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Sustainable HRM, Circular Economy Orientation, Green Supply Chain Integration, and Triple Bottom Line Performance: A Cross-Rater Study of Manufacturing Firms in Seven Emerging Economies

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Abstract

This study examines whether sustainable human resource management (SHRM) is associated with triple bottom line (TBL) performance through circular economy orientation (CEO) and green supply chain integration (GSCI) in manufacturing firms in emerging economies. Drawing on the natural-resource-based view, stakeholder theory, and institutional theory, CEO and GSCI are conceptualized as sequential sustainability capabilities, and strategic environmental orientation (SEO) as a moderator. Survey data were collected from the HR manager and the production/supply-chain line manager of 175 firms in Kenya, Nigeria, Ghana, South Africa, Indonesia, Vietnam, and Bangladesh (350 respondents; effective response rate 45.8%) and analyzed with partial least squares structural equation modeling. In the primary cross-rater model, in which the HR manager reported SHRM and SEO and the line manager reported the other constructs, SHRM was not associated with CEO ($\beta = -0.024$) or GSCI ($\beta = 0.049$); the indirect, serial indirect, and moderation hypotheses were therefore not supported. CEO was strongly associated with GSCI ($\beta = 0.578$), and both CEO ($\beta = 0.270$) and GSCI ($\beta = 0.513$) were positively associated with perceived TBL performance. When one respondent rated all constructs, associations involving SHRM became substantial, showing that rater source strongly shapes findings in this literature. Because the design is cross-sectional and perceptual, the results are associational, not causal.

Keywords: sustainable HRM; circular economy orientation; green supply chain integration; triple bottom line performance; PLS-SEM; cross-rater design; common method variance; emerging economies; manufacturing; N-RBV

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1. Introduction

The global manufacturing sector stands at a critical juncture. Responsible for approximately 20% of global GDP and a disproportionate share of carbon emissions, material waste, and social inequality, manufacturing firms face mounting regulatory, institutional, and market pressures to transition toward genuinely sustainable operations [1,2]. The triple bottom line (TBL) framework encompassing economic viability, environmental stewardship, and social responsibility has emerged as the dominant normative standard against which manufacturing sustainability performance is evaluated [3,4]. However, the organizational mechanisms by which firms build and sustain TBL performance remain poorly understood,

particularly in resource-intensive manufacturing contexts in emerging economies, where institutional infrastructure, technological resources, and managerial sustainability capabilities vary widely [5].

Sustainable human resource management (SHRM) has attracted increasing scholarly attention as a potential strategic lever for organizational sustainability transformation [6,7]. SHRM encompasses HRM practices, including green recruitment, environmental training, sustainable performance appraisal, green rewards, and employee wellbeing programs, that simultaneously pursue economic competitiveness, social equity, and environmental sustainability [6]. Unlike conventional environmental management approaches that focus on technology adoption or process efficiency, SHRM embeds sustainability into the firm's human capital architecture, developing the knowledge, values, and behavioral dispositions that enable employees to contribute to sustainability outcomes across all three TBL dimensions [7,8]. While an emerging body of literature links SHRM to environmental performance outcomes, the pathways through which SHRM practices translate into comprehensive TBL improvements, particularly through supply chain capabilities, remain underexplored [9,10]. Recent studies show that green HRM bundles are related to environmental cooperation with supply chain partners [11], but evidence on the adoption of circular practices comes mainly from advanced economies [12], and meta-analytic evidence on green supply chain management in Asian emerging economies [13] does not address how human resource capabilities feed into circular and supply chain capabilities.

Two organizational capabilities have recently attracted attention as potential mediating mechanisms in the SHRM–sustainability relationship. Circular economy orientation (CEO), encompassing product redesign, waste loop closure, resource circulation, and a closed-loop strategy, represents the firm's internalized commitment to, and capacity for, transitioning from linear to circular production logic [14,15]. Green supply chain integration (GSCI), encompassing supplier environmental criteria, green procurement practices, customer environmental collaboration, and logistics greening, represents the firm's capacity to extend its environmental sustainability standards across inter-organizational supply chain boundaries [16,17]. These two capabilities reflect distinct yet interconnected dimensions of manufacturing sustainability: CEO governs internal material-flow transformation, while GSCI governs the firm's environmental relationship with supply chain partners. Together, they constitute a comprehensive sustainability capability infrastructure that may transmit SHRM's human capital investments into TBL outcomes through a sequential pathway.

The natural-resource-based view (N-RBV) of the firm [18,19] provides the theoretical architecture for this argument. The N-RBV identifies three sequential environmental strategy capabilities: pollution prevention, product stewardship, and sustainable development, each building on the previous to generate progressively more comprehensive competitive advantage. We propose that SHRM practices are associated with the pollution prevention capability manifested in CEO, that CEO is associated with the product stewardship capability manifested in GSCI, and that GSCI is associated with the sustainable development outcomes captured by TBL performance. This ordering is a theoretically motivated sequence rather than a universal hierarchy: circular transformation is often co-developed with suppliers and customers, so that GSCI could also precede or be reciprocally related to CEO (see Section 6.4). Strategic environmental orientation (SEO), the extent to which environmental goals are integrated into a firm's strategic vision and resource allocation [20], is proposed as a boundary condition that may strengthen the association between SHRM and CEO. Stakeholder theory [21,22] and institutional theory [5] further contextualize this model by explaining why manufacturing firms in emerging economies adopt SHRM-driven sustainability strategies and how institutional pressures shape the effectiveness of these strategies.

The seven countries analyzed in this study were selected on theoretical and contextual grounds, not for convenience. First, all seven are classified as emerging or developing economies in which manufacturing (notably food processing, textiles, chemicals, electronics, and metal products) is a strategic pillar of industrialization and export diversification. Second, manufacturers in all seven are integrated, to varying degrees, into global value chains and face buyer-driven environmental requirements, which makes supply chain capabilities such as GSCI particularly pertinent. Third, the countries share comparatively uneven environmental enforcement and institutional support for circular-economy transitions, so that firm-level capabilities, including human resource capabilities, carry much of the burden of sustainability transformation; this is the setting in which the N-RBV and institutional arguments developed below are most informative. Fourth, the set spans Sub-Saharan Africa and Asia, so that the findings are not tied to a single regional context. At the same time, the countries differ in income level, regulatory stringency, and culture, and these differences are examined empirically through region-level multigroup analysis (Section 4.4.3).

Accordingly, the study addresses two questions: (i) whether SHRM is associated with TBL performance through CEO and GSCI, and whether SEO conditions the SHRM–CEO association; and (ii) whether these associations depend on who reports the constructs. This study makes three contributions. First, it tests a sequential capability pathway linking SHRM, CEO, GSCI, and TBL performance in a sample of 175 manufacturing firms from seven emerging economies, and shows that CEO is strongly related to GSCI and that both are related to TBL performance, whereas SHRM, as reported by the HR manager, is not related to either capability. Second, by combining a cross-rater design with same-respondent sensitivity analyses, it shows that the strength of the associations involving SHRM depends heavily on whether SHRM and the capabilities are reported by the same person, a methodological insight that is relevant to the wider green HRM literature. Third, it finds no support for SEO as a moderator of the SHRM–CEO association and no significant association between SEO and CEO in the cross-rater data. The remainder of the paper is organized as follows. Section 2 reviews the literature and develops the hypotheses; Section 3 describes the research design, sampling, measurement, and analytical procedures; Section 4 presents the results; Section 5 discusses the findings; and Section 6 sets out the conclusions, implications, limitations, and directions for future research. Appendices A–C provide the questionnaire items, the recruitment flow, and supplementary analyses.

2. Literature Review and Hypotheses Development

2.1. Sustainable HRM: Conceptualization and Practice Dimensions

Sustainable HRM has evolved from the narrower concept of green HRM to encompass a broader multi-stakeholder orientation that simultaneously targets economic competitiveness, environmental protection, and social equity [6,7]. Kramar [6] defines SHRM as the pattern of planned or emerging HR activities intended to enable the achievement of organizational goals while reproducing the human and social capital required for long-term sustainability.

Järlström et al. [7] identify five core SHRM practice dimensions: green recruitment and selection, environmental training and development, sustainable performance appraisal, green compensation and rewards, and employee wellbeing programs, each addressing a distinct mechanism through which HRM practices can embed sustainability into employee behavior and organizational culture. This five-dimension operationalization distinguishes SHRM from green HRM's narrower focus on environmental compliance, encompassing the social and economic dimensions of sustainability alongside the environmental [9].

Empirical research suggests that SHRM practices are associated with positive environmental performance outcomes through capability development and cultural change

mechanisms [10,23]. Renwick et al. [9] argue that green recruitment builds environmental knowledge stocks; Jabbour and de Sousa Jabbour [10] argue that environmental training is a critical enabler of green supply chain management practices; and Longoni et al. [23] report that SHRM deployment across organizational functions including operations and supply chain management is associated with significant improvements in green supply chain management capability. More recent evidence is consistent with this view: Yu et al. [11] show that green HRM is related to environmental cooperation with supply chain partners in manufacturing firms, and Tang et al. [24] provide a validated multidimensional measure of green HRM practices. However, few studies have examined SHRM as an antecedent of circular economy orientation and, to the best of our knowledge, the complete SHRM–CEO–GSCI–TBL sequence has not been tested in emerging-economy manufacturing.

2.2. Circular Economy Orientation in Manufacturing

The circular economy represents a systemic approach to industrial production designed to eliminate waste and maximize the productive use of resources through the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems [15,25]. Kirchherr et al.'s [14] synthesis of 114 CE definitions shows that circularity is typically framed through reduce, reuse, recycle, and recover activities combined with system-level change. Building on this synthesis, we operationalize CE orientation at the firm level through four facets (product redesign for circularity, waste loop closure, resource circulation, and closed-loop supply strategy); this operationalization is our own and is not taken from a validated scale. Bocken et al. [26] propose that circular business model archetypes can create value across the three TBL dimensions: reducing input costs and extending product revenue cycles (economic), reducing material throughput and manufacturing waste (environmental), and creating employment in repair, refurbishment, and recovery activities (social).

Despite growing interest in CE adoption drivers, the human capital antecedents of CE orientation remain understudied. Ghisellini et al. [25] note that employee knowledge and behavioral dispositions are critical enablers of CE implementation, particularly in the waste loop closure and product redesign dimensions, which require cross-functional employee engagement. Centobelli et al. [27] show that supply chain capabilities in manufacturing are linked to the pursuit of business and environmental strategies, but they do not examine the human capital foundations of these capabilities. Evidence on the adoption of circular practices among manufacturing and other SMEs is concentrated in advanced economies [12], which limits what is known about how human resource capabilities support circular orientation in emerging economies. The SHRM–CEO relationship, while theoretically compelling, has, to our knowledge, not been subjected to large-sample empirical testing in emerging economy manufacturing, representing a significant gap in the sustainability HRM and circular economy literatures.

2.3. Green Supply Chain Integration

Green supply chain integration encompasses the coordination of environmental sustainability practices across the full supply chain, integrating supplier environmental criteria, green procurement standards, customer environmental collaboration, and logistics greening into a coherent cross-boundary sustainability management system [16,17]. Zhu et al. [16] validate a multidimensional measurement model of green supply chain management practices in Chinese manufacturing, from which the GSCI facets used here are adapted; Green et al. [28] demonstrate that GSCI practices generate significant performance improvements across economic, operational, and environmental performance dimensions in US manufacturing. Rao and Holt [29] report a positive GSCI–competitiveness relationship

in Southeast Asian manufacturing, suggesting that supply chain environmental integration is associated with cost leadership and premium market access consistent with TBL economic performance gains. Sarkis et al. [17] synthesize the GSCM literature, identifying inter-organizational green coordination as the primary driver of improvements in supply-chain-level environmental performance. A meta-analysis of studies from Asian emerging economies likewise examines how green supply chain management practices relate to environmental, economic, and operational performance [13]; such evidence is concentrated on practices and performance and says little about the internal human-resource and circular-economy capabilities that precede them.

The relationship between circular economy orientation and green supply chain integration has been proposed theoretically but, to our knowledge, has not been tested at scale. de Sousa Jabbour et al. [30] argue that CE-oriented firms develop the technical vocabulary, material traceability systems, and environmental performance metrics that make green supply chain partnerships both feasible and credible to external partners. Acquaye et al. [31] develop a quantitative approach to supply-chain-level environmental performance measurement, underscoring that part of a firm's environmental impact lies beyond its own boundary. Together, these arguments suggest that circular orientation may be a precondition for credible supply chain environmental integration, a proposition developed in Section 2.8.

