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A Multi-Criteria Finance-Driven Scoring Model to Rank Green SMEs and Startups for Investor Decision-Making

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***Abstract*— Environmental, social, and governance (ESG) considerations have become central to corporate sustainability assessment, yet the methodologies used to score and assess green SMEs and startups remain fragmented and insufficiently adapted to their data constraints. This study aims to identify and compare the techniques used in the ESG–financial performance literature and to propose a more suitable evaluation framework for green SMEs and startups. Using Research Rabbit, 395 records were identified through keyword and citation-network searches, from which 34 papers published between 2013 and 2025 were selected for in-depth analysis, informed by the PRISMA-ScR framework. The selected studies were classified by firm type, methodology, and financial and ESG variables, revealing 23 methodological approaches. The findings show that large-firm studies rely mainly on quantitative methods and standardized disclosures, while SME-focused research is more limited, diverse, and dependent on surveys, qualitative methods, ESG indices, and hybrid models. Accordingly, this study proposes a Fuzzy DEMATEL + TOPSIS framework to assess and rank green SMEs and startups under data uncertainty.**

***Keywords*— Small and Medium-Sized Enterprises, Corporate Sustainability, Sustainable Finance, ESG Reporting, Fuzzy DEMATEL, TOPSIS**

I. INTRODUCTION

Environmental, social, and governance (ESG) considerations have become a central framework for evaluating corporate sustainability, risk management, and long-term financial performance, and are increasingly integrated into investment decision-making ([1], [2]). However, existing evidence remains dominated by large firms (LFs) with developed disclosure infrastructure, while SME-focused research is constrained by limited data availability, inconsistent reporting, and resource limitations ([3]). At the same time, ESG measurement lacks methodological consistency, as studies rely on divergent indicators, scoring systems, and analytical techniques, complicating comparison and limiting the development of an SME-appropriate evaluation framework ([4]).

Against this background, the study addresses the following research question: How can the green SME sustainability assessment literature be synthesized to develop a suitable finance-driven framework for scoring and assessing green SMEs and startups?

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The study contributes by comparing sustainability assessment and scoring approaches used across SME and LF studies, mapping the financial and ESG-related indicators applied in prior research, and translating these findings into a hybrid ESG evaluation model adapted to the data availability, reporting practices, and resource constraints of SMEs and startups.

II. LITERATURE REVIEW

The green transition has reshaped how investors evaluate SMEs, as environmental risk is increasingly recognized as material to financial outcomes ([2], [5]). Traditional criteria — profitability, cash-flow stability, leverage, and growth — are now assessed alongside environmental performance and sustainability-related indicators, reflecting changing financial market expectations and reporting pressures ([6], [7]), as summarized in Fig. 1. Yet SMEs in emerging economies often lack the reporting infrastructure needed to meet these expectations ([8]), leading investors to rely on discretionary judgment or penalize documentation gaps.

