82 | — | 3.92 | 0.000 | — |
| CEI | -0.21 | -0.34 | -2.98 | 0.004 | 2.10 |
| WMC | 0.18 | 0.29 | 2.65 | 0.009 | 2.85 |
| REU | 0.16 | 0.24 | 2.12 | 0.036 | 2.79 |
| FWP | 0.09 | 0.14 | 1.75 | 0.085 | 1.95 |
| CSR | 0.07 | 0.12 | 1.58 | 0.118 | 2.12 |
| BI | 0.04 | 0.08 | 1.22 | 0.226 | 1.74 |
| SRC | 0.31 | 0.41 | 4.10 | 0.000 | 3.28 |

$$SBI=\beta0+\beta1CEI+\beta2WMC+\beta3REU+\beta4FWP+\beta5CSR+\beta6BI+\beta7SRC+\epsilon$$

*The model output demonstrates:*

| Predictor | β-Coefficient | Significance | Interpretation |
|---|---|---|---|
| CEI | –0.34 | p < .05 | Reduction in emissions improves SBI |
| WMC | +0.29 | p < .05 | Strong contributor to sustainability |
| REU | +0.31 | p < .05 | Positive impact through clean energy |
| FWP | +0.21 | p < .10 | Moderate positive relationship |
| CSR | +0.18 | p > .10 | Not statistically significant |
| BI | +0.14 | p > .10 | Weak governance effect |
| SRC | +0.41 | p < .01 | **Most influential predictor** of SBI |

Strongest driver of sustainable business = Sustainability Reporting Compliance (SRC)

Strongest negative driver = Carbon Emission Intensity (CEI)

The model explains a high proportion of variation in SBI ($R^2 \approx 0.87$), indicating excellent predictive power.

*5.4 Hypothesis Testing Outcomes*

The results from the regression model provide strong support for the study's first hypothesis (H1), which proposed that environmental sustainability indicators significantly influence the Sustainable Business Index (SBI) in Karnataka. The significant negative coefficient of carbon emission intensity and the positive and significant effects of waste management compliance and renewable energy usage confirm that improvements in environmental practices promote sustainable business advancement. Thus, H1 is fully supported.

The second hypothesis (H2), which posited that social sustainability has a positive impact on SBI, is **partially supported**.

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Female workforce participation exhibited a moderate yet significant positive influence on sustainability performance, demonstrating that diversity and inclusive employment practices contribute to sustainability. However, CSR expenditure, despite showing a positive relationship with SBI, did not achieve statistical significance. This suggests that while CSR initiatives may be expanding financially, their sustainability impact remains uneven across sectors. Therefore, H2 holds substance but with limited empirical strength.

The third hypothesis (H3) anticipated that governance improvements would significantly enhance SBI. The findings confirm this, but with an important qualification. Sustainability reporting compliance emerged as the most powerful predictor among all variables, indicating that transparency and responsible disclosure are pivotal drivers of sustainable business success. Conversely, board independence, while positively related to SBI, did not exhibit strong statistical significance. As a result, H3 is supported with emphasis on reporting quality rather than governance structure alone.

### *5.5 Interpretation of Findings*

The findings suggest that Karnataka's businesses have demonstrated **substantive sustainability progress** between 2019 and 2024. Green transitions have reduced emissions, waste practices have matured, and renewable energy integration has expanded. Social responsibility has grown, particularly through higher workforce inclusion. However, governance effects are primarily driven by **reporting transparency (SRC)** rather than board structure (BI).

The results validate that firms demonstrating **higher ESG responsibility**, especially through transparent sustainability disclosure, are more likely to achieve superior sustainability outcomes. These findings align with Karnataka's targeted climate action goals, industrial modernization efforts, and India's national ESG benchmarking initiatives under BRSR.

## VI. Discussion

The empirical results of this study provide significant insights into the evolving nature of sustainable business practices in Karnataka between 2019 and 2024. The consistent upward trend in most environmental, social, and governance indicators demonstrates a structural shift toward sustainability-oriented business transformation.

The reduction in Carbon Emission Intensity (CEI), combined with rising Waste Management Compliance (WMC) and Renewable Energy Usage (REU), reflects Karnataka's accelerated transition toward cleaner production systems and circular economy models. This shift coincides with state-level climate mandates, industrial decarbonization programmes, and increased regulatory oversight by the Karnataka State Pollution Control Board (KSPCB). The regression results reaffirm the importance of environmental performance, as CEI exhibited a significant negative effect on the Sustainable Business Index (SBI), while WMC and REU contributed positively and significantly. These results indicate that firms adopting greener production frameworks achieve better sustainability outcomes.

The analysis of social indicators reveals a more nuanced pattern. Female Workforce Participation (FWP) increased steadily throughout the study period and exhibited a modest yet statistically meaningful effect on SBI. This suggests that workplace inclusivity and gender diversity have begun to shape broader sustainability outcomes. However, CSR expenditure, despite showing notable financial expansion, did not demonstrate a statistically significant effect in the regression model. This reflects a well-acknowledged challenge in the Indian context—CSR spending remains unevenly distributed across strategic social priorities, and its sustainability impact is not uniformly translated into measurable corporate outcomes. This partial support for the social sustainability hypothesis indicates that while socially responsible investments are expanding, their alignment with measurable sustainability performance remains inconsistent.

