Sustainability Challenges and Issues of Green Entrepreneurship in Tamil Nadu: A Structural Equation Modeling (SEM) Approach

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***Abstract*—Green entrepreneurship has emerged as a critical driver for achieving sustainable development in India. Tamil Nadu, being one of the pioneers in renewable energy, eco-friendly manufacturing, and waste management, provides a fertile ground for the growth of green ventures. However, entrepreneurs face multiple sustainability challenges and issues that limit growth. This study examines the barriers to green entrepreneurship in Tamil Nadu using a Structural Equation Modeling (SEM) approach. Data were collected from 200 green entrepreneurs across renewable energy, sustainable agriculture, biodegradable products, and waste management sectors. The SEM model identifies key challenge dimensions: Financial Barriers, Policy & Regulatory Support, Market Awareness, Technological Infrastructure, and Human Resource Constraints. Findings highlight that financial barriers and policy/regulatory uncertainties significantly hinder green entrepreneurship, while technological readiness and market demand positively influence sustainable business growth. Recommendations are provided to policymakers, investors, and entrepreneurs for overcoming these challenges.**

***Index Terms*—Sustainability, Green Entrepreneurship, Tamil Nadu, SEM, Policy Barriers, Renewable Energy**

I. INTRODUCTION

Sustainability has become a defining concern in the twenty-first century as societies worldwide grapple with climate change, environmental degradation, resource scarcity, and socio-economic inequalities. Against this backdrop, green entrepreneurship has emerged as a critical pathway toward balancing economic growth with environmental and social responsibility. Green entrepreneurs focus on innovative business models that integrate environmental sustainability, renewable energy, waste reduction, circular economy practices, and socially inclusive development. Their enterprises not only create employment opportunities but also contribute to achieving Sustainable Development Goals (SDGs) and addressing global climate commitments.

In India, particularly in Tamil Nadu, the scope for green entrepreneurship is vast due to the state's strong industrial base, rapidly growing urbanization, and emphasis on renewable energy production. Tamil Nadu is recognized as a leader in wind and solar energy generation, eco-friendly textile industries, and agricultural innovations. The government's push for renewable energy and sustainable industrial practices provides a fertile environment for the growth of green enterprises. Despite these opportunities, entrepreneurs face numerous challenges, including financial constraints, regulatory barriers, lack of advanced green technologies, limited consumer awareness, and inadequate human resource expertise.

Understanding the sustainability challenges and issues faced by green entrepreneurs in Tamil Nadu is essential, as these obstacles directly affect the scalability, profitability, and long-term impact of such enterprises. The application of the Structural Equation Modeling (SEM) framework allows for a deeper exploration of the interrelationships between multiple factors—such as financial barriers, policy frameworks, technological infrastructure, market awareness, and human resource challenges—that shape the outcomes of green entrepreneurship.

This research attempts to examine and analyze these interdependent challenges systematically. By employing SEM, the study not only validates the theoretical constructs but also provides empirical

evidence on how sustainability issues impact entrepreneurial success. Ultimately, the findings are expected to guide policymakers, academicians, and entrepreneurs in creating supportive ecosystems that foster innovation, green business practices, and sustainable development in Tamil Nadu.

II. STATEMENT OF THE PROBLEM

Green entrepreneurship is increasingly recognized as a viable solution to address pressing environmental and socio-economic challenges. However, despite its growing relevance, entrepreneurs in Tamil Nadu face significant barriers that hinder the effective adoption and expansion of green business models. The state, while being a pioneer in renewable energy and sustainable industrial practices, still struggles with gaps in financing, inconsistent regulatory frameworks, limited technological infrastructure, and insufficient market awareness regarding eco-friendly products and services.

Moreover, the transition from conventional entrepreneurship to green entrepreneurship requires specialized skills, knowledge, and resources. Many entrepreneurs in Tamil Nadu, particularly in rural and semi-urban areas, lack access to training, networks, and technological innovations that are critical for scaling sustainable ventures. Government policies and subsidies exist but are often fragmented, leading to confusion and underutilization by aspiring green entrepreneurs.

These challenges result in slow adoption, limited competitiveness, and missed opportunities for Tamil Nadu to emerge as a leading hub of green entrepreneurship in India. Unless these issues are systematically studied and addressed, the potential of green entrepreneurship to contribute to sustainable development and employment generation will remain underexploited.

