Decoding the Financial Efficiency Drivers for Indian Green MSMEs: A DEA-SEM Approach

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Abstract

Given the importance of sustainable business practices in the contemporary scenario, this study delves into the financial efficiency and performance of Indian micro, small, and medium enterprises (MSMEs) in the green sector from 2012 to 2021. This research challenges assumptions about the impact of human capital and research and development spending on the financial dynamics of green MSMEs. Instead, it illuminates the crucial roles of financial literacy, trade credit utilisation, state-backed credit, productivity, and cash flow stability in influencing the success of environmentally conscious businesses. Using an innovative methodology combining Data Envelopment Analysis and Structural Equation modelling, the study challenges existing theories and offers theoretical insights and practical strategies. This study provides practical insights that empower green MSMEs with strategies for resilience, benchmarking, continuous improvement, and an integrated approach to navigating and excelling in the ever-evolving business landscape.

Keywords: Financial Efficiency, SBM-DEA, Structural equation modelling, Green Firms

JEL Classifications: C3, C6, G3, Q3, Q5

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1. Introduction

In the current global landscape, the intersection between business activities and environmental protection has become imperative, driven by the need for sustainability (Cantele & Zardini, 2018). Leading corporations such as Tesla, Amazon, IBM, and Tata are pioneering efforts to align with sustainable practices, influencing their suppliers to obtain certifications that validate their commitment to reducing environmental harm. The United Nations' sustainable development goals further accentuate the importance of organisational compliance, compelling stakeholders and policymakers to seek alternative solutions (Jia & Li, 2022). Consequently, businesses are under increasing pressure to incorporate sustainable practices across environmental, economic, and societal dimensions, not only to operate ethically but also to enhance competitiveness in the market.

As highlighted, sustainable economic practices have become integral for organisations seeking to spend judiciously, operate efficiently, and achieve cost savings (Barros et al., 2021). Similarly, businesses adopt sustainable social practices to ensure fairness and equal opportunities for all, regardless of gender or background. These practices are vital for small businesses that must navigate financial constraints and responsibly manage their resources (Lagerkvist et al., 2020).

Amidst the challenges posed by technological advancements, geopolitical tensions, climate change concerns, and financial market fluctuations (Tripathi et al., 2023), financial efficiency emerges as a crucial factor for ensuring a firm's sustainability for small and medium enterprises. This involves optimising long-term and short-term financial resources, minimising costs, and making sound investment and financing decisions, especially in dynamic environments. While financial efficiency is a concern for all businesses, small firms face unique challenges due to their limited resources and capabilities, hindering their growth and long-term viability (Rao et al., 2021).

This research aims to revisit the efficiency levels of small firms, with a specific focus on Indian Micro, Small, and Medium Enterprises (MSMEs) in the green sector. Additionally, we aim to identify reasons for inefficiency and investigate whether Green MSMEs can optimise inputs to enhance their financial efficiency, ultimately contributing to overall firm performance.

The research also explores various factors influencing the ability of Green MSMEs to manage their funds. Empirically testing factors such as Human capital(HC), research and development expenditure(RD), Trade credit(TCr), Financial Literacy(FL), Cash flow volatility (CFV), State-backed credit (SBC), Net fixed asset ratio (NFAR), and Productivity(PROD), with a dataset of 578 Indian green MSME firms over ten years (2012–2021).

This research contributes to the existing literature by addressing the need for more studies on the influence of determinants on financial efficiency in the context of green firms in developing economies. The study utilises the slack-based DEA method to estimate financial efficiency, which can handle negative data. Additionally, it employs SEM analysis to shed light on financial efficiency and firm performance predictors. The integrated model presented in this study incorporates social,

environmental, technological, and financial factors, providing novel evidence in the literature. Notably, the research implements a combined DEA and SEM modelling approach, a unique aspect that has yet to be explored in previous studies on the financial efficiency of green firms.

The subsequent sections of this article are structured to provide a comprehensive examination of the research problem. Section 2 presents a literature overview on financial efficiency and hypothesis development for all factors considered in the study. Section 3 outlines the research methodology, encompassing data origins, variables, and model specifications. Section 4 unveils the analysis findings and explores their significance for Green MSMEs. Lastly, Section 5 offers final remarks and suggestions for future research, providing a holistic understanding of the financial efficiency landscape in the context of environmentally conscious small businesses.

2. Literature Review

2.1 Theory and Hypothesis Development

Several studies have contributed to understanding the intricate relationship between financial efficiency and firm performance (Gökgöz, 2014; Habib & Shahwan, 2020).

The resource-based view(RBV) emphasises the role of a firm's unique resources and capabilities in achieving a competitive advantage. In our study, we explore how internal resources such as human capital, research and development expenditures, trade credit, financial literacy, cash flow volatility, state-backed credit, net fixed asset ratio, and productivity contribute to the financial efficiency of Green MSMEs. The RBV can provide a theoretical framework to analyse how these internal factors act as drivers of financial efficiency, ultimately influencing the overall performance of green firms.

2.2 Human Capital

The training and development of employees and staff constitute a critical factor for organisational development. Investing in employee training enhances workforce skill sets, knowledge, and expertise (Chadha et al., 2023). A well-trained staff is more proficient in their roles, leading to increased productivity, reduced errors, and improved operational efficiency. This directly impacts financial metrics by optimising resource utilisation and minimising costs, positively contributing to the firm's financial health (Phu et al., 2020).

Furthermore, a skilled and well-trained workforce is better equipped to adapt to new technologies and changing market dynamics. This adaptability enhances the organisation's ability to stay competitive and innovative, which is essential for sustained financial success (Parham & Heling, 2015). Employees with up-to-date skills contribute to developing and implementing efficient processes, which, in turn, positively influences financial efficiency and, thereby, firm performance.

H1a. HC influences financial efficiency.

H1b. HC influences the firms' performance.

H1c. HC influences the firm's performance through financial efficiency.

2.3 Research & Development Expenditure/Investments

Earlier researchers have advocated that firms that invest more in research activities have a competitive edge, leading to better organisational prospects and firm performance (Grant et al., 2020). These investments play a pivotal role in influencing financial efficiency through various mechanisms. Firstly, R&D activities drive organisational innovation (Girma, 2017). This innovation, whether in technology or processes, enables firms to develop new and advanced products, services, or operational methods to boost productivity, contributing positively to their financial metrics. Developing new products or services allows companies to meet evolving market demands, attracting customers and enhancing operational efficiency (Meles et al., 2016). Simultaneously, R&D investments are also instrumental in reducing costs by implementing more efficient processes, positively impacting the bottom line.

Furthermore, R&D activities create intellectual property and proprietary technologies that give companies a sustainable competitive edge (Zangoueinezhad & Moshabaki, 2009).

