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A Set of Sustainability Indicators for Brazilian Small and Medium-Sized Non-Alcoholic Beverage Industries

Alexandre André Feil [1,*], Angie Lorena Garcia Zapata [2], Mayra Alejandra Parada Lazo [2], Maria Clair da Rosa [3], Jordana de Oliveira [4] and Dusan Schreiber [4]

[1] Department of Accounting Science, University of Vale do Taquari-Univates, Lajeado 95914-014, Rio Grande do Sul, Brazil
[2] Department of Accounting Sciences at Uniminuto (Colombia), University of Vale do Taquari-Univates, Lajeado 95900-014, Rio Grande do Sul, Brazil; angie.zapata@universo.univates.br (A.L.G.Z.); mayra.lazo@universo.univates.br (M.A.P.L.)
[3] Department of Pedagogy, University of Vale do Taquari-Univates, Lajeado 95914-014, Rio Grande do Sul, Brazil; maria.rosa9@universo.univates.br
[4] Department of Environmental Quality, Feevale University, Novo Hamburgo 93510-235, Rio Grande do Sul, Brazil; eng.jordanaoliveira@gmail.com (J.d.O.); dusan@feevale.br (D.S.)
* Correspondence: afeil@univates.br

Abstract

Sustainability in the non-alcoholic beverage industry requires effective metrics to assess environmental, social, and economic performance. However, the lack of standardised indicators for small and medium-sized enterprises (SMEs) hinders the implementation of sustainable strategies. This study aims to select a set of sustainability indicators for small and medium-sized non-alcoholic beverage industries in Brazil. Seventy-four indicators were identified based on the Global Reporting Initiative (GRI) guidelines, which were subsequently evaluated and refined by industry experts for prioritisation. Statistical analysis led to the selection of 31 final indicators, distributed across environmental (10), social (12), and economic (9) dimensions. In the environmental dimension, priority indicators include water management, energy efficiency, carbon emissions, and waste recycling. The social dimension highlights working conditions, occupational safety, gender equity, and impacts on local communities. In the economic dimension, key indicators relate to supply chain efficiency, technological innovation, financial transparency, and anti-corruption practices. The results provide a robust framework to guide managers in adopting sustainable practices and support policymakers in improving the environmental, social, and economic performance of small and medium-sized non-alcoholic beverage industries.

Keywords: sustainability indicators; triple bottom line; sustainable management; beverage industry; small and medium-sized enterprises

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1. Introduction

The industrial beverage sector plays a multifaceted role in economic, social, and environmental dimensions, presenting both positive contributions and significant challenges. In Brazil, from an economic perspective, this industrial sector contributes positively to GDP, job creation, and trade balance improvement through exports, among other factors [1]. Socially, both in Brazil and other countries, it generates positive impacts such as income generation and quality-of-life improvements through Corporate Social Responsibility (CSR) programmes [2], but also negative impacts, including health issues (obesity and chronic

diseases) stemming from excessive consumption of sugary and alcoholic beverages [3]. Environmentally, the beverage industry—irrespective of country—has negative impacts due to intensive consumption of natural resources (e.g., water and energy) as well as waste generation [4]. However, while large corporations have advanced in adopting sustainable practices, small and medium-sized enterprises (SMEs) in this sector still lack standardised indicators that account for their operational and financial specificities [5].

Beverage industries, particularly SMEs, face mounting pressure to adopt sustainable practices due to environmental concerns, regulatory requirements, and consumer demands. In this context, multiple studies discuss drivers of sustainability in beverage SMEs. Ref. [6] highlights green process innovation as a strategy to enhance sustainable performance. Ref. [7] argues that financial availability, leadership commitment, and employee engagement with environmental issues are critical determinants for sectoral sustainability. Furthermore, ref. [8] examines global appeals for emission reductions and regulatory pressures on the beverage industry.

Despite these drivers, several barriers hinder the adoption of sustainable practices in beverage SMEs. Knowledge and information-sharing gaps pose significant obstacles, as many SMEs lack awareness of sustainability concepts and practices [9]. Financial constraints, inadequate technological resources, and low employee involvement in environmental mitigation projects further exacerbate these challenges [8]. External barriers, such as supplier integration difficulties and commodity price volatility, also complicate implementation [7].

Adopting a structured management model is essential for achieving sustainability in beverage SMEs, particularly through indicators that measure and improve sustainable performance [10]. These indicators enable the identification of critical success factors and the establishment of best-practice benchmarks, allowing SMEs to enhance their environmental, social, and economic performance [10]. Moreover, systemic sustainability management tools integrating all three dimensions empower organisations—including SMEs—to manage and improve their sustainability outcomes [5].

While the development of indicators is a valuable tool for sustainable management, its relevance extends beyond companies' internal environments. Studies in economics and finance also show increasing interest in environmental and social metrics, given their influence on corporate performance and market decisions [11,12]. Sustainability indicators can function as risk signals, eligibility criteria for credit, and determinants of capital flow. Recent studies provide evidence of this phenomenon; for example, ref. [11] demonstrates that ESG labels and sustainability disclosures significantly increase inflows into investment funds, while [12] show that regulatory warnings, such as visual risk symbols, alter retail investor behaviour. Following this rationale, the creation of clear, auditable indicators tailored to the realities of Brazilian SMEs can foster their integration into global value chains, enhance their attractiveness to investors, and provide a basis for public policies grounded in sustainable performance. Initiatives such as Pronampe, for instance, could link access to credit to measurable targets within these indicators, thereby promoting a virtuous cycle between sustainability and economic competitiveness.

Thus, sustainability indicators play a pivotal role in assessing sectoral performance by providing measurable targets to evaluate progress toward sustainable development. Integrating environmental, social, and economic indicators into a comprehensive framework remains a key challenge for beverage SMEs. Few studies have developed sustainability indicators that systemically capture all three dimensions [13]. Consequently, there is no standardised set of indicators holistically addressing environmental, social, and economic sustainability for SMEs in the non-alcoholic beverage sector.

Within this context, this study aims to select a tailored set of sustainability indicators for small and medium-sized non-alcoholic beverage industries in Brazil. This article addresses a critical gap in the literature by developing the first set of sustainability indicators specifically adapted to Brazilian non-alcoholic beverage SMEs, providing a theoretically grounded and operationally viable framework for integrated assessment (Triple Bottom Line). Its relevance lies in the urgency to align industrial practices with global challenges—such as water scarcity, energy transition, and social equity—within a sector vital to emerging economies. The implications of this study transcend the Brazilian context: the expert consensus-based selection methodology and emphasis on universalizable indicators (e.g., resource management, governance, and community impact) enable adaptation to regions with similar industrial profiles, thereby expanding the potential for application in sectoral policies and SME sustainability strategies at a global scale.