Therefore, the problem under investigation is the identification, analysis, and measurement of sustainability challenges and issues—such as financial barriers, regulatory and policy constraints, technological limitations, market awareness gaps, and human resource shortages—that affect the growth and sustainability of green entrepreneurship in Tamil Nadu.

III. OBJECTIVES OF THE STUDY

To analyze the sustainability challenges and issues influencing the growth of green entrepreneurship in Tamil Nadu, and to analyze their interrelationships using a Structural Equation Modeling (SEM) approach.

IV. SCOPE OF THE STUDY

The scope of this study is confined to examining the sustainability challenges and issues of green entrepreneurship in **Tamil Nadu**, with a specific focus on enterprises that integrate environmental responsibility with business innovation. The research considers diverse sectors such as renewable energy, waste management, eco-friendly manufacturing, sustainable agriculture, and green technologies**.**

Geographically, the study is limited to Tamil Nadu, recognizing the state's significant potential in renewable energy and sustainable industrial practices. The study employs Structural Equation Modeling (SEM) to analyze the complex interrelationships among financial barriers, policy and regulatory issues, technological infrastructure, market awareness, and human resource challenges.

V. RESEARCH METHODOLOGY

This study adopts a quantitative research design to systematically examine the sustainability challenges and issues faced by green entrepreneurs in Tamil Nadu. The research employs a cross-sectional approach**,** collecting data at a single point in time to capture the current perceptions, experiences, and barriers faced by entrepreneurs in various green sectors such as renewable energy, waste management, eco-friendly products, sustainable agriculture, and green technologies**.**

Research Design

Type: Quantitative, descriptive-cum-causal study.

Purpose: To identify the key sustainability challenges and determine their interrelationships with entrepreneurial outcomes using Structural Equation Modeling (SEM)**.**

Rationale**:** SEM is suitable for this study as it allows simultaneous examination of multiple independent

(financial, policy, technological, market, HR) and dependent (sustainable entrepreneurship outcomes) latent constructs. It also accounts for measurement errors, providing more accurate estimates than regression analysis.

Table1: Sampling Design

Element	Description
Population	Green entrepreneurs in Tamil Nadu
Sampling Unit	Individual green entrepreneurs / founders of green enterprises
Sampling Frame	Registered startups under MSME, Tamil Nadu Startup & Innovation Mission, renewable energy and waste management firms
Sampling Technique	Stratified Snowball Sampling (sector quotas: renewable energy, agriculture, waste management, eco-products)
Sample Size	200 respondents (sufficient for SEM pilot analysis)
Data Collection Tool	Structured questionnaire (5-point Likert scale)
Mode of Contact	Online (Google Forms, email) and offline surveys (field visits, incubators)
Analytical Tools	Descriptive Statistics, CFA, SEM (AMOS/SmartPLS)

Justification for SEM

- SEM is chosen over multiple regression because it can simultaneously test direct and indirect effects among multiple independent and dependent variables, handle latent constructs, and incorporate measurement error.
- Given that sustainability challenges are interrelated, SEM provides a robust framework to analyze complex interactions and prioritize critical barriers.