H2a. RD influences financial efficiency.

H2b. RD influences the firms' performance.

H2c. RD influences the firm's performance through financial efficiency.

2.4 Financial literacy of owners and managers

Financial literacy is instrumental in strategic planning, ensuring financial resources are allocated to support long-term growth and competitiveness. Firm owners and managers make well-informed decisions if they understand financial concepts (Tian et al., 2020). Also, it allows them to allocate resources efficiently and develop realistic budgets aligned with strategic goals such as debt management, enabling businesses to navigate borrowing decisions and negotiate favourable terms, consequently minimising interest costs and contributing to financial efficiency (Burchi et al., 2021). Moreover, individuals well-versed in financial literacy are adept at making sound investment decisions, aligning financial goals with strategic objectives, and generating returns that positively impact overall firm performance (Agyei, 2018; X. Li, 2020).

H3a. FL influences financial efficiency.

H3b. FL influences the firms' performance.

H3c. FL influences the firm's performance through financial efficiency.

2.5 Trade credit

Trade credit optimises financial resources and provides a strategic advantage, enhancing overall firm performance in the dynamic business operations landscape (Abuhommous, 2017; Box et al., 2018), allowing firms for purchasing goods and services on credit that significantly impacts working capital management. By deferring payments and optimising cash flow, trade credit enhances financial efficiency, ensuring companies maintain the necessary liquidity to meet short-term obligations without tying up excessive capital (Farooq et al., 2021). Moreover, the cost-effective nature of trade credit contributes to lower financing costs, ultimately improving financial efficiency. Beyond these financial aspects, trade credit fosters positive relationships with suppliers, offering favourable terms and discounts that reduce procurement costs and contribute to supply chain efficiency. The flexibility in payment terms provided by trade credit enables businesses to synchronise cash outflows with sales-related inflows, supporting effective cash flow management and financial stability. (Lin & Zhang, 2020) As these elements of financial efficiency align, they collectively influence broader firm performance indicators, positively impacting profitability, liquidity, and operational competitiveness (Pattnaik & Baker, 2023).

H4a. TCr influences financial efficiency.

H4b. TCr influences the firms' performance.

H4c. TCr influences the firm's performance through financial efficiency.

2.6 State-backed credit

State-backed credit is pivotal in influencing financial efficiency for businesses, bringing about a range of benefits that contribute to operational effectiveness and overall economic health (Cull & Xu, 2003; Yu et al., 2017). One significant advantage is the provision of financing at lower interest rates compared to private lenders (Ye et al., 2021). This lower cost of capital not only eases financial burdens for businesses but also enhances profitability, fostering improved financial efficiency. Additionally, state-backed credit ensures stability and risk mitigation by offering a secure financial structure, potentially leading to enhanced credit ratings and favourable lending terms (Suryani, 2015). The support also extends to liquidity management and working capital, preventing liquidity constraints and facilitating smoother day-to-day operations.

Furthermore, these credit programs often encourage strategic investments in productivity and innovation, improving efficiency in production processes and operations by providing financial resources for initiatives such as expansions or technology upgrades; state-backed credit becomes a catalyst for growth and efficiency (Kamarudin et al., 2016). Ultimately, as a part of broader economic stimulus efforts, state-backed credit supports individual businesses and contributes to economic growth and job creation, reinforcing the positive impact on financial efficiency within the wider economic context (O'Toole et al., 2016).

State-backed credit influences firm performance, shaping businesses' financial landscape and strategic capabilities. The provision of financing at lower interest rates, a hallmark of SBC programs, directly affects firms' capital costs (Wang & Feng, 2014). This cost-effectiveness reduces financial burdens and enhances profitability, improving overall financial performance.

H5a. SBC influences financial efficiency.

H5b. SBC influences the firms' performance.

H5c. SBC influences the firm's performance through financial efficiency.

2.7 Productivity

Productivity directly contributes to cost-effectiveness and operational efficiency. When employees and resources are utilised efficiently, companies can achieve more output with the same or fewer inputs, reducing costs and improving financial efficiency (Almaamari, 2023). This efficiency extends across various operational facets, from manufacturing processes to service delivery, enabling firms to optimise resource allocation and minimise waste.

Moreover, increased productivity often correlates with higher revenue generation. Efficient production processes and timely delivery of products or services enhance customer satisfaction, which, in turn, can lead to repeat business and positive word-of-mouth referrals (Tunio et al., 2021). The resulting revenue growth positively impacts financial performance, reinforcing the symbiotic relationship between productivity and overall firm success.

Additionally, a productivity-driven environment fosters innovation and the adoption of advanced technologies. (Gosnell et al., 2020) Investments in technology and process improvements can further enhance operational efficiency, contributing to cost reduction and improved financial efficiency. Embracing technology can also open new revenue streams and business opportunities, positively influencing overall firm performance.

H6a. PROD influences financial efficiency.

H6b. PROD influences the firms' performance.

H6c. PROD influences the firm's performance through financial efficiency.

2.8 Cash Flow volatility

The stability of a firm's operations is intricately linked to its ability to predict and manage cash flows effectively (Tran et al., 2008). High volatility introduces uncertainties that can disrupt working capital management, forcing firms to hold excess cash as a precautionary measure (Ikromov & Yavas, 2012). This conservative approach may lead to suboptimal resource utilisation, impacting

financial efficiency. Moreover, unpredictable cash flows can influence investment decisions, potentially hindering a firm's ability to engage in long-term projects and capitalise on profitable opportunities (Holthausen et al., 1999). From the perspective of firm performance, cash flow volatility directly impacts investor confidence. Investors generally favour stable and predictable cash flows, and heightened volatility may result in a lower valuation and increased perceived risk (Huang, 2009).

Additionally, for firms with debt obligations, managing cash flow during periods of uncertainty becomes critical for debt servicing and avoiding default. The ability to navigate and mitigate the impact of cash flow fluctuations is essential for strategic planning, sustained investments, and overall long-term success (Dickinson, 2011); hence, firms that manage cash flow volatility are more likely to exhibit higher financial efficiency and superior performance over time.

H7a. CFV influences financial efficiency.

H7b. CFV influences the firms' performance.

H7c. CFV influences the firm's performance through financial efficiency.

