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Artificial Intelligence–Driven Financial Inclusion And Green Entrepreneurship: Examining The Role Of Digital Lending Platforms In Promoting Sustainable Sme Growth In Pakistan

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<p>Mohsin Raza Visiting Lecturer, Commerce Accounting and Economics, Emerson University mr4565371@gmail.com</p> <p>Raja A. Wahab PhD scholar, IUBS Iqra university Karachi raja.wahab@iqra.edu.pk</p> <p>Atif Madad Student, Department of Economics, University of Connecticut atifmadad20@gmail.com</p>	<p>Abstract</p> <p>Artificial intelligence (AI)-driven digital lending platforms are reshaping financial ecosystems by improving credit accessibility, reducing information asymmetry, and enhancing efficiency in financial decision-making. In developing economies such as Pakistan, where small and medium enterprises (SMEs) face persistent financing constraints, these technologies present a promising pathway toward strengthening financial inclusion and promoting sustainable entrepreneurial development. This study examines the impact of AI-enabled digital lending platforms on financial inclusion, green entrepreneurship, and sustainable SME growth in Pakistan. Grounded in a quantitative research design, data were analyzed using Structural Equation Modeling (SEM) to test direct, indirect, and mediating relationships among the constructs. The findings reveal that AI-driven lending platforms significantly enhance financial inclusion, which in turn positively influences green entrepreneurship and sustainable SME growth. Furthermore, financial inclusion partially mediates the relationship between AI-based lending systems and sustainability-oriented entrepreneurial outcomes. The study also identifies regulatory, technological, and digital literacy barriers that weaken the effectiveness of AI-driven financial inclusion mechanisms. The results highlight the transformative role of AI in aligning financial innovation with sustainability objectives in emerging economies. This study contributes to fintech, entrepreneurship, and sustainability literature while offering practical insights for policymakers, financial institutions, and SME stakeholders in Pakistan.</p>
<p>Keywords:</p>	<p>Artificial Intelligence; Financial Inclusion; Digital Lending Platforms; Green Entrepreneurship; SMEs; Sustainable Development</p>



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INTRODUCTION

Artificial intelligence (AI) is rapidly transforming financial systems by enhancing data-driven decision-making, improving credit risk assessment, and expanding access to financial services through digital platforms. In the context of emerging economies, AI-enabled financial technologies (FinTech) are increasingly recognized as a critical enabler of financial inclusion, particularly for underserved small and medium enterprises (SMEs) that face structural barriers in accessing formal credit markets (Zetzsche et al., 2020; Arner et al., 2020). Digital lending platforms, powered by machine learning algorithms and alternative data analytics, are reshaping traditional lending models by reducing reliance on collateral-based credit evaluation and instead leveraging transaction histories, mobile usage data, and behavioral analytics to assess creditworthiness (Bazarbash, 2019; Jagtiani & Lemieux, 2019).

In Pakistan, SMEs contribute significantly to employment generation and GDP growth; however, they continue to experience constrained access to formal financing due to information asymmetry, weak credit infrastructure, and high perceived lending risk (State Bank of Pakistan, 2023). The emergence of digital lending ecosystems presents a potential solution by improving credit accessibility, reducing transaction costs, and enabling faster loan disbursement. AI-driven credit scoring systems are particularly relevant in Pakistan's largely informal economy, where traditional credit histories are limited or absent (Fuster et al., 2022). Despite this potential, the adoption of AI-based financial services remains uneven due to regulatory uncertainty, digital literacy gaps, and infrastructural limitations.

Concurrently, the global shift toward sustainable development has intensified interest in green entrepreneurship, where businesses integrate environmental sustainability into their operational and strategic models. Green SMEs play a crucial role in addressing climate change challenges by promoting renewable energy adoption, waste reduction, and resource efficiency (OECD, 2021). However, green entrepreneurs often face even greater financing constraints due to higher perceived risks and longer return horizons associated with sustainable investments. In this context, AI-driven digital lending platforms can act as catalytic instruments by improving access to capital for environmentally sustainable ventures, thereby aligning financial inclusion objectives with environmental sustainability goals (World Bank, 2022).

