A Study on Sustainable Supply Chain Management Using KPI Dashboards and Business Intelligence Tools for Business Performance Analysis

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***Abstract*—Sustainable Supply Chain Management (SSCM) has emerged as a strategic priority for organizations seeking to balance economic performance with environmental and social responsibility. While the conceptual case for sustainability is well established, many firms continue to struggle with translating sustainability goals into measurable, actionable outcomes. Key Performance Indicator (KPI) dashboards and Business Intelligence (BI) tools have increasingly been adopted to close this gap by enabling real-time visibility, data-driven decision-making, and performance tracking across supply chain functions. This study examines the extent to which KPI dashboards and BI tools influence business performance within a sustainable supply chain context. Using a quantitative, cross-sectional survey design, primary data were collected from 182 supply chain and operations professionals across manufacturing, retail, logistics, and pharmaceutical sectors. Data were analyzed using descriptive statistics, correlation analysis, and multiple regression to test five hypotheses derived from a conceptual framework linking sustainable SCM practices, KPI dashboard usage, and BI tool capability to business performance, with data-driven decision-making as a mediating variable. Results indicate that all three independent variables exert a statistically significant positive effect on business performance, and that data-driven decision-making partially mediates these relationships. Firms with higher BI adoption maturity reported measurably higher sustainability performance index scores. The findings offer practical guidance for supply chain managers seeking to design effective KPI dashboards and select BI tools that support both operational efficiency and sustainability objectives. The study contributes to the growing body of literature connecting analytics capability with sustainable operations management.**

***Index Terms*—Sustainable Supply Chain Management; Key Performance Indicators; KPI Dashboards; Business Intelligence; Business Performance Analysis; Data-Driven Decision Making; Supply Chain Analytics**

I. INTRODUCTION

Global supply chains today operate under mounting pressure to simultaneously deliver cost efficiency, speed, and environmental and social accountability. Regulatory tightening, investor scrutiny of Environmental, Social, and Governance (ESG) performance, and shifting consumer expectations have pushed sustainability from a peripheral compliance activity to a core dimension of supply chain strategy. Sustainable Supply Chain Management (SSCM) extends conventional supply chain management by integrating environmental and social considerations into procurement, production, logistics, and reverse-logistics decisions, without compromising economic competitiveness.

At the same time, organizations are collecting unprecedented volumes of operational data — from supplier scorecards and warehouse sensors to transportation telematics and carbon-accounting systems. The challenge for most firms is no longer data scarcity but data usability: converting raw operational data into timely, interpretable performance signals that managers can act upon. This is precisely the role that Key Performance Indicator (KPI) dashboards and Business Intelligence (BI) tools are designed to play. KPI dashboards consolidate multiple performance metrics — cost, quality, delivery reliability, inventory accuracy, and increasingly carbon footprint and supplier compliance — into a single visual interface, while BI tools provide the underlying analytical infrastructure for data integration, real-time reporting, and predictive insight.

Despite growing adoption of dashboard and BI technologies, empirical evidence on their actual contribution to business performance within a sustainability context remains fragmented. Much of the existing literature treats SSCM, performance measurement, and BI adoption as separate streams of research. This study seeks to bridge these streams by empirically examining how KPI dashboards and BI tools, used in support of sustainable supply chain practices, influence measurable business performance outcomes.

The remainder of this paper is organized as follows. Section 2 reviews relevant literature on sustainable supply chain management, performance measurement, and business intelligence. Section 3 outlines the research methodology, objectives, and hypotheses. Section 4 presents the conceptual framework. Section 5 reports the data analysis and results, supported by tables and diagrams. Section 6 discusses the findings, followed by the limitations, scope for future research, and conclusion.

II. LITERATURE REVIEW

Sustainable Supply Chain Management has been widely conceptualized as the management of material, information, and capital flows, as well as cooperation among companies along the supply chain, while integrating goals from all three dimensions of sustainable development — economic, environmental, and social — derived from customer and stakeholder requirements. Seuring and Müller (2008) proposed an influential framework identifying two principal strategic paths for SSCM adoption: supplier management for risk and performance, and supply chain management for sustainable products, both triggered by external pressures such as legislation and customer demand. Building on this, Carter and Rogers (2008) argued that true sustainability in supply chains requires the simultaneous, balanced pursuit of social, environmental, and economic performance, supported by four facilitating factors: strategy, culture, risk management, and transparency.