2.9 Net fixed asset ratio

The literature examining the relationship between the Net Fixed Asset (NFA) ratio and financial performance consistently emphasises the profound impact of this metric on financial efficiency. Scholars contend that the NFA ratio is a crucial indicator of how efficiently a company utilises its fixed assets to generate revenue, influencing its overall financial efficiency (Akbar et al., 2020; Le et al., 2020). A higher NFA ratio is often associated with enhanced operational efficiency, suggesting that the organization can convert its fixed assets into productive revenue streams (Tang et al., 2023). This heightened efficiency is integral for achieving optimal financial performance, as it reflects a reasonable allocation of resources and an ability to maximise returns on invested capital. Researchers argue that a dynamic analysis of the NFA ratio over time is essential for understanding fluctuations in financial efficiency, enabling stakeholders to identify trends and make informed decisions (Biddle & Hilary, 2006). Additionally, the literature underscores the importance of considering industry-specific benchmarks to contextualise the NFA ratio, acknowledging that the optimal level of financial efficiency varies across sectors. Consequently, the NFA ratio emerges as a vital tool for assessing and enhancing financial efficiency, offering valuable insights into a company's ability to leverage its fixed assets for sustainable and effective economic performance.

H8a. NFAR influences financial efficiency.

H8b. NFAR influences the firms' performance.

H8c. NFAR influences the firm's performance through financial efficiency.

3. Empirical Results

The current research framework is depicted in Figure 1. It consists of two core processes outlined: (i) DEA analysis for calculating financial efficiency and (ii) conducting structural equation modelling by taking the financial efficiency score as a mediator.

For the efficiency analysis stage, we employed the current ratio (CR), Earning retention (ER), and Economic value added (EVA) as input. In contrast, Earnings growth (EGR) and net income (NI) were used as outputs. These inputs and outputs comprehensively cover the financial efficiency of organisations. Structural Equation Modelling (SEM) was applied in the subsequent phase to explore the interdependencies among firm-specific factors. These factors include Human capital (HC), Research and development (RD), financial literacy (FL), Trade credit (TCr), State-Backed credit (SBC), net fixed asset ratio (NFAR), cash flow volatility (CFV), and productivity (PROD). Table 3 provides the descriptive statistics of all the variables.

3.1 Data

Initially, financial information about Indian companies is gathered from the CMIE prowess database (Chadha et al., 2023; Tripathi et al., 2024), encompassing large and small firms. Subsequently, adhering to the criteria outlined in the MSMEs Act 2020, the primary metrics considered are Investment in Plant and machinery (investment) and Turnover (revenue). Companies meeting these criteria are identified and conferred with MSME status, with a comprehensive breakdown provided in Table 1. All variables are presented in ratios, and their elucidation, supported by relevant literature, is detailed in Table 2. Before formulating the model for capturing financial efficiency, a data normalisation process is employed to mitigate the risks of overfitting and minimise errors arising from significant variations among the ranges of different parameters covered.

$$N = \frac{(Y - Y_{min})}{(Y_{max} - Y_{min})} \tag{1}$$

Table 1. Basic Definition of the MSMEs

Type of Firm	Revenue	Plant & Machinery
Micro	≤5 crore	≤1 crore
Small	≥5 crore and ≤ fifty crore	≥1 crore and ≤ 10 crore
Medium	≥50 crore and ≤ 250 crore	≥10 crore and ≤ 50 crore

Note: Amount in INR.

Table 2. Variable Parameters

Variable	Abbreviation	Definition	Source
Current Ratio	CR	Current assets to current liabilities, providing insight into short-term liquidity.	(Akbar et al., 2020)
Earning retention	ER	The efficiency of retaining earnings for future growth opportunities.	(Jia & Li, 2022)
Economic Value Added	EVA	Average Total assets divided by Average shareholders' Equity.	(Bravo-Ortega et al., 2023)
Earning Growth	EGR	The rate at which a company's earnings increase over time	(Al-Twaijry, 2007)
Net income	NI	Total income less the Direct and indirect cost	(Primyastanto, 2019)
Financial efficiency	FE	Financial efficiency score obtained from Employing DEA	Authors own calculation
Human Capital	HC	Expenses on training and development of employees.	(Tripathi et al., 2024)
R&D exp	RD	Resources allocated to innovation and technological advancement	(Seth, Sharma, & Chadha, 2020)
Financial literacy	FL	Understanding of financial concepts by owner or managers.(1 for highest level & 5 for lowest)	(Huston, 2010)
Trade credit	TCr	Trade credit involves the ability to obtain goods or services with delayed payment	(Palacín-Sánchez et al., 2019)
State-Backed credit	SBC	State back credit represents financial support from government institutions	(Cull & Xu, 2003)
Productivity	PROD	The ratio of Wages paid to employees divided by Net Revenue.	(Higuerey et al., 2020)
Net Fixed Asset Ratio	NFAR	Net sales by the average balance of fixed assets	(Chadha et al., 2023)
Cash flow volatility	CFV	Cash flow variability compared to last year	(Ikromov & Yavas, 2012)