2.4. Triple Bottom Line Performance in Manufacturing

Elkington's [3] TBL framework operationalizes organizational sustainability as the simultaneous achievement of economic viability (profitability, revenue growth, cost efficiency, market development), environmental stewardship (carbon and energy reduction, waste minimization, eco-certification), and social responsibility (employee wellbeing, community engagement, fair labor practices, diversity).

Slaper and Hall [4] describe the TBL as a widely used framework for sustainability performance measurement that supports cross-dimensional comparison and integrated reporting, while noting that it does not prescribe a single set of indicators; researchers must therefore specify how each dimension is measured (see Section 3.4). The TBL's theoretical appeal for manufacturing research lies in its explicit recognition that sustainability performance is multidimensional and that trade-offs between dimensions long assumed to be inherent may be reduced or eliminated through comprehensive sustainability capability development [3,4].

Prior research suggests that green supply chain practices are positively related to several performance dimensions [13,28], although effect sizes vary across contexts and performance measures. Green et al. [28], for example, relate green supply chain management practices to environmental, economic, and operational performance in a US manufacturing sample. The role of SHRM practices as distal TBL antecedents, operating through CE and supply chain capabilities, has not been comprehensively modeled, representing the core empirical gap this study addresses.

2.5. Strategic Environmental Orientation as Boundary Condition

Strategic environmental orientation, defined as the extent to which environmental sustainability goals are embedded in the firm's vision, strategic objectives, resource allocation decisions, and policy integration [20], has been proposed as a moderating condition that amplifies the effectiveness of sustainability-oriented organizational practices.

Aragón-Correa and Sharma [20] argue that SEO distinguishes between proactive and reactive environmental strategies, with a proactive strategic orientation potentially generating larger sustainability performance gains from equivalent operational investments.

In the SHRM–CE context, SEO may amplify the association between SHRM and CE by ensuring that sustainability-oriented HRM practices are embedded within a strategic context that signals organizational commitment, allocates resources for CE implementation, and removes institutional barriers to circular economy adoption [5,20].

Alternatively, under conditions of strong institutional isomorphism where environmental strategy adoption becomes a legitimacy imperative rather than a differentiating choice, SEO may converge across firms and lose its moderating distinctiveness, functioning as a performance main effect rather than an interaction amplifier [5]. These competing expectations are formalized in H9 (Section 2.11).

2.6. SHRM and Circular Economy Orientation

SHRM's five practice dimensions are expected to collectively develop the human capital prerequisites for CE adoption. Green recruitment selects employees with CE literacy, sustainability values, and circular design competencies; environmental training programs build the technical knowledge required for waste loop closure, product redesign, and resource recovery operations; sustainable performance appraisal systems embed circularity metrics into employee goal-setting and evaluation frameworks; green rewards incentivize circular behavior and innovation; and employee wellbeing programs generate the psychological safety and organizational commitment that encourage employees to champion circular economy transitions [6,7]. Collectively, these practices are expected to build the individual and organizational-level CE capability that Hart [18] identifies as the pollution prevention foundation of sustainable competitive advantage.

Theoretically, from the N-RBV perspective, the pollution prevention capability described by Hart [18] and Hart and Dowell [19] rests on tacit, employee-embodied knowledge and continuous-improvement routines that are socially complex and therefore difficult to imitate. SHRM is the principal organizational mechanism through which such knowledge is recruited, developed, rewarded, and retained, so firms with more developed SHRM bundles are expected to display a stronger orientation towards circular production. Stakeholder theory [21,22] adds that SHRM treats employees as primary stakeholders whose commitment and discretionary effort are needed for circular redesign and waste loop closure, while institutional theory [5] suggests that SHRM practices also act as normative and mimetic channels through which external expectations about circularity are translated into internal routines. These arguments motivate H1.

H1: *Sustainable HRM practices are positively associated with circular economy orientation.*

2.7. SHRM and Green Supply Chain Integration

Beyond the internal CE pathway, SHRM practices may directly cultivate the relational and inter-organizational competencies on which GSCI depends. Stakeholder-oriented recruitment builds a workforce with supply chain partnership experience and supplier relationship skills; cross-functional environmental training develops employees' capacity to coordinate green procurement and customer environmental collaboration; sustainability appraisal systems that evaluate employees' supply chain environmental relationship management create formal accountability for GSCI outcomes; and green rewards that incentivize inter-organizational sustainability coordination create motivational alignment between SHRM investment and GSCI outcomes [10,21,23].

Theoretically, the N-RBV links the development of boundary-spanning stewardship capabilities to the skills and incentives of the people who manage external relationships [18,19]. Stakeholder theory [21,22] implies that firms whose HR systems recognize multiple stakehold-

ers are more likely to extend their environmental expectations to suppliers and customers, and empirical work in manufacturing indicates that green HRM is related to environmental cooperation with supply chain partners [10,11,23]. Hence, over and above any route through CEO, SHRM is expected to be directly related to GSCI (H2).

H2: *Sustainable HRM practices are positively associated with green supply chain integration*.

2.8. CEO and Green Supply Chain Integration

Circular economy orientation is proposed as a capability that facilitates effective GSCI. Firms that have internalized CE logic through product redesign, closed-loop material recovery, and circular supply strategies develop the technical vocabulary, material traceability infrastructure, environmental performance metrics, and supply chain coordination routines that make green supplier standards feasible to specify and credible to demand. CE-oriented firms are also more attractive GSCI partners for environmentally committed suppliers and customers, who are more willing to invest in joint sustainability initiatives with buyers whose internal practices align with supply chain sustainability requirements [26,30].

Theoretically, the N-RBV conceives product stewardship as building on pollution prevention: capabilities developed to redesign products and close loops inside the firm provide the knowledge base for involving partners in life-cycle environmental management [18,19]. De Sousa Jabbour et al. [30] similarly argue that firms with circular routines are better placed to specify and monitor environmental requirements in their supply chains. Institutional theory [5] adds that firms with a visible circular orientation are better able to meet, and credibly signal compliance with, the environmental expectations of buyers and regulators. We acknowledge that circular transformation is often co-developed with suppliers, customers, and recyclers, so the direction of the relationship could also run from GSCI to CEO or be reciprocal; we adopt the CEO → GSCI ordering because it follows the N-RBV sequence, and we discuss the alternative in Section 6.4.

H3: *Circular economy orientation is positively associated with green supply chain integration*.

2.9. CEO and TBL Performance

Circular economy orientation is expected to be positively related to TBL performance. CE's economic contribution derives from reduced raw material input costs, extended product revenue cycles through remanufacturing and refurbishment, and waste valorization revenues; its environmental contribution from reduced manufacturing waste, energy consumption, and scope 1–2 carbon emissions; and its social contribution from CE-enabled job creation in repair, refurbishment, and recovery sectors, and from reduced community environmental health impacts associated with reduced waste and emissions [14,15,26].

Theoretically, the N-RBV suggests that capabilities that economize on resource use and prevent pollution can simultaneously lower costs (economic), reduce environmental burden (environmental), and, through stakeholder legitimacy and job-related benefits, improve social standing [18,19]. Circular business model archetypes are described as creating value across all three TBL dimensions [26], and stakeholder theory [21,22] supports the expectation that circular practices responsive to community and customer concerns relate to better social outcomes.

H4: *Circular economy orientation is positively associated with triple bottom line performance*.

2.10. GSCI and TBL Performance

Green supply chain integration is expected to be positively related to TBL performance, consistent with the supply chain sustainability literature [13,28]. GSCI's economic contribution derives from supplier environmental auditing that reduces input costs and compliance risks, from green procurement efficiencies that lower logistics and materials costs, and from customer environmental collaboration that opens premium green market segments; its environmental contribution from scope 3 emission reductions achieved through logistics greening and supplier decarbonization; and its social contribution from fair labor practice standards cascaded through supply chains and from community benefits of logistics greening in local sourcing arrangements [16,17,28].

Theoretically, under the N-RBV, the sustainable development capability that underlies TBL outcomes depends on integrating the interests of external stakeholders in value creation [18,19]. GSCI embeds environmental requirements in relationships with suppliers and customers, which stakeholder theory [21,22] treats as a means of aligning the firm with those who influence its resources and legitimacy. Prior evidence shows positive associations between green supply chain practices and several performance dimensions [13,28]. We therefore expect GSCI to be positively associated with TBL performance (H5), without presuming that its association is larger than that of CEO; relative magnitudes are assessed empirically.

H5: *Green supply chain integration is positively associated with triple bottom line performance*.

2.11. Mediating Roles of CEO and GSCI

The N-RBV treats capabilities as the conduits through which resources, here human capital and HR systems, are converted into competitive and sustainability outcomes [18,19]. Resource-based reasoning thus implies that the association between SHRM and TBL performance is at least partly transmitted by capabilities. CEO channels SHRM-developed knowledge into product redesign, resource recovery, and waste valorization that bear on cost, environmental, and social outcomes (H6) [14,26]; GSCI channels SHRM-developed relational competence into supplier and customer environmental collaboration that bears on the same outcomes (H7) [10,16,23]. Stakeholder theory [21,22] supports both channels, because they convert internal commitments into responses to external stakeholders' demands. Because SHRM may also be related to TBL performance directly (for example, wellbeing programs and social performance), we expect partial rather than full mediation, which we assess by estimating the direct SHRM → TBL path.

H6: *Circular economy orientation mediates the relationship between sustainable HRM practices and triple bottom line performance*.

H7: *Green supply chain integration mediates the relationship between sustainable HRM practices and triple bottom line performance*.

2.12. Serial Mediation Through CEO and GSCI

The N-RBV describes a sequence from pollution prevention to product stewardship to sustainable development [18,19]. Internal circular capabilities (design know-how, traceability systems, and environmental metrics) provide the basis for extending environmental requirements to suppliers and customers [30], and GSCI is the boundary-spanning capability through which these are associated with TBL outcomes. A serial indirect effect through CEO and then GSCI is therefore expected. We treat this as a theoretically moti-

vated sequence; because CE is frequently co-developed with partners, the reverse order is a competing possibility that cross-sectional data cannot adjudicate (Section 6.4).

H8: *Circular economy orientation and green supply chain integration serially mediate the relationship between sustainable HRM practices and triple bottom line performance (SHRM → CEO → GSCI → TBL).*

2.13. Moderating Role of Strategic Environmental Orientation

The contingent resource-based view [20] holds that a proactive environmental strategy amplifies the returns to environmental resources and practices. SEO embeds environmental goals in strategy and resource allocation and may thereby provide the mandate, legitimacy, and resources that allow SHRM practices to be translated into circular investments, so that the SHRM–CEO association is expected to be stronger when SEO is high. Institutional theory [5], however, offers a competing expectation: where environmental strategy is widely adopted for legitimacy reasons, SEO varies little across firms and may act as a main effect instead of an interaction (Section 2.5). H9 is stated in the amplifying direction implied by the contingent RBV and is tested against this competing expectation.

H9: *Strategic environmental orientation moderates the positive relationship between sustainable HRM practices and circular economy orientation, such that the relationship is stronger when SEO is higher.*

As illustrated in Figure 1, the research model links SHRM practices to TBL performance (economic, environmental, and social) through two capabilities. SHRM is expected to be positively associated with CEO, the firm's commitment to resource efficiency, waste reduction, and circular production; CEO is expected to be positively associated with GSCI, the environmentally aligned collaboration with suppliers, customers, and logistics partners; and both capabilities are expected to be positively associated with TBL performance. SEO is proposed to moderate the SHRM–CEO association, which is expected to be stronger when environmental objectives are embedded in the firm's strategic priorities.