The article is structured as follows: Section 2 (Theoretical Review: Sectoral Context and Sustainability in SMEs), Section 3 (Methodology: Indicator Selection and Validation), Section 4 (Results: Analysis of the Final Indicator Set), and Section 5 (Conclusions, Limitations, and Future Research).

2. Theoretical Review

2.1. Brief Characterisation of the Non-Alcoholic Beverage Industry in Brazil

The non-alcoholic beverage industry in Brazil represents a robust and dynamic sector undergoing significant transformation, driven by evolving consumer preferences, economic growth, and environmental considerations. The Brazilian market encompasses a wide range of non-alcoholic beverages, including coconut water, fruit pulps, soft drinks, syrups, and others [14]. Non-alcoholic beverages are defined as those containing low or no alcohol content [15].

From an economic perspective, in 2023, Brazil registered 47,963 non-alcoholic beverage products distributed across 3494 establishments [14]. Production exceeded 29 billion litres, with the Southeast region leading at over 13 billion litres. Soft drinks accounted for 79% of national production, reaching approximately 23 billion litres [14]. Market revenue is projected to reach USD 23.62 billion by 2025 [16], while the beverage industry (alcoholic and non-alcoholic) contributed 1.31% to GDP in 2021 [17]. Federal tax revenue (excluding social security contributions) totalled BRL 11.97 billion in 2023, with employer social security contributions amounting to BRL 2.2 billion in 2022. Investments in acquisitions and net improvements to fixed assets reached BRL 7894.55 million in 2022, while business expenditure on Research and Development (R&D) amounted to BRL 100.88 million in 2021 [17]. Additionally, exports totalled USD 271.94 million in 2023, representing 0.11% of industrial goods exports.

Regarding social impacts, in 2023, the sector created 21,158 direct jobs in juice production and 51,198 in soft drinks and other non-alcoholic beverages [14]. The average monthly wage in the broader beverage industry (including alcoholic beverages) was BRL 3929.39 [17], reflecting its role in generating household income, providing employment benefits, health plans, and broader access to food products such as water and functional juices [17]. However, the industry also presents negative health impacts, including the use of ingredients potentially containing chemical, biological, and physical impurities, as well as sweeteners, acidulants, preservatives, carbon dioxide, flavourings, and colourings [18]. Further concerns highlighted in the literature include low nutritional value [19] and high sugar content, which has been linked to rising obesity, type II diabetes, dental caries, and vascular diseases [20].

Environmentally, the beverage industry exhibits significant negative impacts, particularly high water consumption, which constitutes approximately 90% of the final product,

underscoring the sector's heavy reliance on water resources [21]. This dependence often leads to unsustainable water use and inadequate effluent treatment, contributing to aquatic ecosystem degradation [22]. Moreover, the generation of alkaline-pH liquid effluents with high organic loads—primarily from equipment, facilities, and container washing—poses environmental challenges, with key contaminants including sugars derived from syrups and plant extracts [23]. The sector is also energy-intensive, relying on electricity, fuel oil, LPG/propane, and diesel, substantially increasing its carbon footprint [21]. Another critical issue is the generation of large volumes of solid waste—such as plastics, paper, cardboard, wood, PET bottles, glass, scrap metal, and aluminium cans—from packaging and bottling processes [21].

In summary, Brazil's non-alcoholic beverage industry plays a pivotal economic role, generating employment, contributing to GDP, and driving innovation investments. It also delivers positive social impacts, including income generation, improved access to food products, and labour benefits. Nevertheless, its negative impacts remain substantial, spanning public health challenges linked to high sugar and additive consumption, as well as pressure on water resources and the generation of solid waste and effluents.

2.2. Small and Medium-Sized Enterprises and Sustainability

The impact of SMEs on economic, social, and environmental dimensions is significant and, in many respects, surpasses that of large corporations. Recognised for their economic importance, SMEs represent approximately 90% of all businesses, account for over 50% of global employment, and contribute up to 40% of national income (GDP) in emerging economies [24]. Furthermore, they drive innovation and investment, bolstering economic stability [25]. Socially, SMEs promote stability by providing employment opportunities, reducing income inequality, and engaging in corporate social responsibility practices, thereby enhancing relationships with local communities, strengthening their public image, and fostering sustainable development [26]. Environmentally, many small and medium-sized industries have adopted sustainable practices such as waste reduction and energy efficiency [27], while sustainable supply chain practices can improve their market competitiveness and resilience [26].

In contrast, although large corporations possess advanced resources and technological capabilities, they often fail to engage deeply in local development or sustainable practices due to their scale and operational focus [28]. This underscores the unique and underappreciated role of SMEs in fostering more holistic development integrated with communities. However, integrating sustainability principles into SMEs presents a complex landscape of opportunities and challenges [29]. While large corporations advance in adopting sustainability reporting and practices, SMEs face specific difficulties, including limited resources, lack of expertise, and the perceived conflict between sustainability and short-term profitability [30].

SMEs frequently contend with financial constraints that restrict their ability to invest in sustainable practices, such as the high costs of new technologies and training programmes [31,32], as well as limited access to financing [33]. A lack of awareness and understanding of sustainable practices among owners and employees is another common barrier [31,32], exacerbated by insufficient resources for training and skills development [33]. Additionally, complex regulatory frameworks and the absence of supportive government policies hinder the implementation and communication of sustainability initiatives [34,35].

The pursuit of sustainable development in SMEs is intrinsically linked to the adoption of appropriate sustainability indicators, which serve as quantifiable metrics to monitor and evaluate environmental, social, and economic performance [36]. These indicators are essential for measuring progress, identifying areas for improvement, and demonstrat-

ing commitment to responsible practices [37]. However, the specific characteristics of SMEs—such as resource scarcity and lack of expertise—pose significant challenges in this process [30]. Therefore, sustainability indicators or indicator sets must be selected and structured with SME particularities in mind, prioritising simplicity, cost-effectiveness, and local relevance to ensure they are practical, accessible, and aligned with operational capacities and priorities.

2.3. Sustainability Indicators and SMEs in the Beverage Industry

Sustainability indicators play a crucial role as measurement and communication tools for organisational sustainability performance, ensuring operations align with sustainability principles [38]. These indicators enable comprehensive assessment of environmental, social, and economic impacts, providing an integrated and systemic view of organisational performance [39,40]. However, the inherent complexity of reconciling economic growth with environmental preservation, alongside the integration of diverse metrics—particularly for SMEs—demands a refined and strategic approach to embedding sustainability indicators in decision-making processes [41,42].