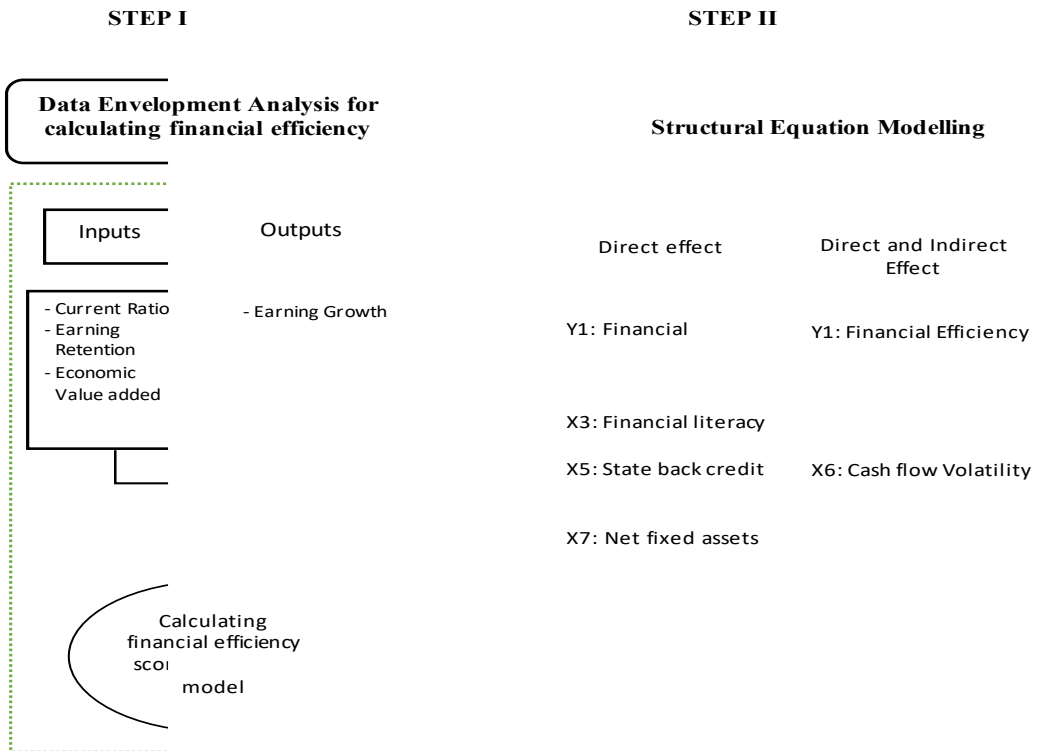

Figure 1. Methodological Framework

3.2 Statistical analysis

3.2.1 SBM DEA model

Consider there are p inputs and q outputs for the n DMUs. The inputs, outputs, and intensity variables for DMU_m are denoted as $\boldsymbol{x}_m = (x_{1m}, x_{2m}, \ldots, x_{pm})^T$, $\boldsymbol{y}_m = (y_{1m}, y_{2m}, \ldots, y_{qm})^T$, and $\boldsymbol{\lambda}_m = (\lambda_{1m}, \lambda_{2m}, \ldots, \lambda_{km})^T$, respectively. Then, the SBM DEA model for a DMU_m is defined as,

Min
$$\rho_m = \frac{1 - \frac{1}{p}\sum_{i=1}^{p} \frac{s_{im}^-}{x_{im}}}{1 + \frac{1}{q}\sum_{j=1}^{q} \frac{s_{jm}^+}{y_{jm}}}$$

Subject to
$$\sum_{k=1}^{n} \lambda_{km} x_{ik} + s_{im}^- = x_{im} \qquad \forall i = 1, \ldots, p \tag{2}$$

$$\sum_{k=1}^{n} \lambda_{km} y_{jk} + s_{im}^+ = y_{jm} \qquad \forall j = 1, \ldots, q$$

$$\lambda_{km} \geq 0, s_{im}^- \geq 0, \; s_{jm}^+ \geq 0, \qquad \forall m = 1, \ldots, n.$$

Model (1) has a fractional objective function, so it cannot be solved. Therefore, the objective function of the model (1) is normalized by multiplying it by a scalar positive number (t>0), which is as follows:

Min $$\rho_m = t + \frac{1}{p}\sum_{i=1}^{p}\frac{S_{im}^-}{x_{im}}$$

$$t + \frac{1}{q}\sum_{j=1}^{q}\frac{S_{jm}^+}{y_{jm}} = 1$$

Subject to $$\sum_{k=1}^{n}\Lambda_{km}x_{ik} + S_{im}^- = tx_{im} \qquad \forall i = 1, \ldots, p \qquad (3)$$

$$\sum_{k=1}^{n}\Lambda_{km}y_{jk} + S_{im}^+ = ty_{jm} \qquad \forall j = 1, \ldots, q$$

$$\Lambda_{km} \geq 0, S_{im}^- \geq 0, \; S_{jm}^+ \geq 0, \text{and } t > 0 \qquad \forall m = 1, \ldots, n.$$

Here, $S_{im}^- = ts_{im}^-$, $S_{jm}^- = ts_{jm}^-$, $\Lambda_{km} = t\Lambda_{km}$.

In the current study, Financial efficiency is calculated using three inputs, i.e., X1: current ratio; X2: Earning retention; and X3: Economic value added, and two outputs, i.e. Y1:Earning growth and Y2: Net income. Then, model (2) becomes,

Min $$\rho_m = t + \frac{1}{3}\sum_{i=1}^{3}\frac{S_{im}^-}{x_{im}}$$

$$t + \frac{S_{1m}^+}{y_{1m}} = 1$$

Subject to $$\sum_{k=1}^{n}\Lambda_{km}x_{ik} + S_{im}^- = tx_{im} \qquad \forall i = 1, \ldots, 3 \qquad (4)$$

$$\sum_{k=1}^{n}\Lambda_{km}y_{1k} + S_{1m}^+ = ty_{1m}$$

$$\Lambda_{km} \geq 0, S_{im}^- \geq 0, \; S_{1m}^+ \geq 0, \text{and } t > 0 \qquad \forall m = 1, \ldots, n.$$

Some of the components of data used in this study comprise negative values. So, to handle such negative data, we have transformed it into positive values using the following translation:

$$\bar{x}_{3k} = (-(min\ x_{3k}) * 1.01) + x_{3k} \qquad \forall k = 1, \ . \ . \ . \ , n$$

$$\bar{y}_{1k} = (-(miny_{1k}) * 1.01) + y_{1k} \qquad \forall k = 1, \ . \ . \ . \ , n.$$

Thus, the model (3) is transformed into the model (4) as,

$$\text{Min} \quad \rho_m = t + \frac{1}{3}\sum_{i=1}^{2}\left(\frac{S_{im}^-}{x_{im}} + \frac{S_{3m}^-}{\bar{x}_{3m}}\right)$$

$$t + \frac{S_{1m}^+}{\bar{y}_{1m}} = 1$$

$$\text{Subject to} \quad \sum_{k=1}^{n} \Lambda_{km} x_{ik} + S_{im}^- = t x_{im} \qquad \forall i = 1, \ . \ . \ . \ , 2 \qquad (5)$$

$$\sum_{k=1}^{n} \Lambda_{km} \bar{x}_{3k} + S_{3m}^- = t \bar{x}_{3m} \qquad \forall m = 1, \ . \ . \ . \ , n$$

$$\sum_{k=1}^{n} \Lambda_{km} \bar{y}_{1k} + S_{1m}^+ = \overline{ty}_{1m}$$

$$\Lambda_{km} \geq 0, S_{im}^- \geq 0, S_{3m}^- \geq 0, \quad S_{1m}^+ \geq 0, \text{and } t > 0 \qquad \forall m = 1, \ . \ . \ . \ , n.$$

The model (4) is a linear programming function, and we have used MATLAB software to assess the Financial efficiency using this model.

3.3 Structural equation modelling

Structural Equation Modelling (SEM) is a robust statistical methodology extensively utilized in diverse academic disciplines, notably in social sciences and related fields(Baser et al., 2017). This advanced analytical technique allows researchers to concurrently investigate and model complex relationships among variables. In contrast to traditional regression analysis, SEM accommodates the examination of both observed and latent constructs, offering a more comprehensive understanding of intricate structures and interdependencies (Dey et al., 2021). Through integrating measurement and structural models, SEM enables the simultaneous assessment of measurement instrument reliability and validity, facilitating a nuanced exploration of causal relationships between latent constructs (Kim & Kim, 2021). Its versatility makes SEM a valuable tool for analysing multifaceted theoretical models, and its applications extend to various domains, including psychology, economics, and marketing (Hair et al., 2019). The method's ability to provide a holistic perspective on complex systems contributes to its widespread use and relevance in contemporary research.