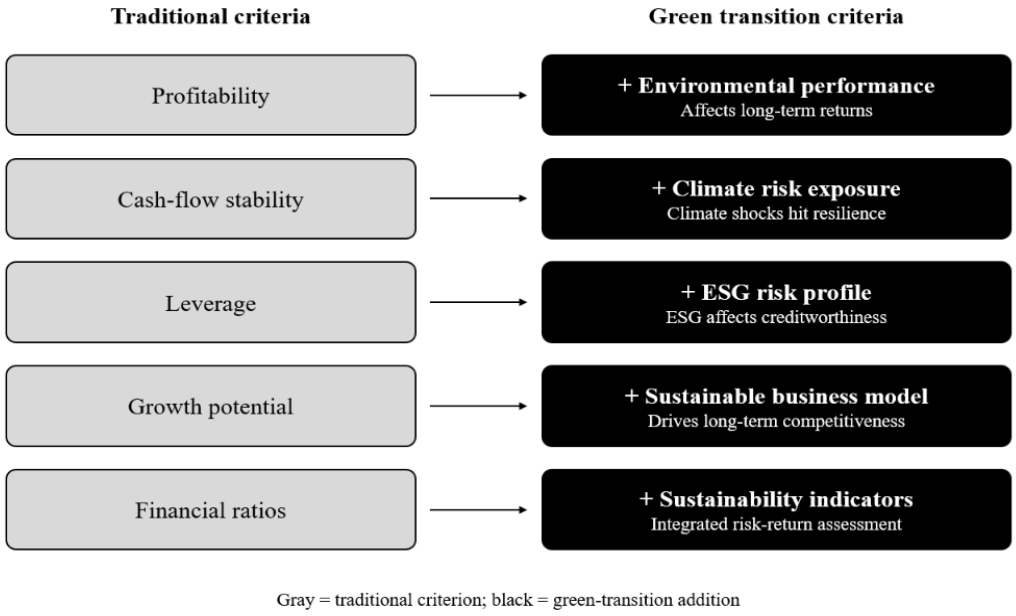


Fig. 1 Evolution of investment evaluation criteria in the green transition

Credit rating illustrates this tension directly: it has historically relied on financial metrics alone but increasingly treats environmental performance as financially material ([2]). Hybrid MCDM approaches integrating financial and environmental criteria improve comparability and objectivity in green credit evaluation ([6], [9]). These models, however, presuppose structured sustainability data that SMEs rarely possess ([8], [10]), and reporting infrastructures remain far more developed among large corporations than among resource-constrained SMEs.

Beyond credit rating design, green finance adoption can strengthen SME financial sustainability, while financial incentives, advisory support, and regulatory mechanisms facilitate green solutions ([9], [11]). Recent evidence further shows that green SME development is shaped by interacting financial, institutional, technological, and leadership-related drivers rather than by environmental commitment alone ([12]). These studies, however, assess green finance and transition drivers through firm-specific or qualitative frameworks rather than standardized scoring instruments, leaving investors without comparable benchmarks ([3], [4]).

Environmental exposure further links sustainability to finance: physical climate risk is priced directly into SME lending, with exposed firms facing higher loan spreads and default risk ([13]). This establishes environmental risk as financially material, yet it remains largely confined to econometric and institutional modelling rather than transparent, investor-facing multi-criteria scoring tools.

Underlying all these strands is a common constraint: reliable evaluation depends on data quality. SMEs often lack awareness of sustainability reporting requirements and rarely maintain formal disclosure systems ([6], [9]).

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This compounds information asymmetry between SMEs, funders, and financial institutions, especially in early-stage entrepreneurial investment where funders rely on credible signals under uncertainty ([5]). As a result, viable firms may be devalued because of reporting gaps rather than genuine underperformance, also weakening MCDM-based ranking accuracy.

Taken together, this literature establishes that evaluation criteria are shifting toward integrated financial-environmental assessment; that credit rating and green finance research have moved toward sustainability integration without producing a standardized scoring instrument; that environmental risk is financially material but rarely operationalized in investor-facing tools; and that data scarcity and disclosure inconsistency constrain these efforts at the SME level. Thus, no existing framework sufficiently combines financial ratios, environmental risk indicators, green SME transition drivers, funder perspectives, and standardized sustainability measures within a single multi-criteria ranking model for data-constrained green SMEs and startups. This is the gap addressed by the present study.

III. METHODOLOGY

To ensure a rigorous dataset, a structured article selection process was conducted using ResearchRabbit, a citation-network-based academic discovery tool for mapping thematically connected literature ([14], [15]). As shown in Fig. 2, records were identified (n = 395, 1986–2025) through keyword querying (ESG, financial performance, CSR, sustainable finance, green SMEs) and citation-network expansion via Earlier and Later Works. This approach enabled discovery-driven identification of related studies without relying on a single predefined Boolean string ([14], [15]).