Sustainability indicators for SMEs are essential, yet to be effective, they must be tailored to SME-specific constraints, such as limited resources and access to capital. Key guidelines defining effective sustainability indicators for SMEs include:

(a) Adaptation of Existing Standards: Many sustainability indicators derive from internationally recognised frameworks like the Global Reporting Initiative (GRI). To ensure applicability for SMEs, these indicators must be simplified and adjusted to their operational limitations and available resources [40,43].
(b) Maturity Models: Implementing maturity models helps SMEs visualise their progression in adopting sustainable practices, enabling structured and incremental self-assessment. Such models facilitate realistic goal-setting and continuous adaptation to market and regulatory demands [35].
(c) Resource Efficiency: Indicators should promote resource optimisation and cost reduction, ensuring sustainable practices are economically viable and compatible with SME operational realities. Resource-efficient indicators thus enhance both environmental sustainability and business competitiveness [44].
(d) Stakeholder Engagement: Involving stakeholders in indicator development ensures they reflect the expectations of employees, customers, and local communities. This engagement enhances indicator legitimacy and strengthens corporate commitment to sustainability, fostering broader stakeholder buy-in [44].

Within the context of the environmental, social, and economic dimensions, it is essential that sustainability indicators also explicitly encompass aspects related to supply chain transparency and coordination. Studies such as [45] highlight that information sharing, traceability, and inter-organisational cooperation are fundamental pillars of Sustainable Supply Chain Management (SSCM) in SMEs. As argued by [46], sustainability in the production chain demands systemic integration among production links, which necessitates indicators focused on traceability, supplier environmental practices, and external verification mechanisms. The incorporation of these elements broadens the evaluative scope of the indicators and strengthens SMEs' capacity to mitigate risks, meet regulatory requirements, and generate competitive advantage in sustainable markets.

For SMEs in the beverage industry, defining a standardised set of indicators that address their unique challenges is imperative. As outlined in Table 1, priority areas for indicator development span the three core dimensions of the Triple Bottom Line.

Table 1. Key priority areas for SMEs in the beverage industry.

Citations	Priority Areas	Dimension
[47–49]	Carbon footprint reduction, water resource management, waste management	Environmental
[47,50,51]	Labour rights, human rights, community development, consumer awareness	Social
[1,47,49]	Cost management, market competitiveness, supply chain efficiency	Economic

Addressing these priorities, the development of standardised indicators is a critical step to guide SMEs in the non-alcoholic beverage sector toward sustainable strategies. Such indicators not only facilitate performance measurement but also support evidence-based decision making, balancing economic viability, social responsibility, and environmental preservation.

3. Methodology

3.1. Research Typology, Techniques, and Data Collection

This study adopts a mixed-methods approach, combining quantitative and qualitative techniques, following recommendations by [52–54]. The research was conducted through a survey employing a structured questionnaire based on sustainability indicators from the Global Reporting Initiative (GRI). The GRI framework can be integrated with other sustainability metrics, as evidenced by the development of customised performance indicators in various case studies [55]. These indicators were selected due to their applicability to organisations of varying sizes and sectors, structured according to the Triple Bottom Line dimensions and developed using criteria of relevance, comparability, and reliability.

From the GRI Standards [56], 74 sustainability indicators were compiled, distributed across environmental (25), social (33), and economic (16) dimensions, with support from NVivo software (version 14). This process enabled the development of a more objective research instrument aligned with the realities of the organisations studied, ensuring a comprehensive sustainability assessment for the sector.

Indicator prioritisation was conducted via survey, where respondents evaluated each item using a five-point Likert scale: *Dispensable (1), Non-Priority (2), Desirable (3), Important (4),* and Very Important (5). The questionnaire targeted managers, employees, researchers, and other professionals affiliated with Brazil's non-alcoholic beverage industry. The Likert scale—widely used for measuring perceptions and attitudes—allowed for quantification of each indicator's perceived importance and facilitated consensus-building regarding essential elements for sectoral sustainability [57].

Non-probability convenience sampling was employed, yielding 299 responses between August 2023 and April 2024, with national coverage. Data collection utilised Google Forms to ensure accessibility and broad dissemination. Respondent anonymity was guaranteed to encourage candid responses, particularly for sensitive questions.

3.2. Analysis of Responses and Consensus Level

The analysis of responses was conducted in two stages: (i) characterisation of respondents' profiles using descriptive statistics and multivariate analysis, including correlations between respondent groups based on education, field of study, and professional experience in relation to the indicators; and (ii) assessment of the level of agreement and consensus, aiming to define a validated set of sustainability indicators for SMEs in the non-alcoholic beverage industry.

Statistical analyses, including correlation tests, descriptive statistics, and measurement of the consensus level, were performed using IBM SPSS Statistics, version 27. To ensure comparability between respondent groups (academics and industry professionals), the Kolmogorov–Smirnov test was applied, as it is appropriate for identifying differences in independent sample distributions [58]. Subsequently, Confirmatory Factor Analysis (CFA) was conducted to validate the theoretical structure of the remaining indicators across the environmental, social, and economic domains, utilising the following metrics: Kaiser–Meyer–Olkin (KMO) test, Bartlett's sphericity test, communalities, and domain-specific explained variance. The application of multiple statistical tests to verify the robustness of the results and establish a methodologically grounded consensus strengthens the reliability of the indicator selection for SMEs in the non-alcoholic beverage sector, as advocated by [59].

Multivariate analysis was conducted using Cronbach's alpha reliability test, assessment of data normality via the Kolmogorov–Smirnov and Shapiro–Wilk tests, and correlation analysis using Spearman's rho coefficient (r_s). Spearman's coefficient identifies relationships between variables influencing indicator selection, with values ranging from $-1 \leq r_s \leq 1$. The correlation strength was categorised according to [60]: negligible (0.0–0.1), weak (0.1–0.39), moderate (0.40–0.69), strong (0.70–0.89), and very strong (0.90–1.00).

Agreement among respondents was analysed using descriptive statistics (mean (μ_x), standard deviation (σ), and coefficient of variation (CV)). The consensus level was measured based on the methodology by [57]. The coefficient of variation, which expresses the relative dispersion of data in relation to the mean, was interpreted according [61]: low CV and high consensus level ($0.0 \leq CV < 0.1$), medium ($0.1 \leq CV \leq 0.2$), high ($0.2 < CV \leq 0.3$), and very high CV, associated with low consensus ($CV > 0.3$).

Consensus can be defined as the degree of agreement among a group of individuals regarding a specific topic. Its level, Cns (X), can be estimated using Equation (1), following the methodology proposed by [57]:

$$Cns(X) = 1 + \sum_{i=1}^{n} p_i log_2 \left(1 - \frac{|X_i - u_X|}{d_X}\right)$$

where μ_x represents the mean of the values of X_i, and d_x is the range of the dataset, defined as $d_x = X_{max} - X_{min}$.