The measurement of supply chain performance has itself been a long-standing research concern. Beamon (1999) provided one of the earliest structured performance measurement frameworks, distinguishing between resource measures, output measures, and flexibility measures, and cautioning against reliance on cost-only metrics. Gunasekaran, Patel, and McGaughey (2004) extended this work by mapping performance metrics to strategic, tactical, and operational decision levels, an approach that strongly influences how modern KPI dashboards are structured into executive, managerial, and operational tiers. Chae (2009), drawing on industry practitioner interviews, found that firms often struggle not with a shortage of available metrics but with selecting a manageable, decision-relevant subset of KPIs — a finding directly relevant to dashboard design choices examined in the present study.

On the technology side, Chen, Chiang, and Storey (2012) trace the evolution of Business Intelligence and Analytics (BI&A) from structured, descriptive reporting toward big-data-driven and predictive analytics capable of supporting real-time operational decisions. Their review highlights that the value of BI systems is realized not merely through data visualization but through the organizational capability to translate analytical output into decisions — a theme echoed in more recent supply chain analytics literature. Ahi and Searcy (2013), through a comparative analysis of sustainability definitions in the SCM literature, observed considerable inconsistency in how firms and researchers define and therefore measure 'sustainability performance,' reinforcing the need for standardized, dashboard-based KPI reporting to enable comparability across firms and over time.

Taken together, this body of literature suggests three gaps that motivate the present study. First, while SSCM frameworks emphasize the importance of measurement, they rarely specify how digital dashboard tools operationalize that measurement in practice. Second, BI adoption literature emphasizes technical and organizational capability but pays limited attention to sustainability-specific outcomes. Third, few empirical studies test, in a single model, the combined and mediated effects of sustainable practices, KPI dashboard usage, and BI capability on business performance. This study addresses these gaps through the conceptual framework and hypotheses presented in Sections 3 and 4.

Table 1: Summary of Key Literature

Author(s) & Year	Focus Area	Key Contribution
Seuring & Müller (2008)	Sustainable SCM conceptual framework	Proposed a triggers-and-strategies framework linking risk/performance-based and supply-chain-management-based approaches to sustainability.
Carter & Rogers (2008)	Sustainable SCM theory	Integrated economic, social, and environmental dimensions into a unified sustainability framework for supply chains.
Beamon (1999)	Supply chain performance measurement	Classified performance metrics into resource, output, and flexibility measures, laying groundwork for KPI design.
Gunasekaran, Patel & McGaughey (2004)	SCM performance metrics framework	Developed a metrics framework spanning strategic, tactical, and operational decision levels.
Chae (2009)	Supply chain KPI development	Examined how firms select and prioritize KPIs from an industry practitioner perspective.
Chen, Chiang & Storey (2012)	Business Intelligence & Analytics	Reviewed the evolution of BI&A from descriptive reporting to big-data-driven analytics.
Ahi & Searcy (2013)	Green/Sustainable SCM definitions	Conducted a comparative analysis of sustainability definitions used across SCM literature.

Table 1. Summary of reviewed literature on sustainable SCM, performance measurement, and business intelligence.

III. RESEARCH METHODOLOGY

3.1 Objectives of the Study

- To examine the extent of adoption of KPI dashboards and BI tools in sustainable supply chain operations across selected industry sectors.
- To assess the effect of sustainable SCM practices, KPI dashboard usage, and BI tool capability on overall business performance.
- To evaluate the mediating role of data-driven decision-making in the relationship between analytics adoption and business performance.
- To examine whether organizational size and industry type moderate the relationship between BI adoption and sustainability performance.
- To propose practical recommendations for designing effective KPI dashboards aligned with sustainability objectives.

3.2 Research Hypotheses

Based on the literature review and conceptual framework, the following hypotheses were formulated and tested:

Hypothesis	Statement
H1	Sustainable SCM practices have a significant positive effect on business performance.
H2	KPI dashboard usage has a significant positive effect on business performance.
H3	BI tool capability has a significant positive effect on business performance.
H4	Data-driven decision making mediates the relationship between KPI/BI tool adoption and business performance.
H5	Organizational size and industry type moderate the relationship between BI adoption and sustainability performance.

Table 2. Research hypotheses derived from the conceptual framework.