In the current study, Structural Equation Modelling (SEM) was utilized to investigate how research and development, State-backed credit, trade credit, financial literacy, Cash flow volatility, net fixed asset ratio, and productivity variables collectively impact financial efficiency and the overall performance of companies operating in the green MSMEs sector. Utilizing the maximum likelihood method, the structural model assumes a normal data distribution. However, when dealing with data that deviates from normality, a commonly adopted alternative approach is weighted least squares (WLS), as suggested by (Seth, et al., 2020). The assessment of SEM involves scrutinising the model fit through various goodness-of-fit indices, with the Chi-square test being one such measure. This comprehensive analysis provides a robust framework to explore the intricate relationships among the specified variables and their combined influence on both financial efficiency and the broader performance of small firms in India.

The present research employs AMOS version 27 for model construction and fit testing.

Table 3. Descriptive Statistics of Variables

Variable	Firm Type	Obs.	Mean	Std. Dev.	Min	Max
Inputs						
CR	Micro	590	0.28	1.49	0.06	2.11
	Small	2960	0.41	2.81	0.02	3.41
	Medium	2230	0.63	1.76	0.03	2.16
ER	Micro	590	0.49	0.86	0.09	1.71
	Small	2960	0.61	1.72	0.16	2.52
	Medium	2230	0.24	0.91	0.07	3.59
EVA	Micro	590	0.37	0.39	0.12	2.84
	Small	2960	0.53	0.69	0.14	3.76
	Medium	2230	0.42	0.37	0.19	2.47
Outputs						
EGR	Micro	590	0.18	1.76	-1.61	4.48
	Small	2960	0.24	1.41	-6.05	6.72
	Medium	2230	0.61	1.39	-0.99	3.65
NI	Micro	590	0.59	59.63	0.05	4.79
	Small	2960	28.91	49.29	6.19	48.92
	Medium	2230	87.14	60.48	53.11	239.28

Endogenous Variables	Firm Type	Obs.	Mean	Std. Dev.	Min	Max
FE	Micro	590	0.68	1.57	0.01	1
	Small	2960	0.53	2.63	0.01	1
	Medium	2230	0.64	1.49	0.02	1
HC	Micro	590	1.39	1.71	-1.14	5.6
	Small	2960	3.12	1.36	-3.36	5.7
	Medium	2230	2.23	1.18	-2.39	6.5
RD	Micro	590	0.41	0.67	0.1	6.2
	Small	2960	0.17	0.82	0.8	5.9
	Medium	2230	0.80	0.84	0.76	6
FL	Micro	590	1.07	2.58	1.0	5.0
	Small	2960	1.12	1.29	1.0	5.0
	Medium	2230	1.23	1.41	1.0	5.0
TCr	Micro	590	1.12	2.71	-2.49	6.34
	Small	2960	0.32	2.12	-3.37	2.92
	Medium	2230	0.57	1.51	-0.91	4.97
SBC	Micro	590	0.28	1.78	0.01	16.26
	Small	2960	0.21	3.71	0.10	41.24
	Medium	2230	0.16	4.41	0.06	14.92
NFAR	Micro	590	0.18	1.62	0.02	15.6
	Small	2960	0.23	2.17	0.03	4.8
	Medium	2230	0.13	4.41	0.06	2.14
CFV	Micro	590	0.31	2.19	0.07	1.38
	Small	2960	0.46	2.37	0.03	2.32
	Medium	2230	0.19	1.48	0.08	3.21
PROD	Micro	590	0.21	2.29	0.14	4.2
	Small	2960	0.17	3.31	0.02	2.6
	Medium	2230	0.15	2.22	0.06	1.4

3.4 Conceptual Framework

Figure 2 elucidates the conceptual model, presenting a visual representation of the relationships among the variables under consideration. This graphical depiction offers a clear and comprehensive overview of the theoretical framework, illustrating how different elements are interconnected and contribute to the model's overall structure. ***Endogenous Variables***

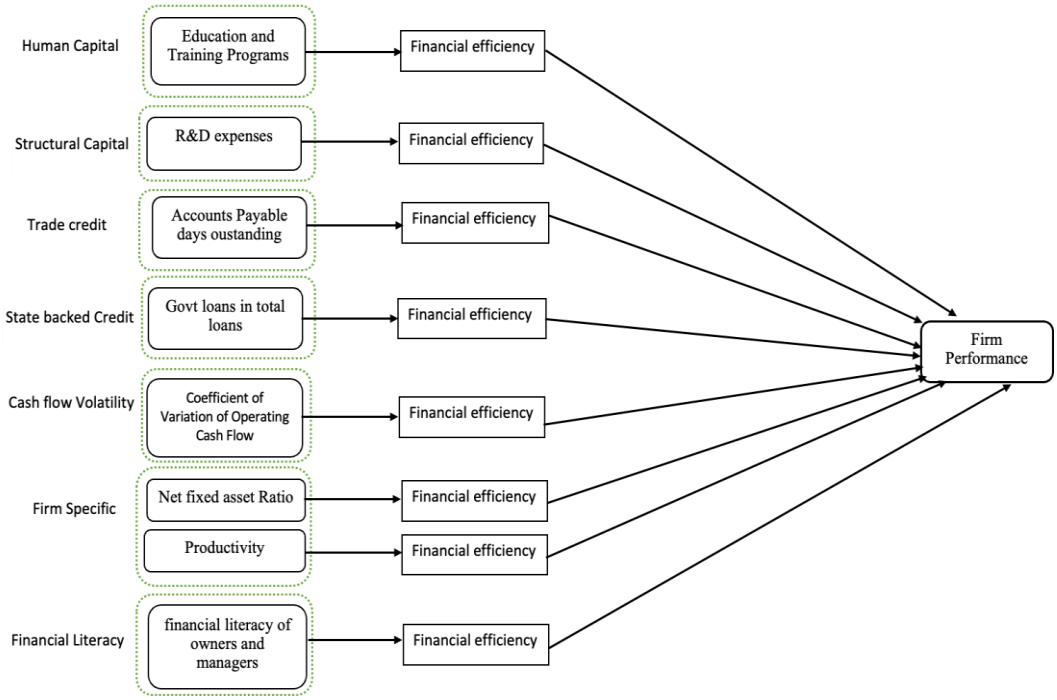

Figure 2. Conceptual Framework

4. Results and Analysis

4.1. Efficiency analysis

We conducted an efficiency analysis for all participating firms, computing their respective efficiency scores. Due to space limitations, detailed data were omitted, and instead, average minimum, average maximum, mean, and median values were presented for each year to facilitate understanding. Figure 3 visually depicts notable volatility in the financial efficiency of all types of firms, with the average maximum efficiency reaching one. Concurrently, mean and median efficiency analyses revealed a consistent decreasing trend over the years.