Ref. [57] refined Shannon's entropy equation to enhance its efficiency in measuring consensus, making it particularly useful for five-point Likert scales. However, this approach does not establish an optimal cut-off point for classifying the consensus level. Thus, the categorisation proposed by [62] was adopted, defining three consensus levels: low (50–69%), medium (70–79%), and high (>80%).

The definition of a minimum consensus threshold varies in the literature. Refs. [63,64] suggest that agreement levels between 51% and 80% may be considered acceptable. In this study, a cut-off criterion of $\geq$70% was adopted, ensuring a sufficiently representative set of indicators aligned with the Triple Bottom Line dimensions. This criterion is also supported by studies such as [59,65], who used similar approaches for selecting sustainability indicators in specific contexts. Despite the adoption of reference values, determining the cut-off point remains a methodological decision for the researcher. Ref. [66] emphasises that there is no universally accepted standard, and different studies adopt varying criteria depending on the research scope and sample characteristics.

4. Results and Analyses

4.1. Analysis of Respondents' Profile

The non-probabilistic sample (n = 299) comprises 189 respondents affiliated with universities (63.2%) and 110 professionals working in the beverage industry (36.8%). This

distribution reflects an intentional balance between academic expertise and practical sectoral experience (Figure 1). To mitigate potential profiling biases, a posteriori comparative analyses between the groups were conducted using the Kolmogorov–Smirnov test, ensuring that the indicators retained operational relevance despite the predominantly academic context (Section 4.2). Notably, the industrial subsample size (n = 110) meets the minimum recommended parameters for factorial analyses in applied studies, as suggested in [67], which proposes 100 as an acceptable threshold for statistical validity.

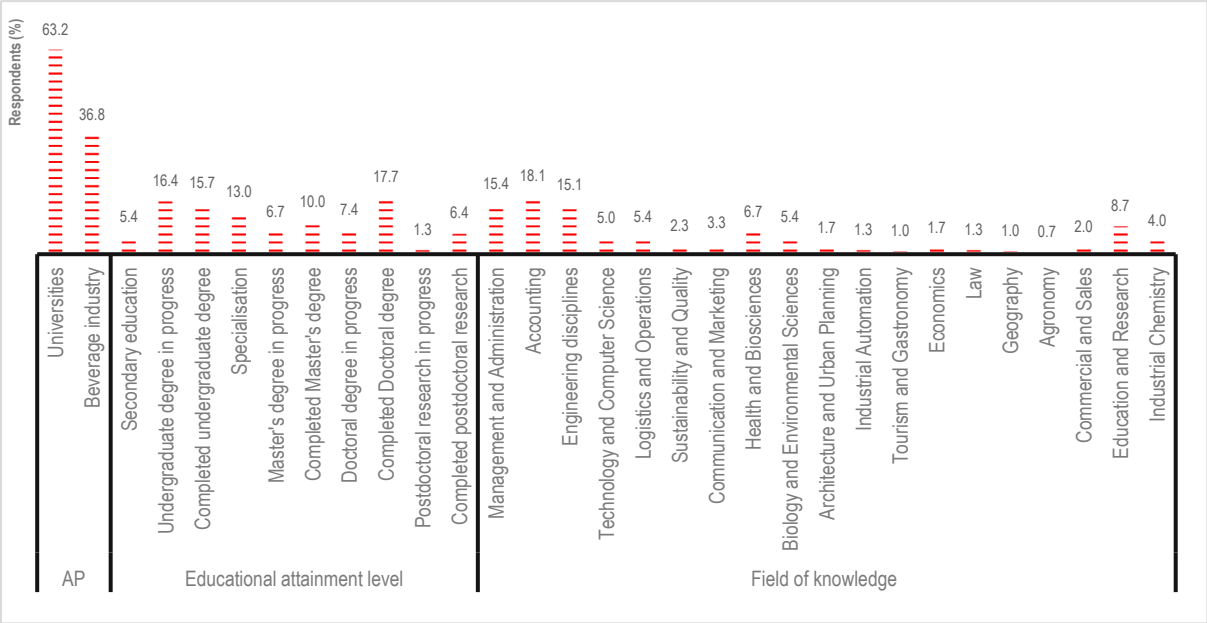


Figure 1. Respondents' Profile. Source: Prepared by the authors. Legend: Management and Administration (Administration, Business Management, Financial Management, Healthcare Management, Market Planning), Accounting (Controllership, Forensic Accounting), Engineering (Electrical Engineering, Civil Engineering, Mechanical Engineering, Production Engineering, Chemical Engineering, Materials Engineering, Food Engineering, Control and Automation Engineering, Environmental Engineering, Forestry Engineering, Process Engineering), Technology and IT (Information Technology, Computer Science, Systems Analyst, Informatics, Industrial Mechatronics), Logistics and Operations (Logistics, Logistics Technology, Machine Operation, Production Assistant, Production Supervisor, Paper Industry), Sustainability and Quality (Environmental Management, Quality Control, Packaging Specialist, International Relations, Local Development, Sustainable Management and Innovation), Communication and Marketing (Advertising and Marketing, Social Communication and Journalism, Press Relations, Graphic Design, Product Design), Health and Biosciences (Nursing, Pharmacy, Veterinary Medicine, Biomedicine, Psychology, Physiotherapy, Nutrition, Nutritionist, Healthcare Management), Biology and Environmental Sciences (Biology, Environmental Sciences, Environmental Monitoring, Oceanography, Genomics and Biotechnology), Tourism and Gastronomy (Tourism, Events and Gastronomy, Dairy Science, Nutrition and Environmental Quality, Animal Science-Quality), Agronomy and Agricultural Sciences (Agronomy, Forestry Engineering, Veterinary Medicine, Animal Science), Education and Research (Pedagogy, Literature, Education, Teaching, Anthropology, Mathematics), Industrial Chemistry (Chemistry, Chemical Engineering, Pharmaceutical Sciences, Clinical Pathology, Immunology).

This mixed perspective (academic and practical) ensures that the selected indicators reconcile theoretical foundations with practical applicability, making them more aligned with the reality of small and medium-sized non-alcoholic beverage industries. According to [68], the academic perspective guarantees that the indicators are aligned with sustainability principles, while [69] emphasises that the participation of industry professionals contributes to the selection of relevant and applicable indicators.

The education level reveals a high level of qualification among participants, with a predominance of graduates (16.4%) and specialists (13.0%), as well as a significant percentage of master's degree holders (10.0%) and doctoral candidates (7.7%). Thus, the solid technical and scientific background of the participants strengthens the credibility of the indicator selection. As [68] argues, a high education level enhances individuals' analytical capacity in evaluating and selecting indicators, ensuring greater scientific validity and reliability.