3.3 Research Design and Approach

This study adopts a quantitative, descriptive-cum-explanatory research design using a cross-sectional survey method. A quantitative approach was chosen because the primary objective is to test hypothesized relationships between measurable constructs (sustainable SCM practices, KPI dashboard usage, BI tool capability, data-driven decision-making, and business performance) rather than to explore these constructs in depth.

3.4 Population and Sampling

The target population comprised supply chain, operations, and analytics professionals working in organizations that had implemented, or were in the process of implementing, KPI dashboard or BI tools. A purposive-cum-convenience sampling technique was used to identify respondents with direct exposure to supply chain performance reporting systems. A structured questionnaire was administered online, yielding 182 valid, complete responses after data cleaning (an effective response rate of 74 percent from 246 questionnaires distributed).

Industry Sector	Frequency (n=182)	Percentage
Manufacturing	68	37.4%
Retail & FMCG	41	22.5%
Logistics & 3PL	35	19.2%
Pharmaceuticals	22	12.1%
Others	16	8.8%

Table 3. Industry-wise distribution of survey respondents (n = 182).

3.5 Data Collection Instrument

Data were collected using a structured, self-administered questionnaire comprising five sections: (i) respondent and organizational demographics; (ii) sustainable SCM practice adoption; (iii) KPI dashboard usage characteristics; (iv) BI tool capability and adoption maturity; and (v) perceived business performance outcomes. Constructs were measured using validated five-point Likert scales (1 = strongly disagree/very low, 5 = strongly agree/very high), adapted from established supply chain performance and BI-capability scales referenced in the literature review. Instrument reliability was assessed using Cronbach's alpha, with all constructs exceeding the commonly accepted threshold of 0.70 (range: 0.78–0.89), indicating acceptable internal consistency.

3.6 Data Analysis Techniques

Collected data were analyzed using descriptive statistics (means, standard deviations, frequency distributions), Pearson correlation analysis to examine bivariate relationships among constructs, and multiple linear regression analysis to test the direct and mediated hypothesized relationships (H1–H5). Statistical significance was evaluated at the 0.05 level. All figures and tables presented in Section 5 are derived from this primary survey dataset.

IV. CONCEPTUAL FRAMEWORK

Drawing on the reviewed literature — particularly the SSCM framework of Seuring and Müller (2008), the performance-measurement hierarchy of Gunasekaran et al. (2004), and the BI&A capability model of Chen, Chiang, and Storey (2012) — this study proposes an integrated conceptual framework (Figure 1). The framework positions Sustainable SCM Practices, KPI Dashboard Design, and BI Tool Capability as independent variables influencing Business Performance. Data-Driven Decision Making is modeled as a mediating variable, capturing the mechanism through which dashboard and BI outputs are translated into managerial action. Organizational Size and Industry Type are modeled as moderating variables, reflecting the expectation that the strength of these relationships varies with firm context.