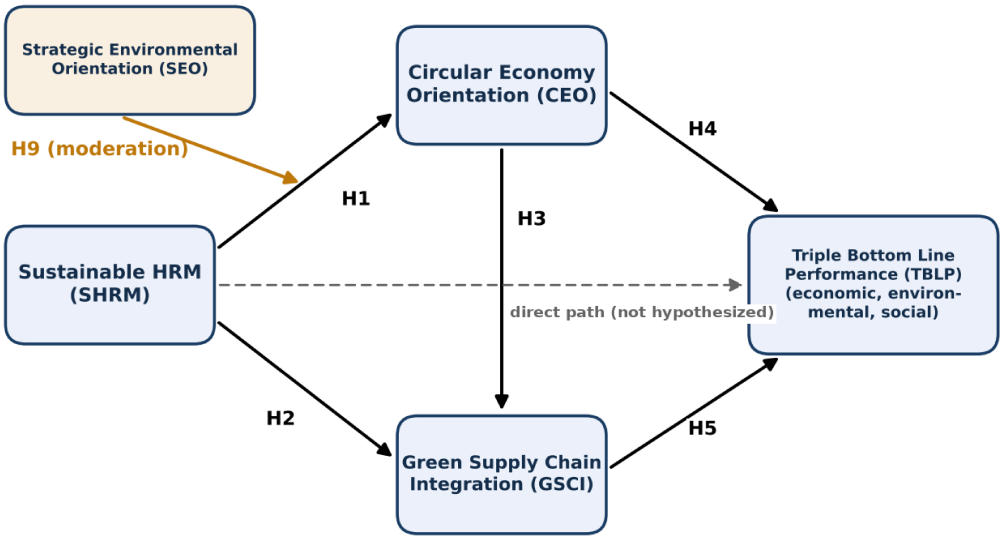


Figure 1. Research model. Dashed line: direct SHRM → TBLP path, estimated but not hypothesized. Indirect effects: H6 = SHRM → CEO → TBLP; H7 = SHRM → GSCI → TBLP; H8 = SHRM → CEO → GSCI → TBLP.

Model specification. Formally, the main structural model is CEO = f(SHRM), GSCI = f(SHRM, CEO), and TBL performance = f(SHRM, CEO, GSCI); the moderation hypothesis is tested in a separate model in which CEO = f(SHRM, SEO, SHRM × SEO) (Section 4.3.4). The direct SHRM → TBL path is estimated, so that the type of mediation can be assessed, but is not itself hypothesized. SHRM, CEO, GSCI, and SEO are reflective first-order constructs measured by five, four, four, and four items, respectively (the reflective specification is justified in Section 3.4). TBL performance is a reflective higher-order construct with three first-order dimensions (economic, environmental, and social performance; four items each), estimated with the two-stage approach: the latent-variable scores of the three dimensions, obtained in a first-stage model, serve as indicators of TBL performance in the second-stage model. Hypotheses H1–H5 are direct paths, H6–H8 are indirect effects (products of the path coefficients shown in Figure 1), and H9 is the interaction effect of SEO on the SHRM → CEO path, estimated with the two-stage product-term approach.

3. Methodology

3.1. Research Design

This study adopts a positivist stance, treating sustainability capabilities and TBL performance as organizational attributes that can be measured, albeit imperfectly, through the reports of informed managers and examined in a large-sample quantitative design [32]. A cross-sectional survey design was employed, using a dyadic respondent structure to reduce the risk of common method bias [33]: SHRM practices and strategic environmental orientation were reported by the HR manager of each participating firm, while CEO, GSCI, and TBL performance were reported by the line manager responsible for production and supply chain operations. This within-firm informant separation means that no single respondent rates both the predictor (SHRM) and the mediators and outcome, which reduces, but does not eliminate, the risk of same-source inflation [33,34]; all measures remain perceptual self-reports (see Section 6.4).

3.2. Sample and Data Collection

The target population comprised manufacturing firms operating across seven emerging economies: Kenya, Nigeria, Ghana, and South Africa (Sub-Saharan Africa), Indonesia and Vietnam (Southeast Asia), and Bangladesh (South Asia). These countries were selected to represent diverse institutional environments, stages of supply chain development, and manufacturing sub-sector compositions, while sharing the contextual characteristics set out in Section 1. Eligible firms employed at least 10 full-time staff, operated in one of five manufacturing sub-sectors (food processing, textile, chemical, electronics, or metal manufacturing), and maintained at least one formal supply chain relationship with an external supplier or customer. The sampling frame in each country was compiled and duplicate entries were removed across these sources, and firms were classified into the five eligible manufacturing sub-sectors before selection. Stratified random sampling was used, with strata defined by country and manufacturing sub-sector ($7 \times 5 = 35$ strata). The purpose of stratification was to ensure that every country and sub-sector was represented, not to reproduce the national distribution of manufacturers; the sample is accordingly not proportionate to the national sampling frames (country shares range only from 13.1% to 16.6%; Figure 2) and is not claimed to be statistically representative of national manufacturing populations.

Within each country-by-sub-sector stratum, eligible firms were assigned a unique identification number. A computer-generated random number sequence was used to select firms for contact, with additional firms randomly drawn where necessary until the planned contact allocation was reached. Initial invitations were sent by institutional or company email

to the firm's HR manager and production/supply-chain line manager. Where no response was received, one reminder was sent after approximately 10 working days; respondents returned the questionnaire electronically.

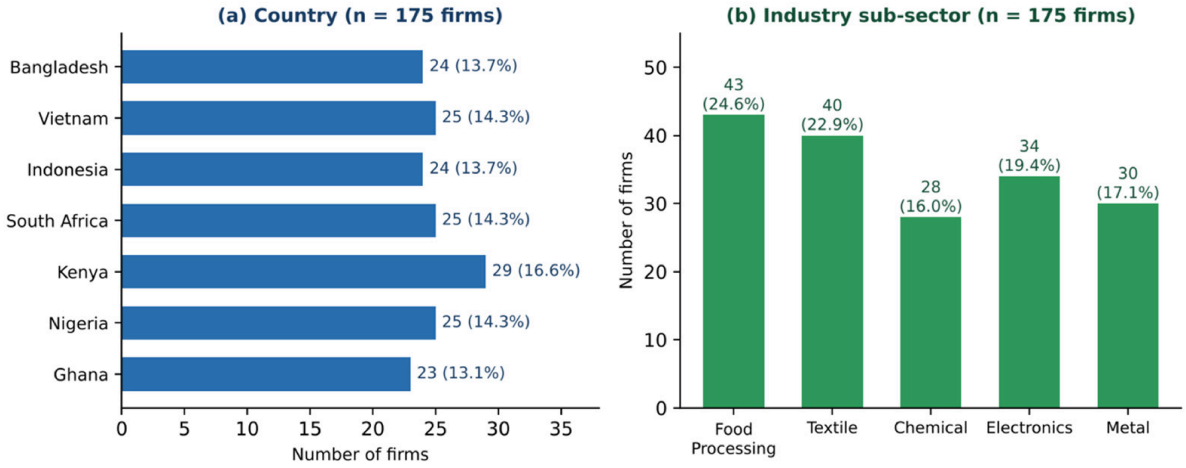


Figure 2. Distribution of the 175 participating manufacturing firms across country (**left panel**) and industry sub-sector (**right panel**). Total $n = 350$ dyadic respondents (HR manager + line manager per firm). Counts and percentages are identical to those reported in Section 4.1.

In each firm, the HR manager and the line manager responsible for production and supply chain operations were approached separately. In total, 382 firms were contacted and 175 firms returned complete dyadic questionnaire pairs (one HR manager and one line manager each), corresponding to an effective response rate of 45.8% (175/382). The two questionnaires of each firm were linked through a pre-assigned firm code printed on the questionnaires. The level of agreement between the two respondents of a firm is reported in Section 4.4.4.

Sample size adequacy. The largest number of structural paths pointing at one construct is three (TBL performance; CEO in the moderation model). A power analysis for multiple regression with three predictors ($f^2 = 0.15$, $\alpha = 0.05$, power = 0.80), computed from the non-central F distribution, gives a minimum of 77 cases, and the 10-times rule gives 30 cases. With $n = 175$, the inverse square root method [35] indicates that a path coefficient of about 0.19 or larger can be detected at the 5% level with 80% power ($n = 85$ for $\beta = 0.27$, the smallest significant coefficient found here; $n = 155$ for $\beta = 0.20$; $n = 275$ for $\beta = 0.15$); the sample is therefore adequate for moderate and large associations but cannot detect small ones. The power to detect a small interaction effect ($f^2 = 0.02$) with $n = 175$ is approximately 0.46, so H9 was tested with limited sensitivity. With 23–29 firms per country, country-specific models were not estimated, and no claim of national representativeness is made.

3.3. Questionnaire Design and Pilot Study

In the primary analysis, SHRM (five items) and SEO (four items) are rated by the HR manager, and CEO (four items), GSCI (four items), and TBL performance (twelve items) by the line manager (Section 3.1). Both respondents nevertheless answered all 29 items, which allows the cross-rater design to be compared with same-respondent estimates (Section 4.4.4). Firm profile information (country, sub-sector, number of employees, firm age, and International Organization for Standardization (ISO) 14001 [36] certification) was recorded for each firm. All substantive items were closed-ended statements rated on a five-point Likert-type scale (1 = strongly disagree; 5 = strongly agree). The questionnaire

was administered in English, and its wording was reviewed for clarity and contextual appropriateness by reviewers familiar with manufacturing and sustainability terminology.

Item development and pilot study. Items were generated from the conceptual definitions in the sources listed in Table 1 and reviewed for content validity. A pilot study was conducted in May 2025 with 12 manufacturing firms (24 respondents: one HR manager and one production/supply-chain line manager per firm) in Kenya and Ghana. The pilot assessed item clarity, completion time, and questionnaire administration. Following the pilot, minor wording changes were made to remove ambiguous terminology and improve consistency in the descriptions of circular economy practices and supply chain collaboration. No construct or item was added solely to improve statistical reliability. Pilot responses were excluded from the main analysis.

Table 1. Measurement instruments and item sources.

Construct	Role	Items	Source(s)
Sustainable HRM (SHRM)	IV (HR Manager)	5 items: green recruitment; environmental training; sustainable appraisal; green rewards; employee wellbeing	Kramar [6]; Järlström et al. [7] (conceptual/qualitative sources; items developed by the authors)
Circular Economy Orientation (CEO)	Mediator 1 (LM)	4 items: product redesign for circularity; waste loop closure; resource circulation; closed-loop supply strategy	Kirchherr et al. [14]; Bocken et al. [26] (conceptual/review sources; items developed by the authors)
Green Supply Chain Integration (GSCI)	Mediator 2 (LM)	4 items: supplier environmental criteria; green procurement; customer environmental collaboration; logistics greening	Zhu et al. [16]; Green et al. [28] (GSCI facets adapted from a validated GSCM instrument [16])
TBL Economic Performance	DV (Line Manager)	4 items: profitability; revenue growth; cost efficiency; market development	Slaper & Hall [4] (conceptual source; items developed by the authors)
TBL Environmental Performance	DV (Line Manager)	4 items: carbon/energy reduction; waste minimization; eco-certification; environmental compliance	Slaper & Hall [4] (conceptual source; items developed by the authors)
TBL Social Performance	DV (Line Manager)	4 items: employee wellbeing; community engagement; labor standards; diversity and inclusion	Slaper & Hall [4] (conceptual source; items developed by the authors)
Strategic Env. Orientation (SEO)	Moderator (HR Manager)	4 items: environmental vision; strategic green goals; environmental resource commitment; green policy integration	Aragón-Correa & Sharma [20] (conceptual source; items developed by the authors)

3.4. Measurement Instruments

Table 1 presents the measurement instruments and item sources. All constructs were measured using multi-item Likert-type scales (1 = strongly disagree; 5 = strongly agree). Table 1 summarizes item content and sources, and Appendix A gives the full item wording. SHRM was operationalized with five items adapted from Kramar [6] and Järlström et al. [7], covering green recruitment, environmental training, sustainable appraisal, green rewards, and employee wellbeing. CEO was measured with four items adapted from Kirchherr et al. [14] and Bocken et al. [26], covering product redesign, waste loop closure, resource circulation, and closed-loop supply strategy. GSCI was measured with four items adapted from Zhu et al. [16] and Green et al. [28], covering supplier environmental criteria, green procurement, customer environmental collaboration, and logistics greening. TBL performance was measured across three sub-dimensions (economic, environmental, social) with four items each, adapted from Slaper and Hall [4]. SEO was measured with four items adapted from Aragón-Correa and Sharma [20].

Origin of the items. The sources cited for SHRM [6,7], CEO [14,26], TBL [4], and SEO [20] are conceptual, qualitative, or review contributions rather than psychometrically

validated multi-item scales. The items for these constructs were therefore developed by the authors from the conceptual definitions in those sources, as indicated in Table 1, and were not adopted directly from validated instruments. Only the GSCI items draw on an established multi-item instrument [16], and they were adapted rather than copied: the four facets used here differ from the practice dimensions of the original instrument. Content validity and pilot testing are described in Section 3.3. Because the scales were newly developed, the measurement evidence in Section 4.2 should be read as an initial validation, and future work should replicate the findings with validated scales (for example, the green HRM scale of Tang et al. [24]).