The analysis of knowledge areas highlights the significant participation of professionals from accounting (18.1%), engineering (15.1%), and administration (15.4%), followed by information technology, logistics and operations, and sustainability and quality. Ref. [70] emphasises that this diversity allows for both a holistic and systemic understanding of sustainability, ensuring the inclusion of economic, environmental, and social aspects. Similarly, ref. [68] highlights that the involvement of experts from different fields facilitates the identification of specific and relevant indicators for distinct sustainability components.

Thus, the research findings indicate that the diversity of respondents' backgrounds, experience, and knowledge contributes to the robustness and consistency of the proposed sustainability indicator set.

4.2. Analysis of Reliability and Consensus Level

The Cronbach's alpha reliability test yielded $\alpha = 0.958$, a value classified as excellent according to [71], indicating high internal consistency of the questionnaire responses. Additionally, the Kolmogorov–Smirnov test was applied to assess potential biases between the groups (academics and beverage industry professionals).

The Kolmogorov–Smirnov test identified statistically significant differences ($p < 0.05$) in the distribution of eight indicators (Community Investment, Regional Development, Consumption of Polluting Substances, Protected or Restored Habitat, Hazardous Air Pollutants (HAPs), Complaints Related to Labour Practices, Fines and Sanctions for Legal Non-Compliance, Non-Compliant Marketing Communications) between university-affiliated and beverage industry respondents (Appendix A). These indicators were excluded, retaining 66 for subsequent analyses to ensure distribution homogeneity—a fundamental requirement for parametric techniques. As recommended by [58] for parametric multivariate methods, variables exhibiting inter-group distributional heterogeneity must be excluded when threatening homoscedasticity assumptions. This procedure prevents subsequent analyses from being biased by systemic differences in institutional response patterns [67].

A Confirmatory Factor Analysis (CFA) was conducted to verify the dimensional structure of the 66 indicators, organised within the theoretical environmental, social, and economic constructs. Sample adequacy was confirmed by the Kaiser–Meyer–Olkin (KMO) test (results: 0.85–0.912, exceeding the 0.80 threshold) and Bartlett's test of sphericity ($p < 0.001$) (see Table 2), which jointly validated sample suitability and correlation matrix non-sphericity. The total variance explained reached 69.32% (environmental), 68.11% (social), and 59.46% (economic)—percentages deemed adequate for applied social studies [67]. Mean communalities (>0.5) validated indicator convergence within their respective constructs, aligning with [72]'s criteria. This outcome satisfies [72]'s guidelines for item retention in factorial models, ensuring construct representation reliability.

The normality analysis, using the Kolmogorov–Smirnov and Shapiro–Wilk tests, resulted in $p = 0.000$, suggesting a skewed and non-normal distribution [73]. Consequently, a non-parametric approach was adopted, with Spearman's rho tests employed to analyse correlations between variables.

Table 2. Results of the confirmatory factor analysis.

Explained Variance	Bartlett's χ^2	KMO	Domain
69.32%	2321.283 *	0.850	Environmental
68.11%	10,465.16 *	0.912	Social
59.46%	1633.08 *	0.856	Economic

* $p < 0.001$. Source: prepared by the authors.

The results of Spearman's rho coefficient indicate that the variables professional experience, education level, and field of study exhibited statistically significant correlations ($p < 0.01$ or $p < 0.05$; see Appendix A), albeit of negligible to weak strength, as per the classification by [60]. Thus, the findings suggest subtle trends in respondents' perceptions without indicating pronounced bias, reflecting a relatively neutral and impartial evaluation of the indicators. This interpretation aligns with the criteria established by [60,73], reinforcing the reliability and validity of the statistical analysis conducted.

The coefficient of variation revealed that 40.45% of the 74 indicators analysed exhibited a medium consensus level ($0.10 \leq CV \leq 0.20$), based on the classification proposed by [61]. Notably, no indicator achieved a high consensus level; however, a significant number of 31 indicators demonstrated relatively homogeneous perceptions among respondents regarding their relevance. This finding may indicate alignment in evaluations or a consolidated understanding of the topics addressed.

The consensus level methodology, Cns (X), proposed in [57], revealed that 18 sustainability indicators (24.3%) presented Cns (X) ≤ 0.50, classified as lacking consensus or unacceptable (see Appendix B), in accordance with [63,64]. Furthermore, the indicators were distributed across different consensus levels based on the classification by [62]: 27 indicators (36.5%) exhibited low consensus, 30 indicators (40.54%) demonstrated medium consensus, and only 1 indicator (1.35%) was classified as having high consensus.

Furthermore, it should be emphasised that adopting a more stringent threshold ($\geq$80%) would reduce the final indicator set to just one measure, rendering a comprehensive sustainability assessment unfeasible. Consequently, the $\geq$70% cut-off, albeit debatable, aligns with the objective of balancing methodological rigour and practical utility for SMEs, thereby ensuring coverage across all three TBL dimensions.

The choice of consensus threshold directly impacts policy and managerial decision making. A stricter cutoff (e.g., $\geq$80%) would yield an excessively narrow set of indicators, undermining the framework's ability to holistically assess SME sustainability and limiting its utility for sector-wide policies. Conversely, a lower threshold (e.g., $\geq$50%) might include less consensual indicators, potentially diluting the credibility of assessments and incentivizing superficial compliance rather than substantive improvements. The 70% threshold thus optimises practical relevance: it ensures a robust yet feasible framework that enables policymakers to design targeted regulations (e.g., linking credit access to Pronampe sustainability targets) while providing managers with actionable priorities aligned with sector-specific challenges like water scarcity and supply chain transparency.

4.3. Set of Indicators for the Non-Alcoholic Beverage Industry

The final selection of indicators was based on the inclusion criterion of those with medium to high consensus levels (Cns (X) ≥ 0.70), as recommended in [59,65].

Consequently, 31 indicators were selected to assess sustainability in small and medium-sized non-alcoholic beverage industries (Table 3, excerpt from Appendix B).

Table 3. Selection of sustainability indicators for the non-alcoholic beverage industry.

Cns (X)	Dimension/Indicators
	Economic Dimension
0.75	Sales revenue
0.78	Operational expenditures
0.74	Employee salaries and benefits
0.71	Dividends and interest on equity
0.71	Taxes and government contributions
0.71	Purchases from local suppliers
0.73	Infrastructure investments in society
0.71	Technological innovations (production and distribution)
0.70	Indirect job creation
	Environmental Dimension
0.78	Recycled materials
0.77	Recycled and reused water
0.71	Company's geographical location
0.71	Energy from non-renewable and renewable sources
0.82	Reused and recycled waste
0.74	Recovered product packaging
0.70	Environmental complaints
0.74	Environmental prevention and management costs
0.71	Environmental supplier policies
0.79	Environmental impact assessments
	Social Dimension
0.70	Number of employees
0.74	Legal employee benefits
0.75	Employee training
0.71	Employee performance
0.71	Social impact assessments through participatory processes
0.72	Public disclosure of environmental and social impacts
0.72	Local development programmes
0.71	Operations evaluated for corruption risks
0.77	Anti-corruption policies and procedures
0.71	Employees trained in anti-corruption measures
0.78	Products with certification and labelling
0.75	Customer satisfaction

Source: prepared by the authors.