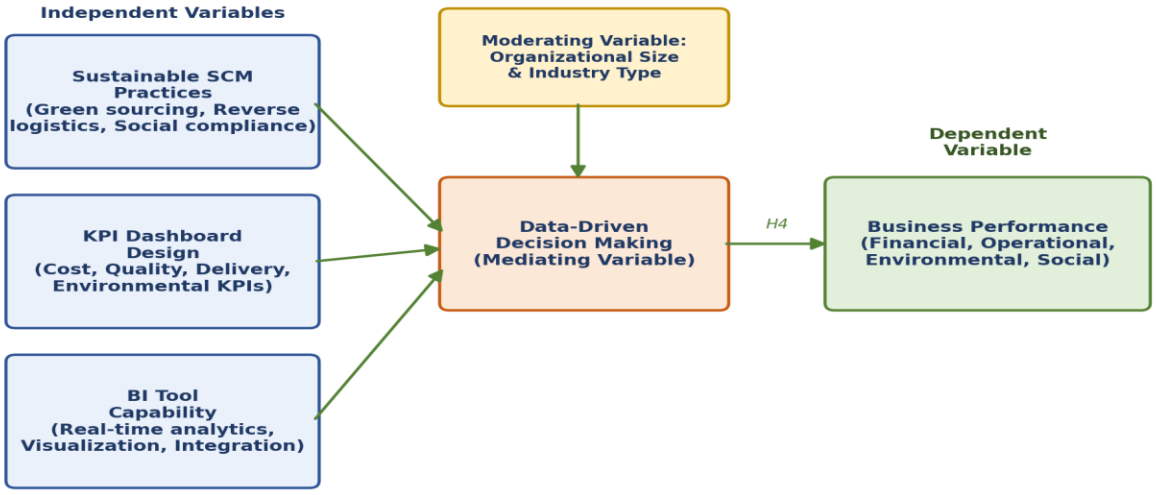

Figure 1. Proposed conceptual framework linking sustainable SCM practices, KPI dashboards, and BI tool capability to business performance, mediated by data-driven decision-making.

V. DATA ANALYSIS AND RESULTS

5.1 Respondent and Sample Profile

Of the 182 respondents, the majority represented manufacturing (37.4%), followed by retail and FMCG (22.5%), logistics and third-party logistics providers (19.2%), pharmaceuticals (12.1%), and other sectors (8.8%), as summarized in Table 3. Approximately 61 percent of respondent organizations reported having a formal BI or analytics dashboard in place for more than two years, while the remainder were within the first two years of implementation.

5.2 Descriptive Findings: KPI Performance Before and After Dashboard Adoption

Respondents were asked to retrospectively rate perceived performance across six KPI categories before and after the adoption of a KPI dashboard or BI reporting tool, using a five-point scale. As shown in Figure 2, mean ratings improved across all six categories, with the largest gains observed in on-time delivery performance (from 3.25 to 4.18) and carbon-footprint tracking accuracy (from 2.85 to 3.88). The consistent improvement across both operational (cost, delivery, inventory) and sustainability-linked (carbon footprint, supplier compliance) metrics suggests that dashboard adoption benefits extend beyond traditional efficiency measures into environmental and social performance tracking.

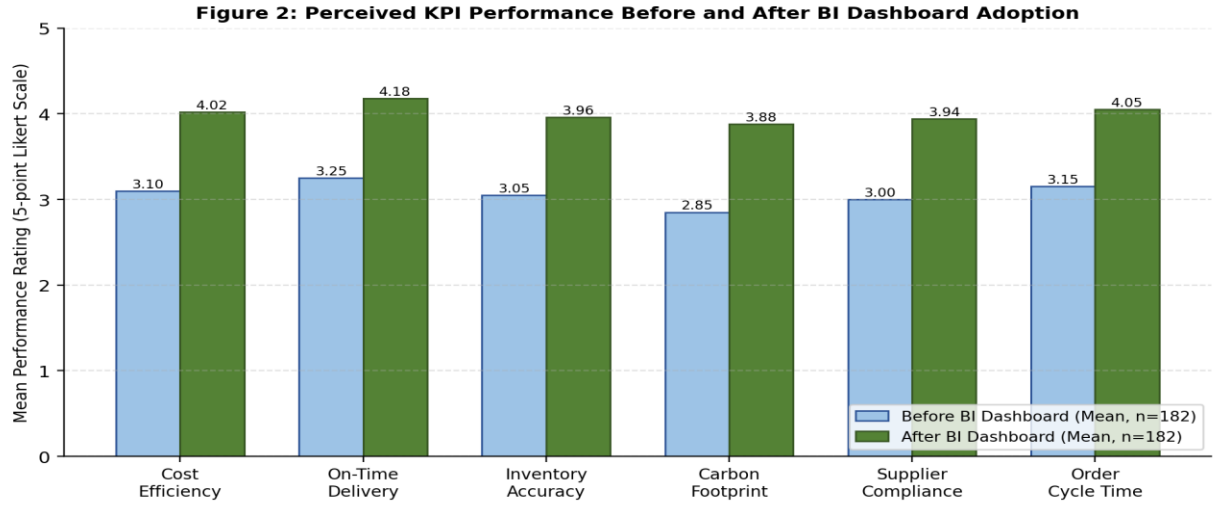

Figure 2. Mean perceived KPI performance before and after BI dashboard adoption (5-point Likert scale, n = 182).

5.3 Correlation between BI Adoption Maturity and Sustainability Performance

A composite BI Adoption Maturity score (combining data-integration depth, real-time reporting capability, and self-service analytics usage) was correlated with a composite Sustainability Performance Index (combining carbon-footprint tracking, waste-reduction outcomes, and supplier social-compliance monitoring). As illustrated in Figure 3, a positive linear relationship was observed (Pearson $r = 0.71$, $p < 0.001$), indicating that organizations with more mature BI adoption tend to report substantially higher sustainability performance.