Measurement of TBL performance. TBL performance is measured through the line manager's perceptions (four items each for economic, environmental, and social performance). The items (Appendix A) ask whether performance has improved or been gained through sustainable practices, without specifying a reference period or comparison group, which limits comparability across firms. Perceptual self-reports may be affected by social desirability and differ from audited indicators. TBL performance was modeled as a higher-order construct. A single aggregate was used because TBL is conceptually an integrated notion of performance [3], because the three dimensions are moderately correlated ($r = 0.518–0.553$) and distinct (HTMT ≤ 0.572; Section 4.2.2), and because it keeps the structural model parsimonious. As aggregation can conceal differences across dimensions, the model was additionally estimated with the three dimensions as separate outcomes (Section 4.4.2).

Specification of the measurement model. The first-order constructs were specified reflectively (Mode A) because each item was written as a manifestation of the firm's overall orientation or practice level in the domain concerned, not as a component that defines the construct. For example, a firm with a strong circular economy orientation is expected to score high on product redesign, waste loop closure, resource circulation, and closed-loop strategy alike, and a change in that orientation is expected to be reflected in all four items. Under this specification, items should be highly intercorrelated and broadly interchangeable, and dropping one should not change the meaning of the construct [32]. This reasoning is least secure for SHRM, whose five items describe distinct HR practices (recruitment, training, appraisal, rewards, and wellbeing programs) that firms could in principle adopt independently, so a formative (Mode B) specification is a defensible alternative. Given inter-item correlations of 0.85–0.89, however, the implied indicator VIFs under a formative specification are approximately 5.4–6.2, above the critical value of 5 [32], so formative weights would be unstable and difficult to interpret.

For the multidimensional TBL construct, a reflective–reflective higher-order specification was adopted because the economic, environmental, and social dimensions are treated as manifestations of a single underlying level of sustainability performance [3], the dimensions are moderately and similarly correlated ($r = 0.518–0.553$), and their second-order loadings are similar in size (0.813–0.853; Section 4.2.1). We acknowledge that TBL is often conceptualized as composed of distinct dimensions, which would favor a reflective–formative specification. Because the specification of a higher-order construct can affect the structural estimates, the model was also estimated with the three dimensions as separate outcomes (Section 4.4.2); that analysis does not depend on how the higher-order construct is specified, and its conclusions match those of the aggregate model.

3.5. Analytical Procedure

Partial least squares structural equation modeling (PLS-SEM) was conducted in SmartPLS 4 (version 4.1.1.9; SmartPLS GmbH, Oststeinbek, Germany) [37], using reflective (Mode A) measurement and the path-weighting scheme. PLS-SEM was chosen because

the study is prediction-oriented, the model contains several mediators and a higher-order construct, and the method does not require normally distributed data [32]. Following Hair et al. [32], the measurement model was evaluated first (reliability, convergent and discriminant validity) and the structural model second (path coefficients, R^2, mediation and moderation). All inferences are based on non-parametric bootstrapping with 5000 sub-samples and 95% bias-corrected confidence intervals [32,38]; bootstrap *p*-values were obtained from the bootstrap standard error with a t distribution ($n - 1$ degrees of freedom). The serial mediation hypothesis (H8) was tested through the specific indirect effect ($a_1 \times b \times a_2$) [38], and the moderation hypothesis (H9) through a standardized product term (SHRM × SEO) estimated with the two-stage approach [32]. The structural assessment also covered inner variance inflation factors (VIF), effect sizes (f^2, interpreted against benchmarks of 0.02, 0.15, and 0.35 [39]), R^2 [40], and Q^2 obtained by blindfolding (omission distance D = 7).

Given that prediction is a stated reason for choosing PLS-SEM, out-of-sample predictive power was evaluated with PLSpredict (10 folds, 10 repetitions) against a linear-model benchmark [41]. Heterogeneity across region, firm size, ISO 14001 status, and sub-sector was examined with the measurement invariance of composites (MICOM) procedure and permutation-based multigroup analysis (1000 permutations) [42] (Section 4.4.3), and firm size, log firm age, ISO 14001 status, sub-sector, and country were entered as controls in bootstrapped regressions of the latent-variable scores (5000 resamples). The cross-rater model is the primary specification; the same model estimated with all constructs reported by one respondent (HR manager or line manager) is reported as a sensitivity analysis (Section 4.4.4).

3.6. Common Method Bias Assessment

Common method bias (CMB) was assessed using three diagnostic procedures, none of which is conclusive on its own. First, Harman's single-factor test was applied to all 29 survey items: the largest unrotated factor explained 38.6% of the variance in the cross-rater data (SHRM and SEO items from the HR manager, other items from the line manager), below the 50% cut-off. Harman's test is insensitive and is reported only as a supplementary diagnostic [33,43]. Within each respondent, however, a single factor accounted for 64.8% (nine HR manager items) and 55.9% (twenty line manager items) of the variance, above the cut-off, which indicates a strong common response tendency within respondents and is consistent with the high inter-item correlations reported in Section 4.2. Second, we applied the Lindell and Whitney [34] marker-variable technique with firm age as the marker.

Firm age is an objective organizational attribute and not a psychometric marker measured through the same response process as the substantive items; it is therefore a weak marker, and its low correlation with the constructs may understate method variance. In this procedure, the marker's smallest absolute correlation with the substantive constructs ($r_M = 0.002$) is taken as the estimate of method variance, each correlation is adjusted as $r_A = (r_U - r_M)/(1 - r_M)$, and the adjusted correlations are retested for significance. The average absolute change in inter-construct correlations was $\Delta r = 0.0016$, and the number of significant correlations (11 of 21) did not change. Given that the marker is weak, this result is supplementary evidence only; future studies should include a theoretically unrelated attitudinal marker or a CFA marker [44]. Third, we applied the full-collinearity test of Kock [45]: the VIFs of all seven latent variables, obtained from the latent-variable correlation matrix (Section 4.2.2), ranged from 1.27 to 2.19 and were below the 3.3 threshold, which is consistent with the absence of pervasive common method bias under this test. Procedurally, the dyadic respondent design, which separates SHRM and SEO measurement from CEO, GSCI, and TBL measurement across two independent within-

firm informants, reduces, but does not eliminate, same-source bias, because all constructs remain perceptual reports and the SHRM × SEO interaction is estimated from a single respondent [33,43].

4. Analysis and Results

Results are presented in four sub-sections: the sample profile (Section 4.1), the measurement model (Section 4.2), the structural model and hypothesis tests (Section 4.3), and robustness and supplementary analyses (Section 4.4). Common method bias is assessed in Section 3.6.

4.1. Sample Demographic Profile

Table 2 presents the full demographic profile. Kenya contributed the largest representation ($n = 29$, 16.6%), followed by Nigeria, South Africa, and Vietnam ($n = 25$ each, 14.3%). Food processing was the most prevalent sub-sector ($n = 43$, 24.6%), followed by textile manufacturing ($n = 40$, 22.9%). Small firms constituted the largest size category ($n = 72$, 41.1%), and 71 firms (40.6%) held ISO 14001 certification. Figure 3 provides a visual profile. Counts and percentages in Figures 2 and 3 are identical to those in Table 2.

Firm size and representativeness. Small firms (<50 employees) accounted for 41.1% of the sample, medium firms (50–249) for 37.7%, and large firms (250+) for 21.1%. Because firms with fewer than 10 employees were excluded, strata were defined by country and sub-sector but not by size, and national SME definitions differ, so this distribution is not nationally representative and very likely over-represents larger firms relative to national enterprise structures. This is treated as a limitation (Section 6.4), and firm size is examined as a control and grouping variable (Section 4.4.3).

Table 2. Demographic profile.

Characteristic	Category	*n*	%
Country	Ghana	23	13.1
	Nigeria	25	14.3
	Kenya	29	16.6
	South Africa	25	14.3
	Indonesia	24	13.7
	Vietnam	25	14.3
	Bangladesh	24	13.7
Sector	Food Processing	43	24.6
	Textile	40	22.9
	Chemical	28	16.0
	Electronics	34	19.4
	Metal	30	17.1
Firm Size	Small (<50)	72	41.1
	Medium (50–249)	66	37.7
	Large (250+)	37	21.1
ISO 14001	Certified	71	40.6
	Not Certified	104	59.4

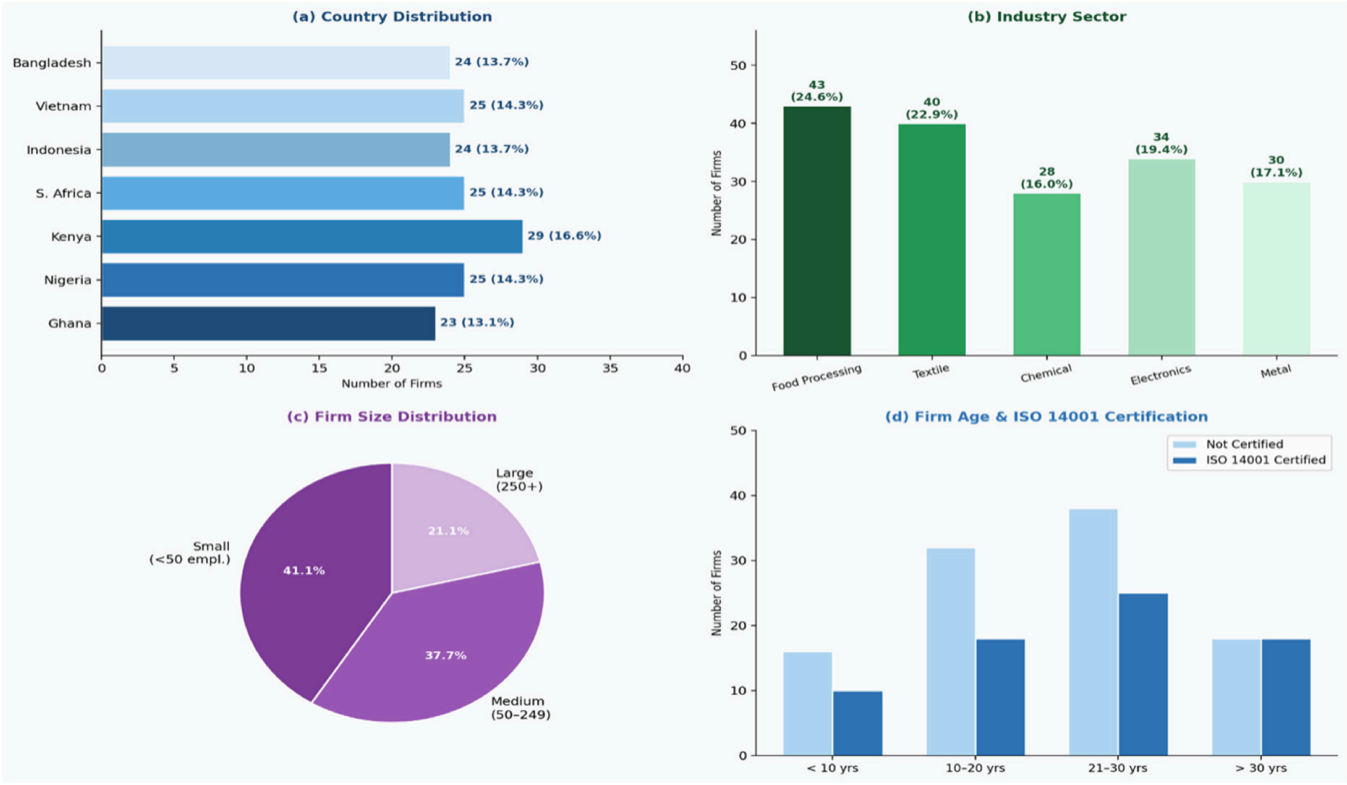


Figure 3. Distribution across (**a**) country, (**b**) industry sub-sector, (**c**) firm size, and (**d**) firm age × ISO 14001 certification. Percentages in panel (**c**) sum to 99.9% because of rounding.

4.2. Measurement Model Assessment

4.2.1. Reliability and Convergent Validity

Table 3 presents the measurement model statistics. All Cronbach's alpha values (0.959–0.970) and composite reliability values (0.970–0.976) exceed the 0.70 threshold [32]. All AVE values (0.891–0.912) exceed 0.50 [46]. All 29 outer loadings (0.936–0.959) exceed 0.70. The second-order TBL construct has loadings of 0.813–0.853, composite reliability of 0.869, and AVE of 0.689. Figure 4 displays all outer loadings.

Table 3. Reliability and convergent validity.