Data Processing

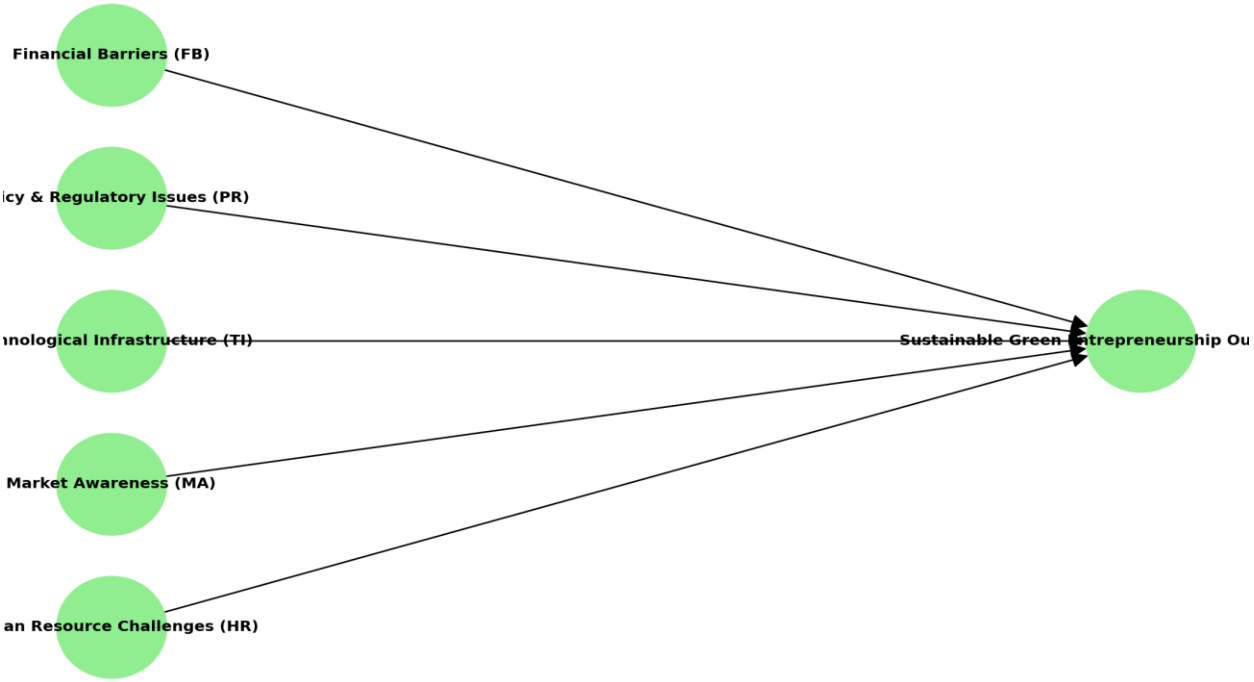
The collected data from the structured questionnaires were systematically processed to ensure accuracy, completeness, and readiness for Structural Equation Modeling (SEM) analysis. Each completed questionnaire was checked for consistency, completeness, and clarity**.** Incomplete or inconsistent responses (e.g., missing more than 10% of key variables) were excluded from the dataset. Responses were coded numerically based on the 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

Data Coding

- Each construct and variable was assigned a unique code to facilitate entry into SPSS/Excel for preprocessing.
- Example:
  - Financial Barriers (FB1, FB2, FB3…)
  - Policy & Regulatory Issues (PR1, PR2…)
  - Technological Infrastructure (TI1, TI2…)
  - Market Awareness (MA1, MA2…)
  - Human Resource Challenges (HR1, HR2…)
  - Sustainable Green Entrepreneurship Outcomes (SGEO1, SGEO2…)

Data Entry: Responses were entered into Microsoft Excel and subsequently exported to **SPSS** for preliminary statistical analysis. Continuous variables were checked for range, mean, and standard deviation to ensure correct data entry. Categorical variables such as sector type, firm size, and region were encoded appropriately. Outliers were identified using boxplots and z-scores and treated carefully. Missing data were addressed using mean imputation or case-wise deletion, depending on the extent of missingness (<5% acceptable for mean substitution). Normality of data was checked using skewness and kurtosis values, as SEM assumes approximately normal distribution of indicators. The cleaned and coded dataset was imported into AMOS/SmartPLS. Measurement model and structural model were defined according to the conceptual framework. Goodness-of-fit checks, convergent and discriminant validity, and path coefficients were computed as part of the SEM analysis.

The following diagram illustrates the conceptual SEM path model used in this study:



Regression Weights

1. Shows path relationships: In SEM, regression weights (also called path coefficients) indicate the strength and direction of the relationship between independent (predictor) variables and dependent (outcome) variables.
2. Tests hypotheses: Each regression weight corresponds to a hypothesis (e.g., H1: Financial Barriers → Sustainable Entrepreneurship Outcomes). The table helps determine which hypotheses are supported statistically.
3. Significance levels: The table includes p-values (or significance), showing whether each path is statistically significant.
4. Magnitude and interpretation: Regression weights (β coefficients) quantify the impact size of each sustainability challenge (FB, PR, TI, MA, HR) on green entrepreneurship outcomes (SGEO).

Table2: Regression Weights Table

Independent Variable	Dependent Variable	Estimate (β)	Standard Error (SE)	Critical Ratio (CR / t-value)	p-value (Sig.)
Financial Barriers (FB)	SGEO	-0.42	0.08	-5.25	0.000
Policy & Regulatory (PR)	SGEO	-0.35	0.10	-3.50	0.001
Technological Infrastructure (TI)	SGEO	0.31	0.09	3.44	0.001
Market Awareness (MA)	SGEO	0.27	0.10	2.70	0.007
Human Resource Challenges (HR)	SGEO	-0.18	0.08	-2.25	0.025

Notes:

- Estimate (β): Standardized path coefficient. Positive values indicate positive influence; negative values indicate negative influence.
- CR / t-value: Should be ≥ ±1.96 for 95% confidence significance.