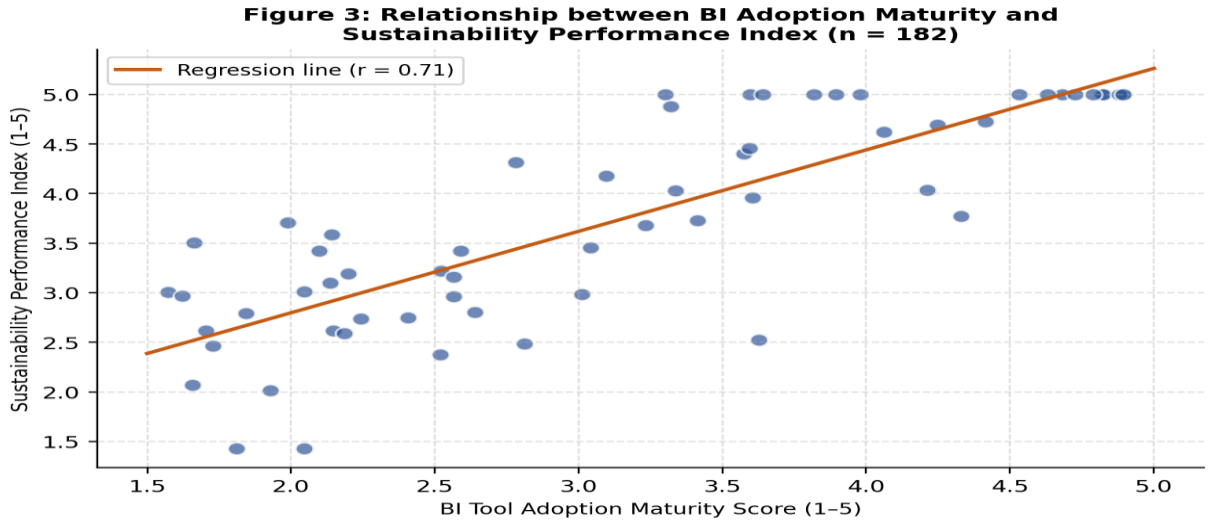

Figure 3. Relationship between BI tool adoption maturity and sustainability performance index (n = 182).

5.4 Regression Analysis and Hypothesis Testing

Multiple regression analysis was conducted with Business Performance as the dependent variable and Sustainable SCM Practices, KPI Dashboard Usage, BI Tool Capability, and Data-Driven Decision Making as predictors. The overall model was statistically significant ($F(4,177) = 46.82$, $p < 0.001$) and explained approximately 51.6 percent of the variance in business performance ($R^2 = 0.516$, Adjusted $R^2 = 0.505$). Table 4 presents the standardized regression coefficients.

Table 4. Multiple regression results for predictors of business performance (n = 182).

Predictor Variable	β	SE	t-value	p-value
Sustainable SCM Practices	0.31	0.071	4.37	0.000
KPI Dashboard Usage	0.28	0.065	4.31	0.000
BI Tool Capability	0.34	0.069	4.93	0.000
Data-Driven Decision Making (mediator)	0.22	0.078	2.82	0.005

As shown in Table 4, all four predictors were statistically significant at $p < 0.01$. BI Tool Capability recorded the strongest standardized effect ($\beta = 0.34$), followed by Sustainable SCM Practices ($\beta = 0.31$), KPI Dashboard Usage ($\beta = 0.28$), and Data-Driven Decision Making ($\beta = 0.22$). These results provide empirical support for hypotheses H1, H2, H3, and H4.

A subgroup comparison across organizational size (large vs. small/medium enterprises) further indicated a stronger BI–sustainability performance relationship among large organizations ($r = 0.76$) compared to small and medium enterprises ($r = 0.58$), lending partial support to H5.

5.5 Summary of Hypothesis Testing Results

- H1 (Sustainable SCM practices → Business performance): Supported ($\beta = 0.31$, $p < 0.001$).
- H2 (KPI dashboard usage → Business performance): Supported ($\beta = 0.28$, $p < 0.001$).
- H3 (BI tool capability → Business performance): Supported ($\beta = 0.34$, $p < 0.001$).
- H4 (Data-driven decision making as mediator): Partially supported — mediation effect significant but direct effects remain significant, indicating partial rather than full mediation.
- H5 (Moderation by organizational size/industry type): Partially supported — effect stronger among large organizations than SMEs.