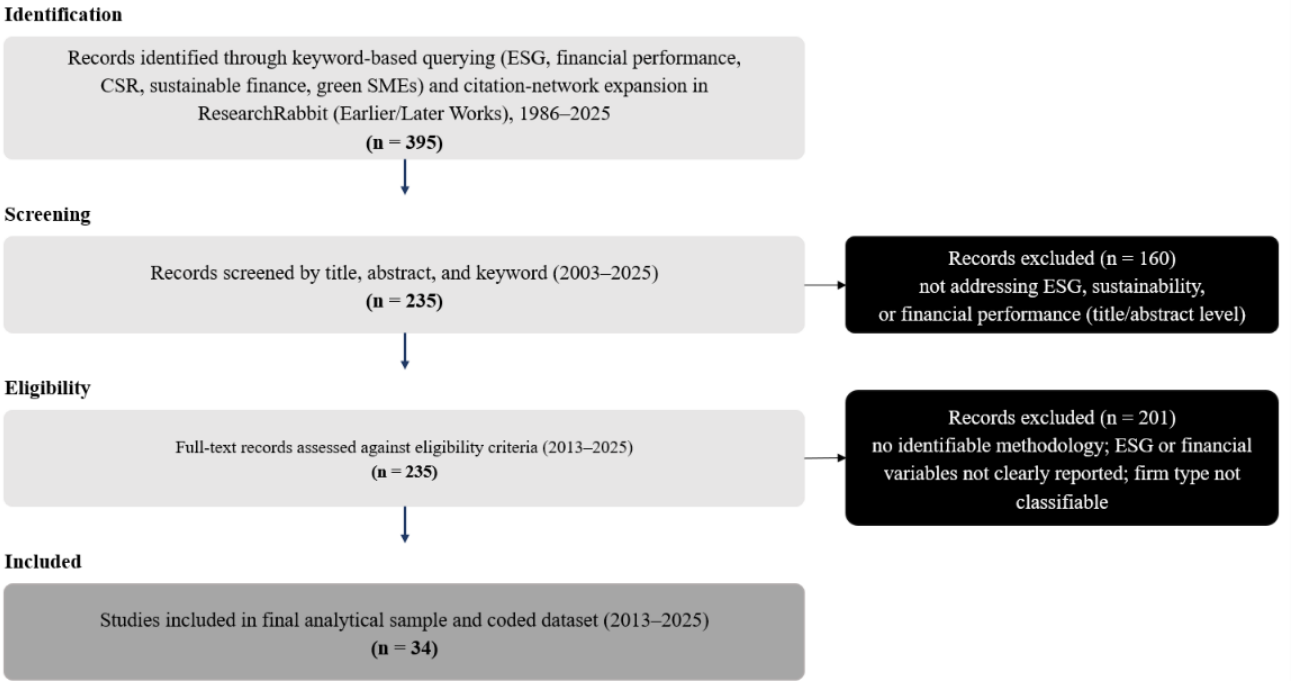


Fig. 2 Flow diagram of article identification, screening, eligibility, and inclusion

Records were screened by title, abstract, and keyword, excluding 160 studies not addressing ESG, sustainability, or financial performance and yielding 235 records for full-text eligibility assessment. At the eligibility stage, full-text records were assessed against criteria addressing methodological technique, ESG and financial variable reporting, and firm-type classifiability; 201 records were excluded, yielding a final sample of 34 articles (2013–2025).

Each included article was coded into a structured dataset by title, year, focus type, methodology, financial variables, ESG variables, and key findings, enabling cross-study comparison rather than a purely descriptive review.

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The review follows the PRISMA-ScR framework ([16]) for transparent reporting, although no protocol was pre-registered, no formal critical appraisal tool was applied, and inter-rater agreement statistics were not calculated. All sources were acknowledged, and the analysis preserved the meaning of original findings while reporting both consistent and inconsistent results.

IV. Results

A. Dominant Research Methodologies in ESG Studies: A Comparative Perspective on SMEs and Large Firms

Across the 34 studies retained through the review process, 23 distinct methodological approaches were identified, confirming that no single method dominates ESG research. Table 1 summarizes these approaches by category and firm type. Quantitative techniques, particularly panel and cross-sectional regression, account for roughly 60–70% of the reviewed literature and are used mainly where standardized, publicly disclosed ESG data exists — predominantly among LFs ([1], [4]). This confirms that much of the ESG–financial performance literature remains shaped by large-firm reporting conditions rather than by SME realities.