The set of 31 sustainability indicators are distributed across the Triple Bottom Line (TBL) dimensions: environmental (10), social (12), and economic (9). The number of indicators is classified as moderate and appropriate, as according to [74], a set of 20 to 50 indicators falls within a suitable range for measuring sustainability. Regarding the balance between TBL dimensions, the distribution is relatively even, which is considered optimal [75]. However, refs. [75,76] note that many sustainability efforts disproportionately focus on environmental and economic factors, often neglecting social aspects. This suggests that despite a balanced number of indicators across dimensions, sustainability measurement practices may still exhibit bias, potentially undervaluing one or two TBL dimensions.

The selected economic sustainability indicators (Table 3) encompass revenues, operational expenditures, salaries and benefits, dividends and interest on equity, taxes, local supplier purchases, societal investments, technological innovations, and indirect job creation. These indicators represent priority areas for economic sustainability in Brazil's non-

alcoholic beverage industry, aligning with key focuses of sustainable business management. Specifically, they reflect cost optimisation and value addition [47], market competitiveness through revenue growth, profitability, and dividend distribution [1], and supply chain efficiency through innovative technologies [49]. Thus, these indicators enable a comprehensive assessment of the sector's economic sustainability, considering both financial viability and socio-economic impact.

Despite progress in selecting economic indicators, it is noted that supply chain transparency remains limited in scope. While the 'Environmental Supplier Policies' indicator represents an advancement, the Sustainable Supply Chain Management (SSCM) literature recommends more specific and operational metrics. Ref. [45] proposes indicators focusing on traceability, supplier certification, and audit frequency, whereas [46] emphasises the importance of supply chain coordination as a critical condition for sustainable performance. Incorporating these dimensions not only enhances control over indirect impacts but also strengthens regulatory compliance and stakeholder credibility. Consequently, we recommend the future inclusion of specific indicators for supply chain monitoring, particularly in sectors such as beverages where input sourcing and supplier practices have significant environmental and social impacts.

The environmental sustainability indicators include recycled materials, water recycling and reuse, company location, energy from renewable and non-renewable sources, waste reuse and recycling, recovered packaging, environmental complaints, environmental management expenditures, supplier environmental policies, and environmental impact assessments. These reflect priority areas for environmental sustainability in small and medium-sized non-alcoholic beverage industries and align with sustainable environmental management principles. The findings correlate with water resource management through recycling technologies [48,49], waste and material management via recycling programmes [50], collaborative environmental risk management [77], and renewable energy use [49]. The selected indicators thus facilitate a holistic evaluation of the sector's environmental performance, promoting sustainable practices and regulatory compliance.

The social sustainability indicators cover employees (number, legal benefits, training, performance), social impact assessments, public disclosure of impacts, local development programmes, corruption risk evaluations, anti-corruption policies, certified and labelled products, and customer satisfaction. These represent priority social focuses for Brazil's non-alcoholic beverage industry and align with the literature on labour rights [47], community development initiatives [50], and consumer awareness [78]. These indicators highlight key areas for social sustainability, serving as essential tools for promoting fairer and more inclusive business practices.

5. Conclusions, Limitations, and Future Research

This study establishes a set of 31 sustainability indicators specifically adapted to small and medium-sized non-alcoholic beverage industries in Brazil, distributed across the environmental (10), social (12), and economic (9) TBL dimensions. The results reveal industry-critical indicators: within the environmental sphere, water management (focusing on water recycling/reuse), energy efficiency (prioritising renewable sources), solid waste management, and ecological impact assessment stand out; in the social dimension, labour practice transparency, corruption prevention, and community development are prominent; and economically, technological innovation, supply chain efficiency, and indirect job generation are paramount. This framework, aligned with Global Reporting Initiative (GRI) guidelines and validated by expert consensus (Cns (X) $\geq$ 0.70), offers an operationally viable tool for managers to monitor sustainable performance and identify improvement

areas, while also informing policymaker development of sector-specific regulations adapted to SME constraints.

However, several limitations warrant acknowledgement. The restricted sectoral scope—exclusively focused on non-alcoholic beverages—may limit immediate applicability to other industrial segments without contextual adaptation. Additionally, the adopted consensus threshold (≥70%), though supported by specialised research, risks excluding indicators relevant to specific contexts. The academic respondent predominance (63.2%) in the sample may also introduce theoretical bias, potentially underestimating practical operational challenges. Furthermore, supply chain transparency—despite its stated importance in the study's title and objectives—was not addressed with commensurate depth. Whilst indicators like 'Environmental Supplier Policies' and 'Operations Assessed for Corruption Risks' provide a foundation, their practical implementation depends on verification mechanisms (e.g., supplier certifications) not detailed herein.

To address these limitations and extend the research scope, future pathways are suggested: standardisation of specific metrics (e.g., quantifying "recycled water" in m^3/litre produced or "carbon emissions" in t CO_2 eq/unit); framework validation in analogous sectors (e.g., fresh foods or dairy) to identify cross-sectoral invariants; development of composite indices incorporating weightings adjusted for SME heterogeneity; longitudinal studies correlating indicator adoption with competitiveness gains (cost reduction, premium market access); and empirical applications validating relationships between proposed indicators and measurable environmental/social/economic performance metrics (e.g., documented energy efficiency, audited financial indicators, effective recycling rates).

To strengthen the practical applicability and robustness of the sustainability indicator set, particularly concerning supply chain transparency, it is suggested that future empirical studies be conducted. Such research could validate the effectiveness of these indicators within real-world contexts of beverage sector SMEs, analysing their correlation with improved sustainable performance and risk mitigation. Empirical validation would allow for the refinement of the indicators, ensuring they are not only theoretically sound but also operationally viable and impactful for managerial decision making and sectoral policy.

Moreover, whilst the indicator set was validated through expert consensus, its practical efficacy in predicting actual sustainability performance requires empirical verification. Future studies should apply these indicators to sectoral SME samples and correlate them with objective metrics (e.g., verified water consumption reduction, audited financial data, occupational accident rates). Such empirical validation would strengthen the framework's robustness and adoption as a management tool.