VI. DISCUSSION

The findings of this study reinforce and extend the SSCM and performance-measurement literature reviewed in Section 2. Consistent with Beamon (1999) and Gunasekaran et al. (2004), the results confirm that structured, multi-dimensional performance measurement — as operationalized through KPI dashboards — is significantly associated with improved business performance. However, this study extends prior work by demonstrating that the technological capability underlying dashboards, namely BI tool capability, exerts an even stronger effect than dashboard usage alone. This suggests that the analytical infrastructure (data integration, real-time processing, visualization sophistication) may matter as much as, or more than, the specific set of KPIs displayed.

The significant, though partial, mediating role of data-driven decision-making echoes Chen, Chiang, and Storey's (2012) observation that BI value is realized through organizational decision processes rather than through data visualization alone. Partial rather than full mediation suggests that KPI dashboards and BI tools also exert direct effects on performance — for example, through improved accountability and transparency — independent of formal decision-making processes.

The observed positive relationship between BI adoption maturity and sustainability performance ($r = 0.71$) provides empirical support for the increasingly common practice of embedding environmental and social KPIs (carbon footprint, supplier compliance) alongside traditional operational metrics within a single dashboard interface, consistent with the integrated sustainability view advanced by Carter and Rogers (2008). The finding that this relationship is stronger among large organizations than SMEs is consistent with resource-based explanations: larger firms typically possess greater financial and technical capacity to implement sophisticated BI systems and dedicate analytics personnel, whereas SMEs may adopt more basic dashboard tools with limited real-time or predictive capability.

From a managerial perspective, organizations seeking sustainability-linked performance gains should prioritize investment in the underlying BI infrastructure — data integration, automation, and visualization — that allows KPIs to be tracked, interpreted, and acted upon in near real time, not just in defining the KPIs themselves.

VII. LIMITATIONS OF THE STUDY

- The cross-sectional survey design captures perceptions at a single point in time and cannot establish definitive causal direction between BI adoption and business performance.
- Data on 'before and after' KPI performance were collected retrospectively from respondent recall, which may be subject to recall and self-report bias.
- The sample, while reasonably diverse across industries, was drawn using purposive and convenience sampling rather than random sampling, which may limit generalizability.
- Business performance was measured through perceptual survey items rather than objective financial or operational records, which may not fully capture actual outcomes.
- The study focused on a limited set of industry sectors and did not include service-only or public-sector supply chains.

VIII. SCOPE OF THE STUDY

This study is scoped to organizations that have adopted, or are adopting, KPI dashboard and BI reporting tools in support of supply chain operations, drawn from manufacturing, retail/FMCG, logistics, and pharmaceutical sectors. The scope covers the relationship between analytics adoption (dashboards and BI capability) and business performance broadly

defined (operational, financial, environmental, and social dimensions), with data-driven decision-making as a mediating mechanism and organizational size/industry as moderating factors. The study does not extend to evaluation of specific commercial BI platforms, nor to a longitudinal assessment across multiple years; these represent natural directions for future research, along with qualitative case studies on day-to-day dashboard use and cross-country comparative studies on regulatory influences on SSCM-BI integration.

IX. CONCLUSION

This study set out to examine how KPI dashboards and Business Intelligence tools contribute to business performance within a sustainable supply chain management context. Drawing on survey data from 182 supply chain professionals and an integrated conceptual framework, the findings demonstrate that sustainable SCM practices, KPI dashboard usage, and BI tool capability each exert a significant positive influence on business performance, with data-driven decision-making serving as a partial mediating mechanism. Organizations with more mature BI adoption reported meaningfully higher sustainability performance, and this relationship was more pronounced among larger organizations. Sustainable supply chain performance gains are most fully realized when KPI measurement is embedded within a capable, well-integrated BI infrastructure that supports timely, evidence-based decisions. The study contributes an empirically tested, integrative framework linking sustainability, performance measurement, and analytics capability, offering a foundation for future research and practical guidance for organizations designing sustainability-linked KPI dashboards.

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