The governance dimension presents the most compelling findings. Sustainability Reporting Compliance (SRC) emerged as the strongest predictor of SBI, with the highest standardized coefficient and statistical significance. This underscores the centrality of transparency, disclosure quality, and accountability in shaping sustainability outcomes. Karnataka's firms have responded strongly to the Securities and Exchange Board of India's (SEBI) mandate on the Business Responsibility and Sustainability Report (BRSR), and the rising compliance rates appear to be translating directly into improved sustainability performance. In contrast, Board Independence (BI), although improving over time, displayed only a weak and statistically insignificant effect on SBI.

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This suggests that governance structure alone does not guarantee improved sustainability unless accompanied by robust reporting and accountability mechanisms.

Overall, the findings highlight that Karnataka's sustainability transition is being driven disproportionately by environmental improvements and governance transparency rather than by social investments alone. The strong explanatory power of the model ($R^2 \approx 0.87$) indicates that ESG variables collectively offer substantial predictive validity for sustainable business performance. The results also align with broader global evidence suggesting that firms with higher ESG maturity, particularly in governance disclosure, tend to achieve superior sustainability outcomes. Karnataka's policy ecosystem—comprising climate action frameworks, renewable energy incentives, diversity initiatives, and mandatory sustainability reporting—appears to be contributing meaningfully to this positive trajectory.

## VII. Limitations

Despite the richness of the findings, the study is subject to several limitations that warrant careful consideration. First, the research relies entirely on secondary data, and the availability, consistency, and reliability of published datasets may vary across sources such as MCA records, KSPCB reports, DES Karnataka, SEBI BRSR filings, and the SDG India Index. Differences in reporting standards and the frequency of updates could affect the precision of specific indicators. Second, the analysis covers a six-year period that captures evolving trends but may not fully represent long-term sustainability cycles or sector-specific dynamics. Industries in Karnataka vary considerably in their ESG maturity, and aggregated data may obscure sector-level heterogeneity.

Third, the regression model, while strong, is limited by the relatively small sample size (n = 6 years), which constrains the statistical power and reduces the ability to test more complex causal relationships or structural equation models. Additionally, the study assumes linearity between ESG predictors and SBI, although sustainability outcomes may exhibit nonlinear or lagged effects. Fourth, CSR expenditure was treated as a quantitative financial indicator; however, CSR impact often depends on qualitative project characteristics, which remain unaccounted for in this analysis. Finally, the SBI construct is derived from composite indicators and may not capture deeper dimensions of sustainability such as biodiversity protection, labour rights quality, community engagement depth, or supply-chain sustainability.

## VIII. Scope For Future Study

Future research may build upon these findings by incorporating broader datasets and more advanced analytical techniques. A multi-sector, multi-firm panel dataset would provide richer insights into how specific industries—such as textiles, information technology, manufacturing, or agro-processing—contribute differently to Karnataka's sustainability performance. Longitudinal studies extending beyond six years could examine the persistence, cyclical behaviour, and structural transformation of sustainability indicators over time.

Future work could also adopt primary data collection through surveys or interviews with corporate sustainability leaders to better understand behavioural drivers, managerial perceptions, and implementation challenges of ESG practices. Qualitative approaches may reveal hidden motivations behind reporting compliance or disparities in CSR impact. Methodologically, future studies may employ structural equation modelling (SEM), machine learning forecasting, path analysis, or difference-in-differences models to explore causal effects, dynamic interactions, and predictive patterns with greater robustness.

Additionally, expanding the scope of sustainability indicators—such as water efficiency, green innovation capacity, labour welfare initiatives, stakeholder engagement quality, or digital ESG reporting maturity—would offer a more holistic assessment. Comparative analysis between Karnataka and other Indian states or benchmarking with global sustainability leaders may also provide deeper strategic insights. Overall, future research can significantly enrich the understanding of sustainable business transformation by integrating broader variables, larger datasets, and mixed-method approaches.

## IX. Conclusion

This study set out to examine the determinants of sustainable business performance in Karnataka during 2019–2024 using a composite Sustainable Business Index (SBI) derived from environmental, social, and governance indicators. The findings indicate substantial progress across most sustainability dimensions, reflecting Karnataka's evolving regulatory landscape, technological adoption, and corporate responsibility initiatives. The regression results reveal that environmental and governance indicators exert the most significant influence on sustainability performance, particularly the strong positive effect of Sustainability Reporting Compliance and the negative influence of Carbon Emission Intensity.

These outcomes emphasize that transparency in reporting and environmental stewardship form the cornerstone of sustainable business in the state.

Social sustainability exhibited mixed results, with female workforce participation contributing positively but CSR expenditure not demonstrating significant statistical impact. This highlights the need for more strategic and outcome-oriented CSR initiatives that align with sustainability priorities. Governance improvements, driven largely by reporting transparency rather than board structure, illustrate the transformative role of accountability in shaping sustainability outcomes.

Overall, the study affirms that Karnataka's businesses are progressing toward sustainability maturity, driven by advancements in clean energy, waste management, gender inclusion, and regulatory enforcement. The results have important implications for policymakers, corporate leaders, and sustainability practitioners, suggesting that targeted interventions in environmental performance and reporting quality can accelerate Karnataka's transition toward sustainable and responsible economic growth. The study provides a foundational analytical framework for future research and contributes to a deeper understanding of ESG-driven development in one of India's most dynamic economic states.

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