Construct	Items	Min λ	Max λ	α	CR	AVE	√AVE
SHRM	5	0.936	0.953	0.970	0.976	0.891	0.944
CEO	4	0.946	0.959	0.964	0.974	0.903	0.950
GSCI	4	0.936	0.949	0.959	0.970	0.891	0.944
TBL Economic	4	0.948	0.954	0.964	0.974	0.902	0.950
TBL Environmental	4	0.953	0.957	0.968	0.976	0.912	0.955
TBL Social	4	0.949	0.955	0.965	0.975	0.906	0.952
SEO	4	0.943	0.951	0.962	0.972	0.898	0.948
TBL (second-order)	3 dimensions	0.813	0.853	—	0.869	0.689	0.830

Note. α = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted. SHRM and SEO are reported by the HR manager and all other constructs by the line manager. The second-order TBL row refers to the loadings of the three dimension scores on TBL performance (two-stage approach). All values exceed the minimum thresholds [32,46]; values above 0.95 may indicate item redundancy [32].

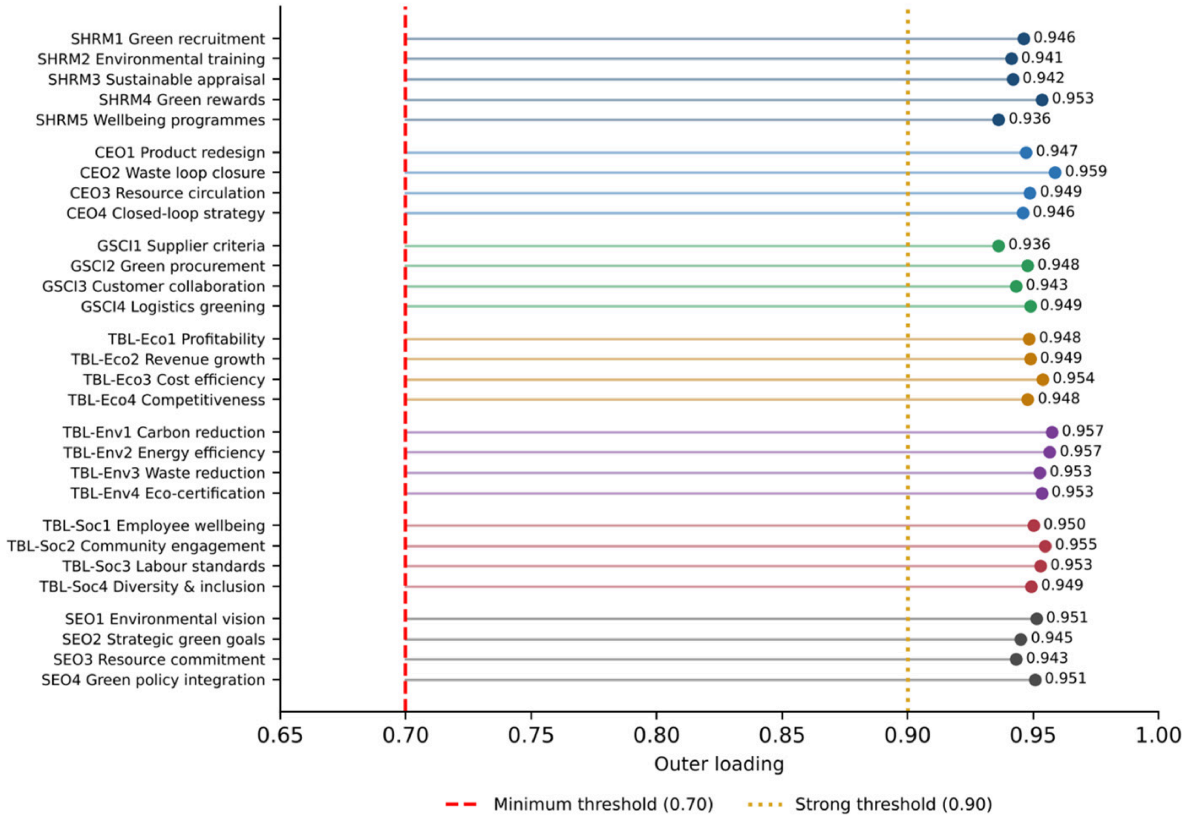


Figure 4. All 29 outer loadings (0.936–0.959) exceed both the minimum threshold of 0.70 (dashed red line) and the strong threshold of 0.90 (dotted gold line). The horizontal axis starts at 0.65 so that the 0.70 threshold line is visible.

Very high reliability: item redundancy or shared response tendencies? The reliability coefficients are unusually high (α = 0.959–0.970; loadings = 0.936–0.959), and mean inter-item correlations within constructs range from 0.855 to 0.883 (SHRM 0.85–0.89; CEO 0.86–0.89; GSCI 0.83–0.87; Eco 0.86–0.88; Env 0.87–0.89; Soc 0.87–0.88; SEO 0.84–0.88). Values of this size do not indicate better measurement. They can arise from item redundancy, that is, items that capture near-identical content, or from a general response tendency (for example, halo or acquiescence) that respondents apply across items [32,33]. We examined both explanations with the available evidence.

First, with respect to redundancy, no loading reaches 0.96 and no inter-item correlation exceeds 0.89, so the items do not meet the usual indication of near-duplication (loadings above 0.95) [32]. An inspection of the item wording (Appendix A) nevertheless shows partial semantic overlap in two constructs: CEO2 (closing waste loops) and CEO3 (reuse and recycling of materials) refer to closely related practices, and SEO1 (strategic vision integrates environmental goals) and SEO2 (environmental targets embedded in strategy) are near-paraphrases. Such overlap can explain high correlations within these pairs, but not the uniformly high correlations among items that describe clearly different practices, such as green recruitment and employee wellbeing programs (SHRM) or supplier selection and logistics greening (GSCI).

Second, three findings point to shared response tendencies within respondents. (i) Within each respondent, a single unrotated factor accounts for 64.8% (HR manager, nine items) and 55.9% (line manager, twenty items) of the item variance (Section 3.6). (ii) Constructs reported by the same respondent correlate at 0.42–0.65, whereas constructs reported by different respondents of the same firm correlate at −0.08 to 0.07 (Table 4). (iii) The HR manager's and the line manager's scores for the same construct are essentially

uncorrelated (−0.08 to 0.08; Section 4.4.4), although both rated the same firm with the same items. If the high inter-item correlations reflected firm-level attributes, the two respondents should agree at least moderately; the near-zero agreement indicates that much of the covariance among the items is specific to the respondent and not to the firm. The evidence is therefore more consistent with a strong respondent-level response tendency than with item redundancy alone. The reliabilities are accordingly read as evidence of internal consistency within respondents, not as evidence that the constructs are comprehensively or validly measured at firm level, and the cross-rater specification (Section 4.3), which prevents one respondent's response tendency from inflating the SHRM–capability paths, is retained as the primary model.

Table 4. Fornell–Larcker discriminant validity matrix (√AVE on diagonal).

Construct	SHRM	CEO	GSCI	TBL Eco	TBL Env	TBL Soc	SEO
SHRM	**0.944**						
CEO	−0.024	**0.950**					
GSCI	0.034	0.576	**0.944**				
TBL Economic	−0.007	0.542	0.520	**0.950**			
TBL Environmental	−0.081	0.449	0.654	0.518	**0.955**		
TBL Social	−0.043	0.420	0.464	0.537	0.553	**0.952**	
SEO	0.438	0.050	0.068	−0.012	0.061	−0.012	**0.948**

Note. Diagonal values (bold) = √AVE; off-diagonal values are correlations of the latent-variable scores. SHRM and SEO are reported by the HR manager and the other constructs by the line manager. Discriminant validity is supported when each diagonal exceeds all off-diagonal values in its row and column.

Response distributions. Every one of the 29 items has a mean of 3.00 and a standard deviation of 1.42, with skewness of 0.00, and each of the five response options was chosen by exactly 70 of the 350 respondents (20.0%) on every item. Such perfectly uniform response distributions are rarely seen in field data and imply that the item scores are symmetric and platykurtic (excess kurtosis = −1.30). PLS-SEM does not assume normality, so estimation is not affected by the shape of the distributions, but the pattern should be borne in mind when interpreting the very high reliabilities.

4.2.2. Discriminant Validity

Table 4 presents the Fornell–Larcker matrix. The criterion was satisfied for all seven constructs: the square roots of AVE (0.944–0.955) exceeded all inter-construct correlations in the corresponding rows and columns. The highest correlation was between GSCI and TBL environmental performance (r = 0.654). The matrix also shows a clear pattern by respondent: the correlation between the two HR-reported constructs (SHRM and SEO) is 0.438, and the five constructs reported by the line manager are correlated with one another at 0.420–0.654, whereas every correlation between an HR-reported construct and a line-manager-reported construct lies between −0.081 and 0.068, that is, close to zero.

Table 5 presents the HTMT matrix. All ratios were below the conservative 0.90 threshold, from 0.018 to 0.679, the highest being GSCI–TBL environmental performance, a theoretically plausible proximity. Taken together with the Fornell–Larcker results, these findings support discriminant validity of the seven constructs. The very low HTMT values for pairs involving an HR-reported and a line-manager-reported construct reflect the near-zero cross-respondent correlations noted above.

Table 5. HTMT discriminant validity matrix.

Construct	SHRM	CEO	GSCI	TBL Eco	TBL Env	TBL Soc	SEO
SHRM	—						
CEO	0.041	—					
GSCI	0.038	0.599	—				
TBL Economic	0.028	0.561	0.540	—			
TBL Environmental	0.079	0.464	0.679	0.536	—		
TBL Social	0.043	0.434	0.482	0.557	0.572	—	
SEO	0.453	0.058	0.071	0.018	0.063	0.022	—

Note. HTMT = heterotrait–monotrait ratio, computed from the item correlations. All values < 0.90 [47]. Maximum = 0.679 (GSCI–TBL environmental).

4.3. Structural Model Results

4.3.1. Explained Variance and Predictive Relevance

Table 6 presents the explained variance and predictive relevance. SHRM explained essentially none of the variance in CEO ($R^2 = 0.001$, $Q^2 = -0.001$, i.e., no predictive relevance); SHRM and CEO together explained 33.5% of the variance in GSCI ($R^2 = 0.335$, $Q^2 = 0.286$); and SHRM, CEO, and GSCI together explained 49.9% of the variance in TBL performance ($R^2 = 0.499$, $Q^2 = 0.323$), a moderate level [40]. Almost all of the explained variance in GSCI and TBL performance comes from the line-manager-reported predictors (Table A2).

Table 6. Explained variance (R^2) and predictive relevance.

Endogenous Construct	R^2	R^2 Adj.	Assessment	Q^2
CEO	0.001	−0.005	Negligible	−0.001
GSCI	0.335	0.327	Moderate	0.286
TBL performance	0.499	0.490	Moderate	0.323

Note. R^2 assessment following Chin [40]: weak ≈ 0.19; moderate ≈ 0.33; substantial ≈ 0.67. Under the stricter benchmarks of Hair et al. [32] (0.25, 0.50, 0.75), GSCI would be classed as weak–moderate and TBL performance as moderate. Q^2 values were obtained by blindfolding (omission distance D = 7); $Q^2 > 0$ indicates predictive relevance. The Q^2 of TBL performance is based on the three dimension scores of the second-stage model; the Q^2 values of the economic, environmental, and social dimensions are 0.308, 0.390, and 0.223, respectively.

4.3.2. Direct-Path Hypotheses (H1–H5)

Table 7 presents the direct path results. Two of the five direct-path hypotheses were supported. SHRM was not significantly associated with CEO (H1: $\beta = -0.024$, 95% CI [−0.177, 0.156]) or with GSCI (H2: $\beta = 0.049$, CI [−0.085, 0.172]); the confidence intervals exclude associations larger than about 0.18 in absolute value. CEO was strongly associated with GSCI (H3: $\beta = 0.578$, CI [0.477, 0.667]), and both CEO (H4: $\beta = 0.270$, CI [0.134, 0.398]) and GSCI (H5: $\beta = 0.513$, CI [0.392, 0.621]) were positively associated with TBL performance. GSCI showed the larger standardized coefficient ($f^2 = 0.350$ versus 0.097 for CEO); this concerns the relative size of the associations and not financial return. The direct SHRM → TBL path was not significant ($\beta = -0.067$, CI [−0.177, 0.055]).

Table 7. PLS-SEM direct-path results (H1–H5).