The Average Maximum Efficiency underscored that, on average, firms achieved optimal performance, reaching a score of one. This suggests instances where firms operated at their maximum potential. However, the Mean Efficiency, calculated as the arithmetic average, exhibited a declining trend, indicating an overall reduction in financial efficiency across the analyzed firms. The Median Efficiency, representing the middle point of the data set, echoed this downward trajectory, suggesting that extreme values did not significantly influence the overall trend.

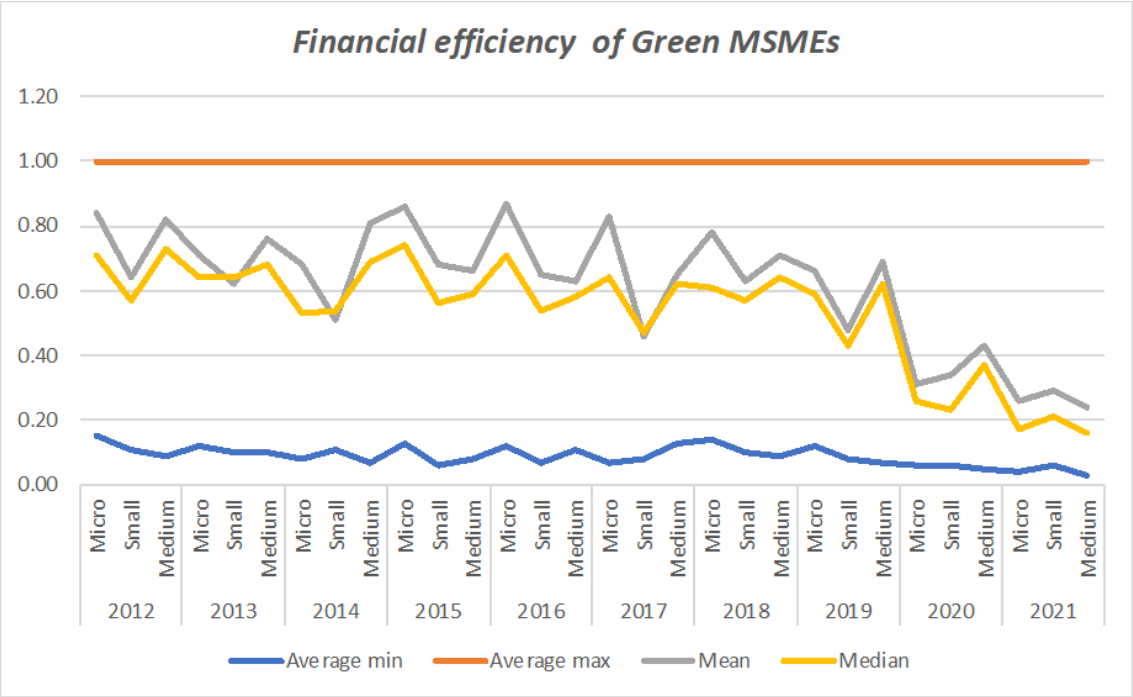

Figure 3. The Financial Efficiency of Green Firms

4.2 Comparative Financial Efficiency Analysis by Firm Size and Overall Combined Average

Figure 4 illustrates the financial efficiency based on the size of firms. Notably, micro firms exhibit the highest efficiency, followed by medium-sized firms, while small firms demonstrate the lowest average efficiency. Upon comparing individual firm efficiency with the combined efficiency of all firms, it becomes apparent that both micro and medium-sized firms surpass the overall combined efficiency, whereas small firms have the least efficiency.

Furthermore, all types of firms have experienced considerable fluctuations, particularly during COVID-19, where their efficiency significantly declined. This suggests that external factors, such as the economic impact of the pandemic, have played a substantial role in influencing the financial efficiency of firms across different sizes. The observed trends underscore the dynamic nature of financial efficiency within various firm categories, highlighting the need for a nuanced understanding of the factors contributing to fluctuations and disparities in performance.

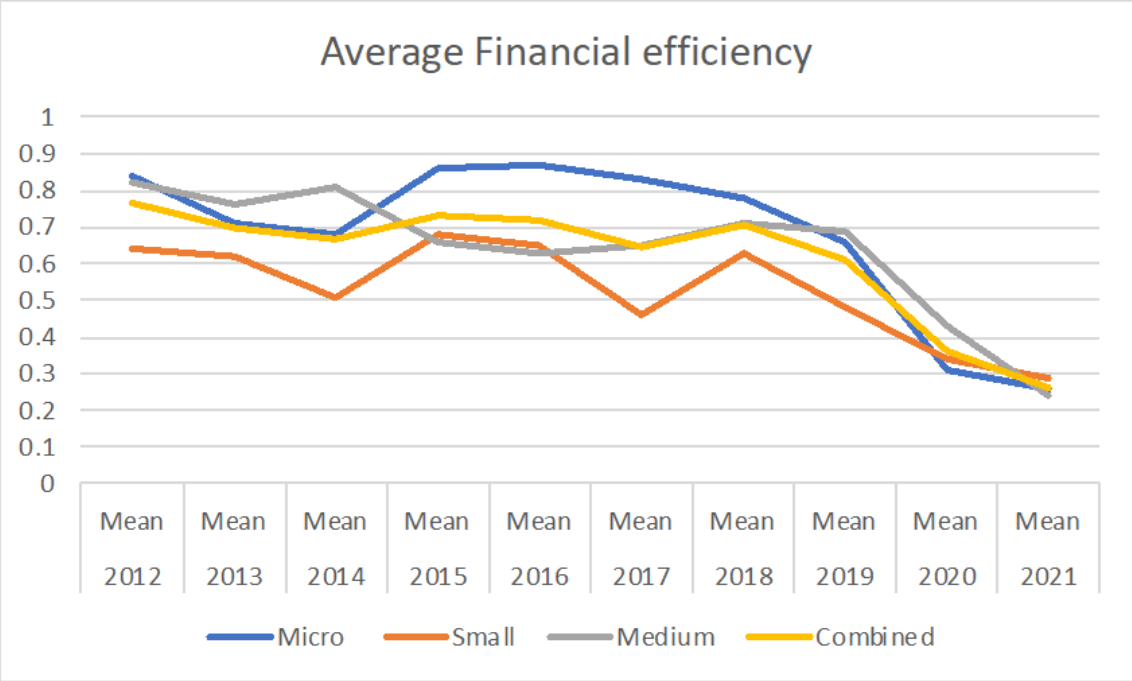

Figure 4. Average Financial Efficiency of Green MSMEs

4.3 Model fit and results of Structural equation modelling.

The study conducted Structural Equation Modelling (SEM) to assess the hypotheses formulated in the research. Weighted least squares were applied to determine the direct and indirect effects of the study variables. The analysis specifically investigated how these variables influence the efficiency and performance of the firm, as illustrated in the path diagram outlined in Figure 5.