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Appendix A

Kolmogorov–Smirnov *p*-Value	Spearman's Rho			
	Knowledge Area	Education Level	Company	Variable
	−0.034	0.471 **	1	Company
	−0.105	1	0.471 **	Education Level
	1	−0.105	−0.034	Knowledge Area
0.998	0.01	0.023	−0.049	Sales Revenue
1.000	−0.007	0.102	−0.014	Operating Expenditure
0.846	0.151 **	0.049	0.033	Employee Wages and Benefits
0.951	0.083	−0.041	0.096	Dividends and Interest on Equity Paid
0.995	0.081	0.073	0.085	Taxes and Levies Paid to Government
0.049	0.164 **	0.058	0.135 *	Community Investment
0.697	0.183 **	0.015	0.095	Private Pension Plans
1.000	0.102	−0.114 *	0.028	Government Incentives
0.995	−0.016	−0.056	0.013	Wage vs. Local Minimum Wage
0.130	0.152 **	0.016	0.160 **	Senior Management from Local Community
0.060	0.140 *	0.004	0.150 **	Purchases from Local Suppliers
0.651	0.140 *	−0.002	0.103	Infrastructure Investment in Society
0.999	0.057	−0.093	0.049	Technological Innovations (Production and Distribution)
0.005	0.091	0.055	0.195 **	Regional Development
0.892	0.064	−0.127 *	0.075	Products and Services for Low-Income Individuals
0.607	0.098	−0.023	0.112	Indirect Job Creation
0.600	0.054	0.089	0.035	Non-Renewable and Renewable Materials
0.647	0.011	0.008	0.064	Recycled Materials
0.093	0.007	0.118*	0.052	Energy from Non-Renewable and Renewable Sources
1.000	0.088	0.015	−0.002	Surface and Groundwater
0.309	0.063	0.115 *	0.082	Recycled and Reused Water
0.566	0.097	−0.087	0.066	Geographical Location of the Company

0.997	0.143 *	−0.117 *	0.018	Size of Operational Unit
0.005	0.087	0.003	0.037	Consumption of Polluting Substances
0.128	−0.01	0.013	0.038	Use of Invasive, Harmful, and Pathogenic Species
0.124	0.006	0.004	0.051	Species Reduction
0.004	0.139 *	0.087	0.237 **	Protected or Restored Habitat
0.406	0.022	−0.02	0.029	Emissions of Ozone-Depleting Substances (ODS)
0.138	0.057	0.004	0.048	Persistent Organic Pollutants (POPs)
0.486	0.029	−0.015	0.062	Particulate Matter (PM) Generation
0.017	0.006	0.03	0.054	Hazardous Air Pollutants (HAPs)
0.890	0.016	0.092	0.061	Reused and Recycled Waste
0.180	0.06	0.031	0.124 *	Incineration Waste
0.547	0.018	0.042	0.077	Waste Sent to Landfills
0.843	0.073	−0.012	0.091	On-Site Waste Storage
0.626	0.063	0.084	0.055	Environmental Impact of Products
0.771	0.053	0.048	0.085	Recovered Product Packaging
0.331	0.041	0.041	0.074	Environmental Fines and Sanctions
0.634	0.092	−0.054	0.103	Environmental Complaints
0.150	0.011	0.057	0.145 *	Environmental Prevention and Management Expenditure
0.314	0.027	0.037	0.099	Supplier Environmental Policies
0.989	0.033	−0.07	0.047	Number of Employees
0.808	−0.039	−0.097	−0.047	Employee Turnover
1.000	0.095	−0.026	0.009	Statutory Employee Benefits
0.745	0.031	−0.05	0.037	Employees with Occupational Illnesses
1.000	0.057	−0.043	−0.007	Employee Training
0.990	0.077	0.003	0.088	Retirement or Redundancy Programs
0.505	0.039	−0.101	−0.03	Employee Performance Reviews
0.766	0.129 *	−0.031	0.102	Employees by Functional Category
0.796	0.133 *	0.031	0.096	Suppliers Selected Based on Labour Practices
0.005	0.027	0.038	0.131 *	Complaints Related to Labour Practices
0.278	−0.019	0.012	0.083	Complaints Related to Human Rights
0.951	0.022	0.019	−0.025	Operations with Human Rights Violations
0.645	−0.006	0.05	0.012	Discrimination Practices
0.131	−0.025	0.099	0.049	Supplier Operations with Child Labour Risks
0.986	−0.018	0.073	0.004	Occurrence of Forced/Slave Labour
0.272	−0.096	0.037	0.121 *	Employee Training on Human Rights Policies
0.991	−0.005	0.046	−0.008	Violation of Indigenous and Traditional Peoples' Rights
0.271	0.047	−0.017	0.119 *	Social Impact Assessments via Participatory Processes
0.773	0.031	0.078	0.125 *	Environmental Impact Assessments
0.085	0.035	0.11	0.263 **	Public Disclosure of Environmental and Social Impacts
0.460	0.062	0.058	0.172 **	Local Development Programs
0.234	0.094	0.107	0.11	Operations Assessed for Corruption Risks
0.573	0.014	0.118 *	0.149 *	Anti-Corruption Policies and Procedures
0.674	0.036	0.051	0.140 *	Employees Trained in Anti-Corruption Measures
0.929	0.06	0.043	0.046	Corruption Cases and Measures Taken
0.549	−0.029	−0.019	0.094	Contributions to Political Parties
0.491	−0.089	0.022	0.103	Legal Actions for Unfair Competition
0.038	−0.05	0.073	0.195 **	Fines and Sanctions for Legal Non-Compliance

1.000	0.147 *	−0.088	−0.005	Products with Certification and Labelling
1.000	0.065	−0.057	0.02	Customer Satisfaction
0.940	−0.004	−0.002	−0.029	Sale of Banned or Controversial Products
0.035	−0.004	−0.034	−0.002	Non-Compliant Marketing Communications
0.843	0.014	−0.03	0.041	Complaints Regarding Privacy and Data Loss