H	Path	β	SE	95% CI	*p*	Decision
H1	SHRM → CEO	−0.024	0.089	[−0.177, 0.156]	0.785	Not supported
H2	SHRM → GSCI	0.049	0.066	[−0.085, 0.172]	0.457	Not supported
H3	CEO → GSCI	0.578	0.049	[0.477, 0.667]	<0.001	Supported ***
H4	CEO → TBL	0.270	0.068	[0.134, 0.398]	<0.001	Supported ***
H5	GSCI → TBL	0.513	0.059	[0.392, 0.621]	<0.001	Supported ***
—	SHRM → TBL (direct, not hypothesized)	−0.067	0.059	[−0.177, 0.055]	0.261	Not significant

Note. β = standardized path coefficient; SE = bootstrap standard error; CI = 95% bias-corrected bootstrap confidence interval (5000 resamples); *p*-values from the bootstrap standard error (t distribution); *** $p < 0.001$. SHRM is reported by the HR manager; CEO, GSCI, and TBL by the line manager.

4.3.3. Mediation Analyses (H6–H8)

Table 8 presents the specific indirect effects; Figure 5 visualizes the bootstrap confidence intervals. None of the three mediation hypotheses was supported: the indirect effect through CEO (H6: IE = −0.007, CI [−0.054, 0.044]) and through GSCI (H7: IE = 0.025, CI [−0.044, 0.090]) and the serial indirect effect through CEO and GSCI (H8: IE = −0.007, CI [−0.054, 0.047]) were all indistinguishable from zero, because SHRM was not associated with either mediator. Given the cross-sectional design, indirect effects describe statistical mediation and do not establish temporal ordering [48].

Table 8. Bootstrap mediation results (H6–H8).

H	Path	IE	95% CI	Mediation Type	Decision
H6	SHRM → CEO → TBL	−0.007	[−0.054, 0.044]	None	Not supported
H7	SHRM → GSCI → TBL	0.025	[−0.044, 0.090]	None	Not supported
H8	SHRM → CEO → GSCI → TBL	−0.007	[−0.054, 0.047]	None	Not supported
—	Total effect of SHRM on TBL	−0.055	[−0.200, 0.125]	—	—

Note. IE = specific indirect effect (standardized), bias-corrected bootstrap CIs (5000 resamples). All three CIs include zero. The direct SHRM → TBL path is β = −0.067, CI [−0.177, 0.055], $p = 0.261$; the total effect is −0.055, CI [−0.200, 0.125].

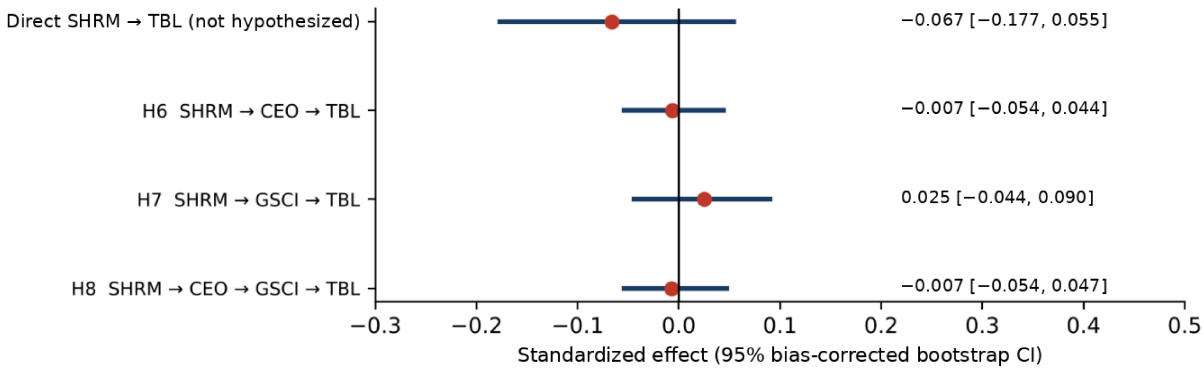


Figure 5. Specific indirect effects and 95% bias-corrected bootstrap CIs for H6–H8. The direct SHRM → TBL effect is also shown. All intervals include zero.

4.3.4. Moderation Analysis (H9)

Table 9 presents the moderation results. The SHRM × SEO interaction was not significant (β = −0.114, CI [−0.283, 0.064], $p = 0.211$), providing no support for H9 (the simple slopes are plotted in Figure 6). The main effects of SHRM (β = −0.107, $p = 0.386$) and SEO (β = 0.119, $p = 0.298$) on CEO were also not significant, and the model explained 2.5% of the variance in CEO. The effect-size estimate for the interaction was $f^2 = 0.013$, a negligible value, and the power to detect $f^2 = 0.02$ was approximately 0.46.

Table 9. Moderation results: H9 (SHRM × SEO → CEO).

Predictor	β	95% CI	*p*	Decision
SHRM (main)	−0.107	[−0.285, 0.137]	0.386	Not significant
SEO (main)	0.119	[−0.134, 0.284]	0.298	Not significant
SHRM × SEO (H9)	−0.114	[−0.283, 0.064]	0.211	H9 not supported

Note. R^2 of the moderation model = 0.025. Two-stage product-term approach; CIs are bias-corrected bootstrap intervals (5000 resamples).

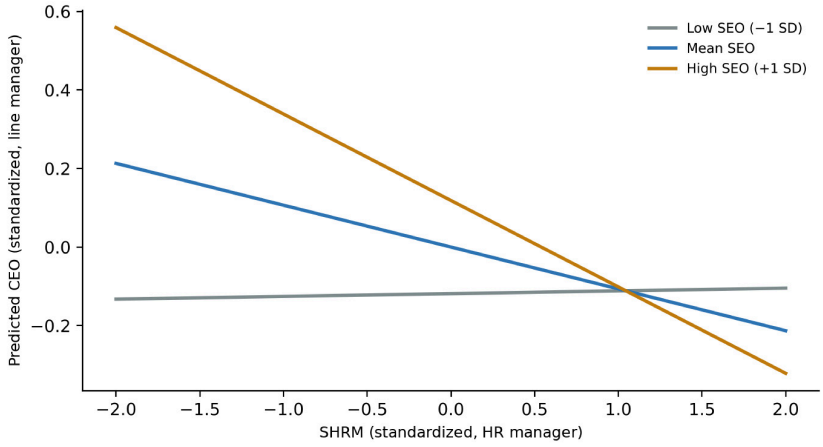


Figure 6. Simple slopes of CEO on SHRM at low (−1 SD), mean, and high (+1 SD) SEO; the slopes do not differ significantly (interaction β = −0.114, $p = 0.211$).

4.3.5. Hypothesis Testing Summary

Table 10 summarizes the outcomes of all hypothesis tests.

Table 10. Consolidated hypothesis testing summary.

H	Hypothesis	β/IE	95% CI	*p*	Outcome
H1	SHRM → CEO	−0.024	[−0.177, 0.156]	0.785	Not supported
H2	SHRM → GSCI	0.049	[−0.085, 0.172]	0.457	Not supported
H3	CEO → GSCI	0.578	[0.477, 0.667]	<0.001	Supported ***
H4	CEO → TBL	0.270	[0.134, 0.398]	<0.001	Supported ***
H5	GSCI → TBL	0.513	[0.392, 0.621]	<0.001	Supported ***
H6	SHRM → CEO → TBL (mediation)	−0.007	[−0.054, 0.044]	0.796	Not supported
H7	SHRM → GSCI → TBL (mediation)	0.025	[−0.044, 0.090]	0.461	Not supported
H8	SHRM → CEO → GSCI → TBL (serial)	−0.007	[−0.054, 0.047]	0.786	Not supported
H9	SHRM × SEO → CEO (moderation)	−0.114	[−0.283, 0.064]	0.211	Not supported

Note. β = standardized path coefficient (H1–H5, H9); IE = specific indirect effect (H6–H8). *** $p < 0.001$; ns = not significant. Bootstrap: 5000 resamples, 95% bias-corrected CIs.

4.4. Robustness and Supplementary Analyses

This section reports analyses that complement the main results: collinearity, effect sizes, and predictive power (Section 4.4.1); a disaggregated analysis of the three TBL dimensions (Section 4.4.2); heterogeneity across region, firm size, certification status, and sub-sector, and control variables (Section 4.4.3); and the agreement between the two respondents together with same-respondent sensitivity analyses (Section 4.4.4).

4.4.1. Collinearity, Effect Sizes, and Predictive Power

Collinearity. Inner VIF values were 1.00 for the predictors of GSCI (SHRM and CEO), between 1.00 and 1.50 for the predictors of TBL performance (SHRM, CEO, and GSCI), and between 1.01 and 1.24 for the predictors of CEO in the moderation model (SHRM, SEO, and SHRM × SEO), all well below the conservative threshold of 3.0 [32] (Table A2). Because all constructs are reflective, item-level VIFs are not used to judge collinearity; the high inter-item correlations implied by loadings above 0.93 are discussed in Section 4.2. Multicollinearity among the structural predictors is therefore not a concern for the path estimates.

Effect sizes. Following Cohen's benchmarks [39], the f^2 values (Table A2) were large for CEO → GSCI (0.502), medium to large for GSCI → TBL (0.350), small for CEO → TBL (0.097), and negligible (below 0.02) for SHRM → CEO (0.001), SHRM → GSCI (0.004), SHRM → TBL (0.009), and for the SHRM × SEO interaction (0.013).

Predictive power. Q^2 values (Table 6) were obtained with the blindfolding procedure (omission distance D = 7). PLSpredict results (10 folds, 10 repetitions) are reported in Table A3. For GSCI and for the economic, environmental, and social dimensions, Q^2predict was positive for all indicators (0.275 to 0.314 for GSCI; 0.282 to 0.344, 0.367 to 0.412, and 0.187 to 0.233 for the three TBL dimensions), and the PLS-SEM prediction errors were lower than those of the linear-model benchmark for all four indicators of each construct, which indicates high predictive power following [41]. For CEO, Q^2predict was slightly negative for all four indicators (−0.016 to −0.012), so the model has no out-of-sample predictive power for CEO, in line with the absence of an SHRM → CEO association.

4.4.2. Disaggregated TBL Dimensions

To examine whether the aggregate TBL construct conceals differences, the model was re-estimated with economic, environmental, and social performance as three separate endogenous constructs (Table A4). SHRM had no significant direct association with any dimension, and the serial indirect effects through CEO and GSCI were close to zero and not significant for all three (economic −0.004, environmental −0.008, social −0.005). GSCI was significantly associated with all three dimensions, most strongly with environmental performance (β = 0.599, CI [0.470, 0.723]), whereas CEO was significantly associated with economic (β = 0.363) and social performance (β = 0.225) but not with environmental performance (β = 0.101, CI [−0.048, 0.245]). The variance explained was 35.9% (economic), 44.5% (environmental), and 25.3% (social). The conclusions drawn from the aggregate model therefore hold, but the dimension-level results show that the relative role of CEO and GSCI differs across dimensions.

4.4.3. Heterogeneity by Region, Firm Size, Certification, and Sub-Sector, and Control Variables

Industries differ in the financial, technological, and human resources available for SHRM, and institutional and cultural contexts differ between countries. We therefore examined whether the structural relationships differ by (i) region (Sub-Saharan Africa, $n = 102$; Asia, $n = 73$), (ii) firm size (SMEs with fewer than 250 employees, $n = 138$; large firms, $n = 37$), (iii) ISO 14001 certification (certified, $n = 71$; not certified, $n = 104$), and

(iv) sub-sector group (process-oriented sub-sectors, namely food processing, textile, and chemical, $n = 111$; assembly-oriented sub-sectors, namely electronics and metal, $n = 64$). For each grouping, measurement invariance of composites was assessed with the MICOM procedure and, because compositional invariance was supported for all six first-order composites in all four groupings (permutation $p > 0.05$; Table A5), groups were compared with permutation-based multigroup analysis (1000 permutations) [42]. Equal means and variances (full invariance) were not supported in three cases (TBL economic means by firm size, TBL social variances by region, and GSCI variances by ISO status), so partial invariance holds, and the path comparisons are interpretable. No path coefficient differed significantly between groups at the 5% level (smallest permutation $p = 0.057$, for the direct SHRM → TBL path by ISO 14001 status), so no hypothesis changes by group. Country-level institutional and cultural variables could not be modeled as moderators because only seven countries are represented; heterogeneity was examined through region groupings and country dummies as controls. Sample sizes within countries (23–29) and sub-sectors (28–43) are too small for separate model estimation.