The presumed influence of the independent variable on the dependent variable is through single-headed arrows. The standardised regression weights (β) associated with each arrow signify the strength of their predictive relationship.

Figure 5 provides valuable insights into the relationships between predictors and financial outcomes. Notably, Human capital represents a firm's workforce's knowledge, skills, and abilities, which was insignificant for direct and indirect effects on financial efficiency and firm performance. The R&D expenditure reflects the resources allocated to innovation and technological advancement, which were also insignificant for financial efficiency and firm performance.

Financial literacy measures a firm's understanding of financial concepts. The direct effect on financial efficiency is significant at 0.09 ($p<0.01$), indicating that a better understanding of financial matters contributes to improved financial efficiency. Although the direct effect on firm performance is not statistically significant (0.006), the significant indirect effect of 0.03 ($p<0.05$) implies that financial literacy indirectly influences firm performance in the model.

Trade credit involves obtaining goods or services with delayed payment. The direct effect on financial efficiency (0.11, $p<0.01$) suggests that utilising trade credit positively impacts financial

efficiency. The indirect effect on firm performance was insignificant, emphasising that trade credit does not influence firm performance. However, the notable negative direct effect of cash flow volatility on financial efficiency (-0.18) and its positive direct impact on firm performance (0.019) results in a negative indirect effect on firm performance (-0.07).

State back credit represents financial support from government institutions. The direct effect on financial efficiency is substantial at 0.14 ($p<0.01$), indicating that state-backed credit significantly enhances financial efficiency. However, the direct effect on firm performance is minimal (0.002), and the indirect effect of 0.11 ($p<0.05$) suggests that state back credit indirectly influences firm performance.

The net fixed asset ratio measures the proportion of a firm's fixed assets. The direct effect on financial efficiency (0.19, $p<0.01$) and firm performance (0.001) suggests that maintaining a higher ratio positively affects financial efficiency, but the impact on firm performance is minimal. The substantial indirect effect on firm performance (0.14, $p<0.05$) emphasises the importance of NFAR in influencing firm performance.

Despite these complexities, Productivity emerges as a critical driver, showcasing positive direct effects on both financial efficiency (0.12) and firm performance (0.16), contributing significantly to the model's explanatory power (Squared Multiple Correlation, R2 = 0.69) with favourable goodness-of-fit indices (root mean square error approximation = 0.031, goodness-of-fit index = 0.861). These results suggest a strong alignment of the model with the data.

For a comprehensive overview of the prediction estimates, both direct and indirect effects of independent variables on financial efficiency and firm performance are detailed in Table 4.

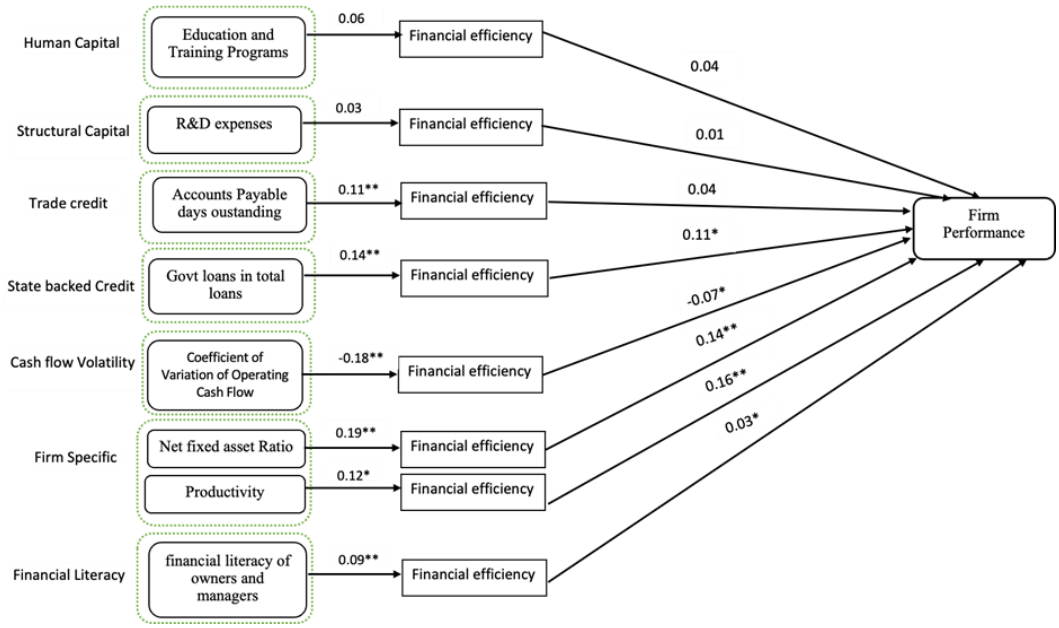

Figure 5. Factor Loadings of SEM Model

Note(s): **p<0.01; *p<0.05

Table 4. Prediction Estimates for Financial Efficiency and Firms' Performance

Effects on Financial Efficiency and Performance			
Predictors	**Direct Effect on Financial Efficiency**	**Direct Effect on Firm Performance**	**Indirect Effect on Firm Performance**
Human Capital	0.06	0.003	0.04
R&D exp	0.03	0.014	0.01
Financial literacy	0.09**	0.006	0.03*
Trade credit	0.11**	0.007	0.04
State back credit	0.14**	0.002	0.11*
Net fixed Asset Ratio	0.19**	0.001	0.14**
cash flow volatility	- 0.18**	0.019	-0.07*
Productivity	0.12*	0.014	0.16**
Squared Multiple Correlation (R2)	0.69		

Note(s): **p<0.01; *p<0.05.

5. Discussion

This study contributes valuable insights by explicitly introducing a framework for financial efficiency and performance for green firms. Additionally, it highlights the potential for improvement in less efficient firms through benchmarking against their more efficient counterparts. The research empirically identifies the factors influencing financial efficiency and overall performance.

The current research suggests that Indian eco-friendly companies should consider factors like FL, TCr, SBC, NFAR, PROD, and CFV to improve their financial efficiency and overall performance. However, the research found that investments in human capital and research and development do not impact how well these companies do financially or in terms of overall performance.

The financial literacy (FL) of owners and managers directly affects financial efficiency, suggesting that a firm's deep understanding of financial concepts positively influences financial decision-making and resource allocation (Klapper et al., 2020). Literature supports that financially literate managers are better equipped to manage risks, optimise capital structure, and allocate

resources efficiently (Karan Ingale & Achuta Paluri, 2022). The indirect effect on firm performance aligns with studies emphasising that financial literacy contributes to strategic decision-making, influencing overall firm performance (Sisharini et al., 2019). Identifying and mitigating financial risks and comprehending the financial implications of operational choices enhances risk management and operational efficiency (Huston, 2010). Furthermore, financial literacy contributes to employee productivity and satisfaction beyond traditional finance roles by fostering an understanding of employee benefits and retirement planning.