TABLE I
COMPARATIVE OVERVIEW OF ESG RESEARCH METHODOLOGIES FOR SME ANALYSIS

Methodology	Freq.	Firm category	SME suitability
Quantitative			n=7
Panel Regression	4	LFs / Mixed	Moderate
Regression Analysis	6	LFs / SMEs	Moderate
Survey	2	LFs	High
ANOVA + Survey	1	SMEs	Moderate
Difference-in-Differences	1	SMEs	Moderate
Logistic Regression	1	LFs	Moderate
OLS Regression + Index	1	SMEs	Moderate
Mixed methods			n=4
Survey + Regression	2	LFs	High
Survey + SEM (AMOS / PLS-SEM)	3	SMEs	High
SEM (PLS-SEM / Hybrid / ANN)	2	SMEs	High
Mixed Methods	1	SMEs	High
Qualitative			n=2
Qualitative Interviews	1	LFs	High
Qualitative Comparative Analysis	1	SMEs	Moderate-High
Literature-based			n=4
Systematic Literature Review	1	Both	High
Literature Review + Comparative	1	SMEs	High
Systematic Mapping + TF-IDF	1	SMEs	Moderate
Meta-analysis	1	Both	Moderate
MCDM / modelling			n=6
AHP	1	LFs	High
Fuzzy DEMATEL	1	LFs	Very High
Fuzzy DEMATEL + TOPSIS	1	SMEs	Very High
Fuzzy AHP + DEMATEL	1	LFs	High
ESG Index Model	1	SMEs	Moderate-High
Conceptual + System Design	1	SMEs	High

Note: The Table reports the frequency of each method, firm category, and suitability for SME evaluation. Source: authors' own work.

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SME-focused studies follow a different methodological pattern. Because formal ESG disclosure is rare and inconsistent at this scale, survey-based methods, mixed-methods designs, ESG indices, and MCDM or fuzzy approaches are more common. These methods compensate for limited standardized data and allow qualitative or incomplete sustainability information to be incorporated into evaluation ([3]). Among these approaches, MCDM methods — particularly Fuzzy DEMATEL + TOPSIS — are especially relevant because they identify the relative importance of financial and ESG criteria and rank firms even when data are incomplete or partly qualitative ([17]). Thus, the results show a clear methodological split: large-firm research prioritizes statistical rigor under abundant data, while SME research requires flexible tools suited to scarce and fragmented data. This supports the use of Fuzzy DEMATEL + TOPSIS as the scoring approach developed in Section V.

B. Financial Performance Indicators: Common Metrics and Variations Across Firm Types

The financial and ESG variables used in the literature also diverge by firm size. Large-firm studies rely heavily on standardized financial ratios such as ROA, ROE, EBITDA, and Tobin's Q, together with disclosure-based ESG indicators such as emissions, board structure, and transparency ([1], [4]). SME-focused studies instead use broader proxies for business performance, growth, default risk, and operational sustainability, including green supply chain management, sustainability innovation, environmental awareness, and internal green practices ([18]). This divergence shows that conventional ESG metrics may understate SME sustainability performance because many SME practices are operational rather than formally disclosed. Collectively, these findings reinforce the need for the framework developed in Section V, which treats data incompleteness and qualitative sustainability evidence as core design conditions rather than limitations added after the fact.

V. The Fuzzy DEMATEL + TOPSIS Framework: A Suitability Approach for SME ESG Evaluation

Building on the methodological and data-availability gaps identified in the Results, we propose a hybrid ESG evaluation model for green SMEs and startups grounded in the Fuzzy DEMATEL + TOPSIS framework. The model integrates financial performance indicators with ESG-related indicators within a single scoring system, combining quantitative financial variables — profitability, liquidity, and revenue growth — with qualitative ESG indicators — energy efficiency, waste management, employee wellbeing, and governance transparency — summarized in Fig. 3. Fuzzy DEMATEL is used to identify the relative importance and interdependence of these criteria, while TOPSIS ranks SMEs according to their closeness to an ideal sustainable investment profile ([17]). This makes the framework suitable for SME environments where sustainability information is often incomplete, qualitative, or operationally embedded.