Control variables. When firm size, log firm age, ISO 14001 status, sub-sector, and country were entered as controls, the substantive results were unchanged (Table A5): SHRM → CEO $\beta = -0.051$ ($p = 0.520$; $R^2 = 0.041$), SHRM → GSCI $\beta = 0.059$ ($p = 0.365$), CEO → GSCI $\beta = 0.586$, SHRM → TBL $\beta = -0.081$ ($p = 0.162$), CEO → TBL $\beta = 0.248$, and GSCI → TBL $\beta = 0.522$ ($R^2 = 0.545$); the SHRM × SEO interaction remained non-significant ($\beta = -0.126$, $p = 0.132$).

4.4.4. Agreement Between the Two Respondents and Same-Respondent Sensitivity Analyses

Because the dataset contains the responses of both the HR manager and the line manager of each firm to all 29 items, the agreement between the two respondents could be examined directly. The two respondents gave exactly the same rating on 19.8% of firm-item pairs, essentially the 20.0% expected by chance for five equally likely response options. The within-firm agreement index (rwg, with a uniform null distribution, $\sigma^2EU = 2.0$) averaged across the 29 items had a median of 0.17 across firms, and only 8 of the 175 firms reached 0.70. The correlation between the HR manager's and the line manager's composite score for the same construct ranged from −0.08 to 0.08 across the seven constructs. The two respondents of a firm therefore did not agree on the firm's SHRM, circular-economy, supply-chain, performance, or strategy characteristics, and the two reports cannot be treated as interchangeable measures of the same attributes. Consequently, the cross-rater estimates reported in Section 4.3, in which the HR manager reports SHRM and SEO and the line manager reports the remaining constructs, are the estimates least affected by shared-respondent bias.

As a sensitivity analysis, the model was re-estimated using, for all constructs, the responses of the same respondent (Table A6). When all constructs were reported by the HR manager, SHRM was significantly associated with CEO ($\beta = 0.476$, CI [0.358, 0.581]) and GSCI ($\beta = 0.210$), and the serial indirect effect was significant (IE = 0.074, CI [0.040, 0.130]); with all constructs reported by the line manager, the corresponding estimates were $\beta = 0.604$ (CI [0.492, 0.695]) and IE = 0.100 (CI [0.062, 0.156]). In both same-respondent models, the interaction SHRM × SEO was not significant (HR: $\beta = 0.047$; line manager: $\beta = 0.048$). The associations involving SHRM therefore appear when one person reports both sides of the relationship and disappear when different people report them. These data cannot separate a shared common-method or halo effect from genuine differences in what each respondent can observe, but the pattern is the one expected if common-rater effects contribute to same-respondent associations.

5. Discussion

This study examined whether SHRM practices are associated with TBL performance through CEO and GSCI as sequential mediators, with SEO as a proposed boundary condition. The findings are interpreted through the N-RBV [18,19], stakeholder theory [21], and institutional theory [5]. Because the data are cross-sectional and rely on perceptual reports, the results are read as associations and not as evidence of causal or temporal ordering.

5.1. SHRM and the Two Sustainability Capabilities

The hypothesized links from SHRM to the two capabilities were not supported: with SHRM reported by the HR manager and the capabilities by the line manager, SHRM was not associated with CEO (H1: $\beta = -0.024$, CI [−0.177, 0.156]) or with GSCI (H2: $\beta = 0.049$, CI [−0.085, 0.172]), and explained essentially none of the variance in CEO. The confidence intervals exclude associations larger than about 0.18, so the result is a precise null for effects of moderate or large size and not merely an underpowered one. This does not accord with the N-RBV argument that SHRM supports pollution-prevention capabilities [18,19] or with stakeholder-theory reasoning that HRM systems oriented towards several stakeholders support external environmental coordination [11,21,23]. It also contrasts with published studies that find positive associations between green HRM and environmental outcomes [9–11].

A methodological explanation deserves attention: the sensitivity analyses show that SHRM is substantially associated with CEO and GSCI ($\beta = 0.476$–0.604 for CEO) when the same respondent reports both, and the two respondents of a firm agreed no more than chance on any construct (Section 4.4.4). Same-respondent associations may therefore partly reflect shared response tendencies, whereas cross-rater estimates remove them; alternatively, the HR manager and the line manager may simply observe different parts of the organization. The present data cannot distinguish these explanations.

5.2. Circular Economy Orientation, Green Supply Chain Integration, and TBL Performance

CEO was strongly associated with GSCI (H3: $\beta = 0.578$), and both CEO (H4: $\beta = 0.270$) and GSCI (H5: $\beta = 0.513$) were positively associated with TBL performance as perceived by the line manager, with GSCI showing the larger standardized coefficient. These three links are consistent with the N-RBV that internally developed circular capabilities are linked to boundary-spanning stewardship capabilities [18,19] and with the argument that firms with circular routines are better placed to specify environmental requirements to suppliers and customers [30]; they agree in direction with earlier evidence that green supply chain practices relate to several performance dimensions [13,28]. All three constructs were reported by the same respondent, so shared-rater effects may inflate them.

The larger coefficient for GSCI concerns the relative size of standardized associations in this sample. It does not show that GSCI offers a higher financial return or a lower cost per unit of investment, because neither investment costs nor financial returns were measured, and the coefficients could differ if the CEO–GSCI ordering were reversed (Section 6.4). The dimension-level analysis shows that GSCI is related to all three dimensions, most strongly to environmental performance, whereas CEO is related to economic and social but not to environmental performance.

5.3. Indirect Effects and the Role of Strategic Environmental Orientation

The indirect effects of SHRM through CEO (H6: IE = −0.007, 95% CI [−0.054, 0.044]), through GSCI (H7: IE = 0.025, 95% CI [−0.044, 0.090]), and through CEO and then GSCI (H8: IE = −0.007, 95% CI [−0.054, 0.047]) were not significant, as expected when the first link of each chain is absent. The direct SHRM → TBL path was also not significant

(β = −0.067, p = 0.261), so there is no evidence of partial or full mediation in the cross-rater data. By contrast, in same-respondent models, the serial indirect effect was significant (HR manager: IE = 0.074; line manager: IE = 0.100). Circular transformation is frequently co-developed with suppliers, customers, and recyclers, so GSCI may equally be an antecedent of, or reciprocally related to, CEO; the cross-sectional data cannot distinguish these possibilities [48].

SEO did not moderate the SHRM–CEO association (H9: β = −0.114, p = 0.211) and was not significantly associated with CEO in the cross-rater model (β = 0.119, p = 0.298). The interaction test has limited power to detect small effects (approximately 0.46 for f^2 = 0.02 with n = 175), SEO and SHRM were reported by the same respondent, and country-level differences may mask conditional effects in a single-level model. The null result is therefore not evidence that SEO is irrelevant as a boundary condition, and it cannot be interpreted through institutional theory [5] without additional evidence on institutional variation.

5.4. Overall Assessment

Overall, the data in this sample support a link from CEO to GSCI and from both to perceived TBL performance when reported by the line manager, but provide no support for a role of HR-reported SHRM at the start of the sequence, for mediation of the SHRM–TBL association, or for SEO as a moderator. The results therefore do not validate the proposed human-capital-to-performance pathway and call for replication with independent measures of SHRM, such as documented HR practices, and with multiple informants.

6. Conclusions, Implications, Limitations, and Future Research

6.1. Conclusions

This study investigated whether SHRM practices are associated with TBL performance through serial mediation by CEO and GSCI, with SEO as a proposed moderator. Using PLS-SEM on data from 175 manufacturing firms in seven emerging economies (350 respondents; HR manager and line manager in each firm), the study found support for three of nine hypotheses (H3, H4, and H5), all concerning the line-manager-reported links from CEO to GSCI and from both to TBL performance. The hypotheses involving SHRM (H1, H2), the indirect and serial indirect effects (H6–H8), and the moderation by SEO (H9) were not supported. The findings are associational, because the design is cross-sectional and the measures are perceptual.

CEO was strongly associated with GSCI (H3: β = 0.578), and both CEO (H4: β = 0.270) and GSCI (H5: β = 0.513) were positively associated with TBL performance, GSCI showing the larger standardized association. SHRM, as reported by the HR manager, was not associated with CEO (β = −0.024) or GSCI (β = 0.049), and the serial indirect effect through CEO and GSCI was not significant (IE = −0.007). SEO did not moderate the SHRM–CEO association (H9: β = −0.114, p = 0.211). Agreement between the two respondents of a firm was no better than chance, and when the same respondent reported all constructs, SHRM was substantially associated with CEO and GSCI.

These findings are consistent with a pathway in which circular economy orientation is linked to green supply chain integration and to economic, environmental, and social performance as perceived by line managers, but they do not support the proposition that SHRM is the starting point of this pathway. They suggest that the strength of associations involving SHRM in survey research may depend on whether the same respondent reports both sides of the relationship. Longitudinal, multi-informant, and multi-level research, and the use of documented HR practices and objective performance data, are needed to establish causal ordering, test competing and reciprocal models, refine institutional boundary conditions, and assess generalizability.

6.2. Contributions and Theoretical Implications

This study makes three contributions, offered with the caveats set out in Section 6.4. First, it provides evidence, in a sample of 175 manufacturing firms from seven emerging economies, that CEO is strongly related to GSCI and that both are related to perceived TBL performance, with differences across the economic, environmental, and social dimensions. Second, it reports a precise null result for the association between HR-reported SHRM and the two capabilities in a cross-rater design, together with same-respondent estimates that are substantially larger; this adds a methodological caution to the literature on green HRM and sustainability capabilities. Third, it finds no evidence that SEO moderates the SHRM–CEO association. The finding that GSCI is at least as strongly related to TBL performance as CEO is a proposition that warrants testing with designs able to establish ordering.

In theoretical terms, the study contributes to the N-RBV [18,19] by providing evidence for the link between internal circular capabilities and boundary-spanning supply chain capabilities and for their association with perceived TBL performance, while showing that the link from human resource systems to these capabilities was not supported in a cross-rater design. It adds to stakeholder theory [21,22] a caution that the association between multi-stakeholder-oriented HRM and external environmental coordination may be sensitive to who reports it. For institutional theory [5], the absence of moderation by SEO cannot be interpreted without country-level institutional measures.

6.3. Practical Implications

Managerial Implications

For manufacturing managers, the results suggest that attention to circular economy orientation and to green supply chain integration is warranted, since firms whose line managers reported stronger CEO also reported stronger GSCI and higher economic, environmental, and social performance. The study provides no evidence that HR-reported SHRM practices, such as green recruitment, training, appraisal, and rewards, are associated with these capabilities, so managers should not assume such links without evidence from their own firms. Evaluating HR initiatives with independent indicators, and not only with managers' perceptions, would help to establish whether they contribute.

Supplier environmental auditing, green procurement standards, and customer environmental collaboration were associated with higher perceived economic, environmental, and social performance, most strongly environmental performance. Because costs and returns were not measured, and because the three constructs were reported by the same respondent, the findings do not indicate which investment yields the highest return.

The results do not support a coordinated HRM–circular economy–supply chain pathway as tested here; whether coordinating these initiatives is worthwhile remains an empirical question for designs that can establish ordering and use independent measures. Finally, SEO did not strengthen any association involving SHRM, which suggests that a stated environmental strategy is not by itself sufficient to alter the contribution of SHRM in the sectors studied.

Policy Implications

Industrial sustainability policy might consider supporting both operational circular-economy implementation and supply-chain-oriented measures such as green public procurement, export certification for green supply chains, and trade preferences for verified green manufacturers [16,17], consistent with SDG 12 [1], although this study provides no evidence on their cost-effectiveness or on the contribution of workforce-development measures such as green HRM training programs.

Sustainability Reporting Implications

The CEO–GSCI–TBL link can serve as an organizing framework for describing how circular-economy and supply-chain initiatives relate to perceived performance in sustainability reporting (for example, GRI standards, TCFD disclosures, and ESG communication), provided that the associations are not presented as proven causal effects. Only 40.6% of sampled firms held ISO 14001 certification, and certification was not part of the tested model; the study therefore draws no conclusion about its relationship with TBL performance.