Financial literacy did not affect the firm's performance, but it directly relates to financial efficiency; hence, we accept H3a and H3c, whereas we reject H3b.

Trade credit(TCr) positively directly affects financial efficiency but does not affect firm performance. The literature highlights the role of trade credit in improving liquidity, facilitating business transactions, and enhancing operational efficiency (Abuhommous, 2017; Karakoç, 2022). Prior studies suggest that firms actively utilising trade credit experience lower transaction costs, improved cash flow management, and increased financial flexibility, contributing to financial efficiency (Devalkar & Krishnan, 2019; D'Mello et al., 2021; Pattnaik et al., 2020). Hence, we accept H4a but reject H4b and H4c.

SBC significantly affects the financial efficiency and firm performance. The result is supported by research emphasising the positive impact of government-backed financial support on a firm's financial position and stability (Cull & Xu, 2003; Jena & Thatte, 2018; Kamarudin et al., 2016). Literature suggests that state-backed credit programs can mitigate financial constraints, allowing firms to invest in projects with positive long-term returns (O'Toole et al., 2016; Ye et al., 2021). The indirect effect on firm performance aligns with the idea that such credit can stimulate investment and innovation, contributing to sustained growth (Yıldırım et al., 2021). Hence, we accept H5a and H5c but reject H5b.

Productivity has positive direct effects on both financial efficiency and firm performance. The results align with earlier studies highlighting the critical role of productivity in driving operational efficiency and overall firm success (Almaamari, 2023). Literature suggests that improvements in productivity lead to cost savings, increased output, and enhanced competitiveness, contributing to better financial efficiency and firm performance (Cao & Rees, 2020; J. Chen et al., 2016; Corte & Gaudio, 2014). The indirect effect on firm performance further emphasises the multifaceted impact of productivity on innovation, competitiveness, and market performance (C. Chen et al., 2016; Gosnell et al., 2020). Hence, we accept H6a and H6c, whereas we reject H6b.

CFV has negative direct effects on financial efficiency and firm performance and aligns with literature emphasising the adverse effects of cash flow volatility on a firm's ability to plan, invest, and meet financial obligations (Holthausen et al., 1999). Studies suggest that firms with stable cash flows can better manage operational and financial risks, improving financial efficiency and

sustained firm performance (Chadha et al., 2023; Huang, 2009; Safitri et al., 2020; Tripathi et al., 2024) The significant indirect effect on firm performance underscores the broader impact of stable cash flows in supporting strategic decision-making and sustained growth. Hence, we accept H7a and H7c but not H7b.

NFAR positive direct effect on financial efficiency suggests that maintaining a higher net fixed asset ratio contributes to better asset utilization and operational efficiency (Jin et al., 2021; Sin, 2020; Yang, 2006). Literature indicates that firms with efficient asset management experience reduced production costs and enhanced profitability, improving financial efficiency (Kouvelis & Qiu, 2022). The substantial indirect effect on firm performance aligns with studies highlighting the role of asset efficiency in supporting overall firm competitiveness and growth (K. Li et al., 2021; Maroušek et al., 2015; Neves et al., 2021; Yaremko et al., 2023). Hence, we accept H8a and H8c, whereas H8b was rejected.

In the context of green MSMEs (Micro, Small, and Medium Enterprises), the current study observed that human capital and research and development expenditures had minimal impact on these environmentally conscious firms' financial efficiency and performance. Consequently, hypotheses H1a, H1b, H1c, H2a, H2b, H2c were rejected. For green MSMEs, the study recommends that inefficient firms prioritise adopting lean approaches focused on financial efficiency to enhance their overall performance (Seth, et al., 2020). Additionally, efficient green firms may explore implementing cost-intensive techniques to achieve higher performance.

6. Implications

The results of this study offer several practical implications for environmentally conscious Micro, Small, and Medium Enterprises (MSMEs) in the green sector.

Firstly, recognising the fluctuations in financial efficiency observed during COVID-19, green MSMEs should develop contingency plans and resilience strategies to navigate external shocks. Building financial reserves and establishing flexible business models can help mitigate unforeseen events' impact on financial efficiency and overall performance.

Furthermore, considering the efficiency disparities among different-sized firms, particularly micro firms exhibiting higher efficiency, small and medium-sized green MSMEs may benefit from benchmarking against their more efficient counterparts. Identifying and implementing best practices from more efficient firms can provide valuable insights for improving their financial efficiency and performance.

Additionally, given the dynamic nature of financial efficiency within various firm categories, green MSMEs should adopt a continuous improvement mindset. Regularly reassessing financial strategies, incorporating feedback, and adapting to changing market conditions can contribute to sustained financial efficiency and overall firm success.

Collaboration and information-sharing among green MSMEs can also be beneficial. Establishing networks or industry associations can facilitate the exchange of best practices, insights, and resources, creating a supportive ecosystem that promotes the collective improvement of financial efficiency and overall performance.

Lastly, the study's incorporation of social, environmental, technological, and financial factors in the model suggests that green MSMEs should adopt an integrated approach to business management. Balancing environmental sustainability with financial efficiency and performance is crucial for long-term success.

7. Conclusion

This comprehensive study on the financial efficiency and performance of Indian Micro, Small, and Medium Enterprises (MSMEs) in the green sector contributes valuable insights into the intersection of sustainability, financial management, and business performance. The research, conducted over ten years (2012–2021), delves into the complexities of operating environmentally conscious businesses in a dynamic global landscape.

The rejection of hypotheses related to the influence of human capital and research and development expenditures emphasises the need for a nuanced understanding of success factors in the green sector. The recommendation for inefficient firms to adopt lean approaches and efficient firms to explore cost-intensive techniques aligns with the broader narrative of tailoring strategies to sustainable business practices' unique challenges and opportunities.

The identified factors influencing financial efficiency and overall firm performance, including financial literacy, trade credit utilisation, state-backed credit, productivity, and cash flow stability, provide actionable insights for green MSMEs. The results emphasise the multifaceted nature of success in the green sector, extending beyond traditional economic drivers to encompass social and environmental considerations.

The research methodology, combining slack-based Data Envelopment Analysis (DEA) and Structural Equation Modelling (SEM), contributes a novel analytical approach to the literature. This integrated model, incorporating social, environmental, technological, and financial factors, enhances our understanding of the intricate relationships shaping financial outcomes in the green MSME context.

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