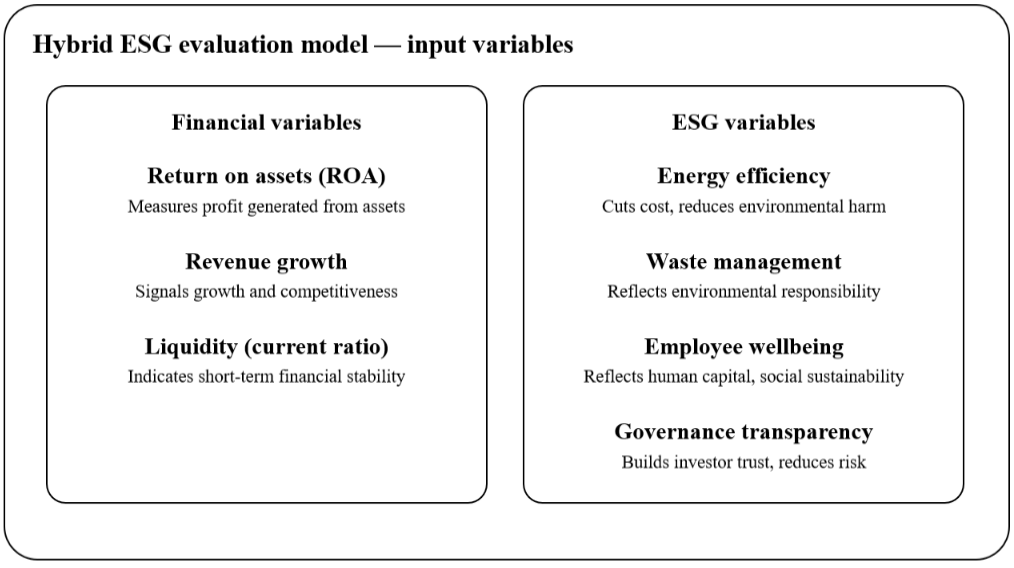


Fig. 3 Input variables of the proposed hybrid ESG evaluation model

Because SME data on financial and sustainability performance is typically mixed in form, quantitative indicators are used directly where available, while qualitative ESG indicators are converted into numerical

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scores using a standardized one-to-five scale. The weighted score then combines both types of indicators into a composite ESG–financial measure, enabling systematic comparison and ranking even where complete disclosure is unavailable. This design allows financial and ESG performance to be assessed jointly and can be implemented through common spreadsheet software, making it practical for investors evaluating early-stage or resource-constrained firms.

Fig. 4 summarizes the implementation process from data collection to investment decision-making. It shows how the model balances financial and sustainability criteria, allowing SMEs with strong sustainability practices to score competitively even when their financial performance is moderate.

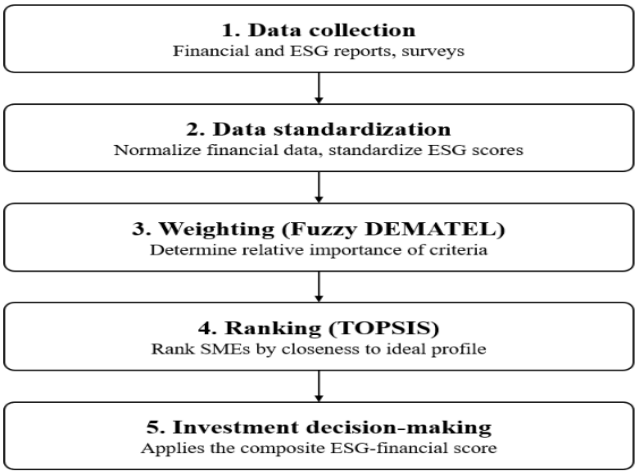


Fig. 4 Implementation steps of the hybrid ESG evaluation model

VI. Conclusion, Recommendations, Limitations and Future Directions

This review, which refined 395 initial studies into 34 for in-depth analysis, identifies structural and methodological gaps in ESG performance assessment. Quantitative methods provide stable results for LFs because they rely on standardized data, but they poorly capture SMEs' informal and operationally embedded sustainability practices, which may undervalue sustainable SMEs in investment assessment.

Based on this comparative analysis, Fuzzy DEMATEL combined with TOPSIS emerges as a suitable methodology for investor-oriented ESG evaluation of green SMEs, as it integrates causal analysis, flexible weighting, qualitative interpretation, and final ranking under incomplete or non-standardized disclosure conditions. The proposed Hybrid ESG Evaluation Framework therefore offers a more adaptive SME-oriented alternative to disclosure-dependent assessment systems.

The study remains limited by its reliance on secondary literature, definitional inconsistencies across ESG studies, and the absence of empirical testing using real SME data. Future research should validate the proposed model using actual SME datasets, improve ESG data collection through digital or AI-based tools, and test the framework across different geographic and economic contexts.

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