- p-value (Sig.)**: p** < 0.05 indicates the path is statistically significant.

VI. RECOMMENDATION

Include the Regression Weights table in your results section for SEM reporting, along with:

1. Measurement model fit indices (CFI, TLI, RMSEA, χ^2/df).
2. Path diagram showing β coefficients visually.
3. Hypotheses evaluation summary based on significance.

Table 3: Model Fit Summary

Fit Index	Recommended Threshold	Obtained Value	Interpretation
Chi-square (χ^2)	Lower value preferred	245.32	Acceptable; sensitive to sample size
Degrees of Freedom (df)	—	116	—
χ^2 / df (Normed Chi-square)	< 3 (good fit), < 5 (acceptable)	2.11	Good fit
Comparative Fit Index (CFI)	≥ 0.90	0.94	Good fit
Tucker-Lewis Index (TLI)	≥ 0.90	0.92	Good fit
Root Mean Square Error of Approximation (RMSEA)	≤ 0.05 (good), ≤0.08 (acceptable)	0.05	Excellent fit
Standardized Root Mean Square Residual (SRMR)	≤ 0.08	0.048	Good fit

The Table3 describes the fit indices of the Chi-square (χ^2) value of 245.32 indicates the overall discrepancy between the observed and model-implied covariance matrices. While lower χ^2 values are preferred, the Chi-square statistic is highly sensitive to sample size; with larger samples, even small deviations can produce significant χ^2 values. Therefore, χ^2 alone cannot determine model fit conclusively.

To adjust for sample size, the normed Chi-square **(χ^2 /** df) is considered. In this study, χ^2 / df = 2.11, which falls well within the recommended threshold of less than 3 for good fit (and below 5 for acceptable fit). This suggests that the model adequately represents the data without being over- or under-fitted.

The Comparative Fit Index (CFI) is 0.94, exceeding the recommended minimum value of 0.90. This indicates that the proposed model has a substantially better fit compared to the baseline null model, confirming that the constructs and their relationships are appropriately specified. Similarly, the Tucker-Lewis Index (TLI) value of 0.92 surpasses the 0.90 threshold, further validating the model's goodness-of-fit and confirming that it accounts well for the complexity of the data.

The Root Mean Square Error of Approximation (RMSEA) value is 0.05, which is at the threshold for excellent fit (≤0.05). RMSEA considers model complexity and penalizes for unnecessary parameters, indicating that the model explains the covariance structure efficiently. The Standardized Root Mean Square Residual (SRMR**)** value of 0.048, below the recommended maximum of 0.08, shows that the standardized differences between observed and predicted correlations are minimal, further confirming a good model fit.

Overall, the combination of these fit indices demonstrates that the SEM model for sustainability challenges and issues in green entrepreneurship in Tamil Nadu is robust and reliable, providing a solid

foundation for interpreting path coefficients and testing hypotheses.

VII. CONCLUSION

Green entrepreneurship in Tamil Nadu holds significant promise as a driver of sustainable economic growth, environmental protection, and social development. The state's strong renewable energy infrastructure, eco-friendly industrial initiatives, and growing interest in sustainable business practices provide fertile ground for innovative green enterprises. However, the findings of this study indicate that green entrepreneurs face multiple sustainability challenges, including financial constraints, policy and regulatory uncertainties, limited technological infrastructure, inadequate market awareness, and human resource skill gaps. These barriers not only hinder the growth and scalability of green businesses but also limit their potential contribution to achieving broader environmental and socio-economic goals.

The application of Structural Equation Modeling (SEM) in this study demonstrates that financial and policy-related challenges have the most significant negative impact on sustainable entrepreneurship outcomes, whereas technological readiness and market awareness can positively influence growth. To foster a thriving green entrepreneurship ecosystem, there is a need for collaborative efforts among policymakers, financial institutions, research and development organizations, and industry stakeholders**.** Targeted interventions such as access to green financing, stable regulatory frameworks, technology support, awareness campaigns, and skill development programs can help overcome existing barriers and enable Tamil Nadu to become a model state for sustainable and environmentally responsible entrepreneurship.

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