6.4. Limitations and Future Research Directions

Several limitations qualify the findings. First, the cross-sectional design precludes causal and temporal inference. The assumed ordering SHRM → CEO → GSCI → TBL rests on theory; competing orderings, such as GSCI → CEO or reciprocal relations, are plausible because circular transformation is often co-developed with suppliers, customers, and recyclers, and could not be tested here. Second, all measures are perceptual reports, and TBL outcomes are not objective. The cross-rater design separates the respondent who reports SHRM and SEO from the one who reports CEO, GSCI, and TBL, but the line manager reports the capabilities and the outcomes, so associations among these constructs may be inflated by shared-rater effects; the marker-variable test used firm age, which is a weak marker, and Harman's test is an insensitive diagnostic. Third, the two respondents of a firm agreed no more than chance, so it is unclear whose reports best reflect the underlying practices; SHRM was reported by one HR manager and was not verified against documented practices. Fourth, TBL was modeled as a single higher-order construct, which may conceal differences across dimensions; disaggregated results are reported in Section 4.4.2.

Fifth, the SHRM, CEO, TBL, and SEO items were developed from conceptual sources rather than adopted from validated scales, the evidence in Section 4.2 indicates that much of the item covariance reflects respondent-level response tendencies rather than firm-level attributes, and the SHRM items, which represent distinct practices, might alternatively be modeled formatively (Section 3.4). Sixth, the sample (175 firms; 23–29 per country) was drawn to cover each country and sub-sector and not to be proportionate to national populations, includes only firms with at least 10 employees, and very likely over-represents larger firms relative to national enterprise structures; the results should not be generalized to national populations or to developed economies. Seventh, the sample is too small for country-level estimation, and the interaction test has limited power for small effects. Finally, PLS-SEM's prediction-oriented estimation does not provide the global fit tests of CB-SEM; replication with CB-SEM or Bayesian SEM would give complementary evidence.

Six directions emerge. First, longitudinal panel studies, and studies comparing the proposed sequence with alternative and reciprocal models (for example, GSCI → CEO), would allow tests of temporal ordering. Second, multi-informant designs with documented HR practices, objective or multi-source performance data, and validated measurement scales (for example, the green HRM scale of Tang et al. [24]) would reduce reliance on perceptual reports and on newly developed items, and would allow rater effects in the SHRM–capability relationship to be separated from substantive associations. Third, multi-level analyses incorporating national institutional and cultural variables would allow moderation hypotheses to be tested where institutional variation is largest, potentially clarifying the role of SEO. Fourth, digital technology enablers, such as Industry 4.0, IoT material tracking, and blockchain supply chain transparency, warrant investigation as additional mediators or boundary conditions. Fifth, comparative replication in samples from industrialized economies would show whether the observed links are context-specific or generalizable. Sixth, larger samples would allow adequately powered comparisons across sectors, firm sizes, and ownership types.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Questionnaire Items

The two questionnaires were completed by the HR manager (SHRM, SEO in the primary analysis) and by the line manager responsible for production and supply chain operations (CEO, GSCI, TBL performance in the primary analysis). All items used a five-point scale (1 = strongly disagree; 5 = strongly agree). Table A1 gives the item wording as recorded in the study codebook, together with the variable names used in the dataset.

Table A1. Questionnaire items by construct.

Code	Construct (Respondent)	Dataset Variable	Item Wording
SHRM1	SHRM (HR manager)	SHRM_Green_Recruitment	We recruit for environmental awareness & values
SHRM2	SHRM (HR manager)	SHRM_Env_Training	We provide training on environmental sustainability
SHRM3	SHRM (HR manager)	SHRM_Sustainable_Appraisal	Performance appraisals include sustainability metrics
SHRM4	SHRM (HR manager)	SHRM_Green_Rewards	Rewards are tied to sustainable behaviours
SHRM5	SHRM (HR manager)	SHRM_Employee_Wellbeing_Programs	We have structured employee wellbeing programs
CEO1	CEO (line manager)	CE_Product_Redesign	We redesign products to extend lifecycle
CEO2	CEO (line manager)	CE_Waste_Loop_Closure	We close waste loops in our production process
CEO3	CEO (line manager)	CE_Resource_Circulation	We maximize reuse and recycling of materials
CEO4	CEO (line manager)	CE_Closed_Loop_Strategy	Our strategy prioritizes circular value creation
GSCI1	GSCI (line manager)	GSCI_Supplier_Env_Criteria	We apply environmental criteria in supplier selection
GSCI2	GSCI (line manager)	GSCI_Green_Procurement	We implement green procurement policies
GSCI3	GSCI (line manager)	GSCI_Customer_Env_Collab	We collaborate with customers on environmental goals
GSCI4	GSCI (line manager)	GSCI_Logistics_Greening	We have greened our logistics and distribution
TBL-Eco1	TBL economic (line manager)	Economic_Profitability	Profitability has improved through sustainable practices
TBL-Eco2	TBL economic (line manager)	Revenue_Growth	Sustainability has contributed to revenue growth
TBL-Eco3	TBL economic (line manager)	Cost_Efficiency	Sustainable operations have reduced costs
TBL-Eco4	TBL economic (line manager)	Market_Competitiveness	We have gained competitive advantage through sustainability
TBL-Env1	TBL environmental (line manager)	Carbon_Emission_Reduction	We have significantly reduced carbon emissions
TBL-Env2	TBL environmental (line manager)	Energy_Efficiency	Energy use per unit output has improved
TBL-Env3	TBL environmental (line manager)	Waste_Reduction	Waste generation has declined

Table A1. *Cont.*

Code	Construct (Respondent)	Dataset Variable	Item Wording
TBL-Env4	TBL environmental (line manager)	Eco_Certification	We hold environmental certifications or eco-labels
TBL-Soc1	TBL social (line manager)	Employee_Wellbeing	Employee wellbeing outcomes have improved
TBL-Soc2	TBL social (line manager)	Community_Engagement	We actively engage local communities
TBL-Soc3	TBL social (line manager)	Labour_Standards	We maintain high labour standards
TBL-Soc4	TBL social (line manager)	Diversity_Inclusion	We promote diversity and inclusion
SEO1	SEO (HR manager)	SEO_Env_Vision	Our strategic vision integrates environmental goals
SEO2	SEO (HR manager)	SEO_Strategic_Green_Goals	Environmental targets are embedded in strategy
SEO3	SEO (HR manager)	SEO_Env_Resource_Commitment	We allocate resources specifically for env. strategy
SEO4	SEO (HR manager)	SEO_Green_Policy_Integration	Green policies are integrated into business operations

Note. The item codes are the labels used in Figure 4. Items are shown in the order of the codebook.

Appendix B. Supplementary Analyses

Table A2. Inner VIF and effect sizes (f^2).

Path	Inner VIF	f^2	Effect Size
SHRM → CEO	1.000	0.001	Negligible
SHRM → GSCI	1.001	0.004	Negligible
CEO → GSCI	1.001	0.502	Large
SHRM → TBL	1.004	0.009	Negligible
CEO → TBL	1.503	0.097	Small
GSCI → TBL	1.504	0.350	Medium–large
SHRM → CEO (moderation model)	1.229	0.009	Negligible
SEO → CEO (moderation model)	1.239	0.012	Negligible
SHRM × SEO → CEO	1.009	0.013	Negligible

Note. Inner VIFs are the diagonal of the inverse correlation matrix of the predictors' latent-variable scores. Full-collinearity VIFs of the seven constructs: SHRM 1.28, CEO 1.73, GSCI 2.19, TBL Economic 1.82, TBL Environmental 2.14, TBL Social 1.67, SEO 1.27. f^2 benchmarks: 0.02 small, 0.15 medium, 0.35 large [39].

Table A3. Out-of-sample predictive power (PLSpredict; 10 folds, 10 repetitions).

Endogenous Construct	Indicators	Q^2predict (Range)	Indicators with PLS RMSE < LM RMSE	Predictive Power
CEO	4	−0.016 to −0.012	4 of 4	Lacking
GSCI	4	0.275 to 0.314	4 of 4	High
TBL economic	4	0.282 to 0.344	4 of 4	High
TBL environmental	4	0.367 to 0.412	4 of 4	High
TBL social	4	0.187 to 0.233	4 of 4	High

Note. Predictions use the direct antecedents of each construct. Predictive power classified following Shmueli et al. [41]: high if Q^2predict > 0 and all indicators have a lower PLS-SEM than linear-model RMSE; lacking if Q^2predict ≤ 0.

Table A4. Structural results with economic, environmental, and social performance as separate outcomes.

Path/Statistic	Economic β [95% CI]	Environmental β [95% CI]	Social β [95% CI]
SHRM → outcome (direct)	−0.009 [−0.146, 0.127]	−0.099 [−0.208, 0.016]	−0.049 [−0.185, 0.084]

Table A4. *Cont.*

Path/Statistic	Economic β [95% CI]	Environmental β [95% CI]	Social β [95% CI]
GSCI → outcome	0.311 [0.165, 0.451]	0.599 [0.470, 0.723]	0.336 [0.181, 0.483]
R^2	0.359	0.445	0.253
Serial IE: SHRM → CEO → GSCI → outcome	−0.004 [−0.035, 0.025]	−0.008 [−0.063, 0.048]	−0.005 [−0.039, 0.027]

Table A5. Measurement invariance (MICOM), multigroup comparisons, and control-variable model.

Grouping	Group 1 (*n*)	Group 2 (*n*)	MICOM Result	Paths Differing (*p*-Value)
Region	Sub-Saharan Africa (102)	Asia (73)	Compositional invariance supported for all six composites (smallest $p = 0.25$); equal Soc variance not supported	None (smallest $p = 0.222$, path H4)
Firm size	SMEs (<250) (138)	Large (250+) (37)	Compositional invariance supported for all six composites (smallest $p = 0.12$); equal Eco mean not supported	None (smallest $p = 0.171$, path H5)
ISO 14001	Certified (71)	Not certified (104)	Compositional invariance supported for all six composites (smallest $p = 0.66$); equal GSCI variance not supported	None (smallest $p = 0.057$, path dTBL)
Sub-sector	Process-oriented (111)	Assembly-oriented (64)	Compositional invariance supported for all six composites (smallest $p = 0.10$); full invariance supported	None (smallest $p = 0.137$, path H4)

Note. Permutation tests with 1000 permutations. Country-specific models were not estimated (n = 23–29 per country). Control-variable model (firm size, log firm age, ISO 14001, sub-sector, and country entered as controls; bootstrapped regressions of the latent-variable scores): SHRM → CEO −0.051 ($p = 0.520$), SHRM → GSCI 0.059 ($p = 0.365$), CEO → GSCI 0.586, SHRM → TBL −0.081 ($p = 0.162$), CEO → TBL 0.248, GSCI → TBL 0.522; R^2 = 0.041 (CEO), 0.387 (GSCI), 0.545 (TBL); SHRM × SEO → CEO −0.126 ($p = 0.132$). No hypothesis changes.

Table A6. Cross-rater estimates compared with same-respondent estimates.

Path	Cross-Rater (Primary): β [95% CI]	All Constructs from HR Manager	All Constructs from Line Manager
H1 SHRM → CEO	−0.024 [−0.177, 0.156]	0.476 [0.358, 0.581]	0.604 [0.492, 0.695]
H2 SHRM → GSCI	0.049 [−0.085, 0.172]	0.210 [0.070, 0.344]	0.310 [0.171, 0.446]
H3 CEO → GSCI	0.578 [0.477, 0.667]	0.508 [0.374, 0.637]	0.389 [0.260, 0.512]
H4 CEO → TBL	0.270 [0.134, 0.398]	0.348 [0.206, 0.471]	0.157 [0.008, 0.308]
H5 GSCI → TBL	0.513 [0.392, 0.621]	0.308 [0.177, 0.440]	0.427 [0.298, 0.538]
SHRM → TBL (direct)	−0.067 [−0.177, 0.055]	0.247 [0.125, 0.366]	0.270 [0.138, 0.409]
H6 SHRM → CEO → TBL	−0.007 [−0.054, 0.044]	0.165 [0.094, 0.250]	0.095 [0.007, 0.194]
H7 SHRM → GSCI → TBL	0.025 [−0.044, 0.090]	0.065 [0.023, 0.129]	0.132 [0.071, 0.207]
H8 SHRM → CEO → GSCI → TBL	−0.007 [−0.054, 0.047]	0.074 [0.040, 0.130]	0.100 [0.062, 0.156]
H9 SHRM × SEO → CEO	−0.114 [−0.283, 0.064]	0.047 [−0.059, 0.167]	0.048 [−0.051, 0.151]
R^2 (CEO/GSCI/TBL)	0.001/0.335/0.499	0.226/0.404/0.558	0.365/0.393/0.535

Note. Same model and estimation as in Section 4.3; only the source of the ratings differs. The cross-rater model uses the HR manager for SHRM and SEO and the line manager for CEO, GSCI, and TBL performance. Bias-corrected bootstrap CIs (5000 resamples).

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