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Appendix B

				Likert Scale					
Cns (X)	**CV**	**SD**	**(μX)**	**5**	**4**	**3**	**2**	**1**	**Indicators**
0.8	0.2	0.7	4.5	195	79	18	7	0	Sales Revenue
0.8	0.1	0.6	4.6	204	79	13	2	1	Operating Expenditure
0.7	0.2	0.7	4.5	177	91	25	6	0	Employee Wages and Benefits
0.7	0.2	0.9	4.0	96	125	58	18	2	Dividends and Interest on Equity
0.7	0.2	0.9	4.1	107	128	49	11	4	Taxes and Levies Paid to Government
0.7	0.2	1	4.1	136	88	58	13	4	Community Investment
0.6	0.3	1	3.7	74	97	90	30	8	Private Pension Plans
0.7	0.3	1	4.0	110	103	60	20	6	Government Incentives
0.4	0.5	1.4	3.0	48	81	55	49	66	Wage vs. Local Minimum Wage
0.6	0.3	1.1	3.8	89	100	68	36	6	Senior Management from Local Community
0.7	0.2	0.9	4.0	98	119	66	14	2	Purchases from Local Suppliers
0.7	0.2	0.8	4.2	127	118	48	6	0	Infrastructure Investment in Society
0.7	0.2	0.9	4.2	120	130	32	15	2	Technological Innovations (Production and Distribution)
0.7	0.2	0.9	4.3	148	97	45	6	3	Regional Development
0.7	0.2	0.9	4.2	144	92	51	10	2	Products and Services for Low-Income Individuals
0.7	0.2	0.9	4.2	126	110	51	10	2	Indirect Job Creation
0.7	0.2	0.9	4.3	156	100	27	8	8	Non-Renewable and Renewable Materials
0.8	0.1	0.7	4.6	207	76	11	4	1	Recycled Materials
0.7	0.2	0.9	4.4	183	84	21	3	8	Energy from Non-Renewable and Renewable Sources
0.7	0.2	0.9	4.3	159	96	32	9	3	Surface and Groundwater
0.8	0.1	0.7	4.6	204	74	16	4	1	Recycled and Reused Water
0.7	0.2	0.9	4.2	132	122	33	8	4	Geographical Location of the Company
0.7	0.2	0.9	4.0	96	135	46	17	5	Size of Operational Unit
0.4	0.4	1.5	3.8	137	69	31	14	48	Consumption of Polluting Substances
0.3	0.4	1.5	3.7	138	57	29	22	53	Use of Invasive, Harmful, and Pathogenic Species
0.3	0.4	1.5	3.6	130	61	27	27	54	Species Reduction
0.6	0.2	1	4.4	195	60	25	12	7	Protected or Restored Habitat
0.4	0.4	1.4	4.1	186	47	15	9	42	Emissions of Ozone-Depleting Substances (ODS)

0.5	0.3	1.4	4.1	173	60	18	12	36	Persistent Organic Pollutants (POPs)
0.5	0.3	1.3	3.9	144	79	27	14	35	Particulate Matter (PM) Generation
0.4	0.3	1.4	4.1	171	59	23	6	40	Hazardous Air Pollutants (HAPs)
0.8	0.1	0.5	4.7	217	72	9	1	0	Reused and Recycled Waste
0.6	0.2	1	4.1	130	107	34	21	7	Incineration Waste
0.6	0.2	1	4.2	154	99	22	14	10	Waste Sent to Landfills
0.7	0.2	1	4.2	141	104	32	14	8	On-Site Waste Storage
0.6	0.2	1.1	4.4	210	54	9	9	17	Environmental Impact of Products
0.7	0.2	0.7	4.5	189	89	15	2	4	Recovered Product Packaging
0.7	0.2	0.9	4.5	190	80	17	5	7	Environmental Fines and Sanctions
0.7	0.2	0.9	4.4	180	88	20	5	6	Environmental Complaints
0.7	0.2	0.7	4.5	178	91	27	2	1	Environmental Prevention and Management Expenditure
0.7	0.2	0.8	4.4	174	85	34	4	2	Supplier Environmental Policies
0.7	0.2	0.9	4.2	129	123	28	16	3	Number of Employees
0.6	0.3	1.1	4.0	135	88	43	19	14	Employee Turnover
0.7	0.2	0.7	4.4	172	93	30	3	1	Statutory Employee Benefits
0.6	0.3	1.1	4.1	135	100	36	12	16	Employees with Occupational Illnesses
0.8	0.2	0.7	4.5	194	80	22	1	2	Employee Training
0.7	0.2	0.9	4.2	140	94	56	6	3	Retirement or Redundancy Programs
0.7	0.2	0.8	4.4	158	103	32	2	4	Employee Performance
0.7	0.2	0.9	4.1	123	115	46	10	5	Employees by Functional Category
0.7	0.2	0.9	4.3	152	100	38	5	4	Suppliers Selected Based on Labour Practices
0.7	0.2	1	4.2	145	106	29	8	11	Labour Practice Complaints
0.7	0.2	0.9	4.4	172	86	27	6	8	Human Rights Complaints
0.5	0.3	1.3	4.2	183	58	21	7	30	Operations with Human Rights Violations
0.5	0.3	1.3	4.2	188	56	19	5	31	Discrimination Practices
0.5	0.3	1.3	4.2	195	53	13	6	32	Supplier Operations with Child Labour Risks
0.5	0.3	1.3	4.3	206	39	15	4	35	Occurrence of Forced/Slave Labour
0.7	0.2	0.9	4.4	183	81	27	1	7	Employee Training on Human Rights Policies
0.4	0.3	1.4	4.1	173	58	24	6	38	Violation of Indigenous and Traditional Peoples' Rights
0.7	0.2	0.8	4.4	164	95	33	4	3	Social Impact Assessments via Participatory Processes
0.8	0.1	0.6	4.6	208	72	16	3	0	Environmental Impact Assessments
0.7	0.2	0.8	4.4	178	82	33	5	1	Public Disclosure of Environmental and Social Impacts
0.7	0.2	0.8	4.4	167	95	30	5	2	Local Development Programs
0.7	0.2	0.8	4.5	192	71	27	6	3	Operations Assessed for Corruption Risks
0.8	0.2	0.7	4.6	208	68	18	4	1	Anti-Corruption Policies and Procedures
0.7	0.2	0.8	4.4	179	82	30	6	2	Employees Trained in Anti-Corruption Measures

0.7	0.2	0.9	4.4	189	72	22	9	7	Corruption Cases and Measures Taken
0.4	0.5	1.5	3.0	74	49	50	56	70	Contributions to Political Parties
0.5	0.3	1.3	3.8	117	84	44	29	25	Legal Actions for Unfair Competition
0.5	0.3	1.2	4.1	150	80	32	15	22	Fines and Sanctions for Legal Non Compliance
0.8	0.1	0.7	4.6	211	71	14	1	2	Products with Certification and Labelling
0.7	0.2	0.7	4.5	188	83	24	3	1	Customer Satisfaction
0.4	0.4	1.4	3.9	150	69	27	12	41	Sale of Banned or Controversial Products
0.6	0.3	1.2	4.0	133	94	41	11	20	Non-Compliant Marketing Communications
0.6	0.2	1	4.3	175	70	36	5	13	Complaints Regarding Privacy and Data Loss

Source: Prepared by the authors. Legend: Likert scale (1 = Dispensable, 2 = Non-Priority, 3 = Desirable, 4 = Important, 5 = Very Important), μx = Mean, SD = Standard Deviation, CV = Coefficient of Variation, Cns (X) = Consensus Level (Tastle & Wierman, 2007 [57]).

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