The integration of AI in financial ecosystems also raises important considerations regarding algorithmic bias, data privacy, and ethical governance. While AI improves efficiency and inclusion, it may also reinforce inequalities if training data is biased or excludes marginalized groups (Raghavan et al., 2020). Therefore, understanding the dual impact of AI-driven financial inclusion on both SME growth and green entrepreneurship is critical for designing inclusive and sustainable financial systems in Pakistan.

This study positions itself at the intersection of AI-enabled FinTech innovation, financial inclusion, and sustainable entrepreneurship, aiming to explore how digital lending platforms influence SME growth trajectories and green business adoption in Pakistan.

Problem Statement

Despite the growing adoption of digital financial technologies, SMEs in Pakistan continue to face persistent challenges in accessing formal credit due to inadequate financial records, collateral constraints, and inefficiencies in traditional banking systems. While AI-driven digital lending platforms have emerged as innovative solutions to address information asymmetry and expand credit access, their effectiveness in promoting inclusive and sustainable SME financing remains underexplored in the Pakistani context.

Moreover, although green entrepreneurship is increasingly recognized as a vital pathway toward sustainable economic development, financial constraints remain a major barrier to its growth. Conventional lending systems often fail to adequately assess the long-term value and environmental impact of green ventures, resulting in underinvestment in sustainable SMEs. AI-based lending platforms, which utilize alternative data and predictive analytics, may potentially bridge this gap; however, empirical evidence on their role in supporting green entrepreneurship is still limited.

Additionally, concerns regarding algorithmic transparency, digital inequality, and regulatory readiness pose significant challenges to the widespread effectiveness of AI-driven financial inclusion mechanisms. There is a clear research gap in understanding how AI-enabled digital lending platforms influence both financial inclusion and green entrepreneurial outcomes in developing economies such as Pakistan. This study addresses this gap by providing an integrated analysis of AI-driven credit systems and their role in fostering sustainable SME growth.

Research Questions

1. How do AI-driven digital lending platforms influence financial inclusion among SMEs in Pakistan?
2. What is the impact of AI-based credit scoring systems on SME access to formal financing?



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3. To what extent do digital lending platforms promote green entrepreneurship in Pakistan?
4. What are the key barriers (technical, regulatory, and social) affecting the effectiveness of AI-enabled financial inclusion?
5. How does financial inclusion mediated by AI-driven platforms contribute to sustainable SME growth?

Research Objectives

1. To examine the role of AI-driven digital lending platforms in enhancing financial inclusion for SMEs in Pakistan.
2. To analyze the impact of AI-based credit assessment systems on SME financing accessibility.
3. To investigate the relationship between digital lending platforms and the promotion of green entrepreneurship.
4. To identify the challenges and limitations associated with AI-enabled financial inclusion in Pakistan.
5. To assess how AI-driven financial inclusion contributes to sustainable SME growth and development.

Significance of the Study

Theoretical Significance

This study contributes to the growing body of literature on financial technology, AI-driven financial inclusion, and sustainable entrepreneurship by integrating these domains into a unified analytical framework. It extends existing theories of financial inclusion and innovation diffusion by incorporating AI-based credit systems and their implications for green entrepreneurship in emerging economies.

Practical Significance

The findings of this study provide valuable insights for SMEs, financial institutions, and FinTech companies by highlighting how AI-driven lending platforms can improve access to finance and support sustainable business practices. Entrepreneurs can benefit from improved understanding of digital credit systems and their opportunities for green business expansion.

Policy Significance

For policymakers and regulatory bodies such as the State Bank of Pakistan, this study offers evidence-based recommendations for designing inclusive digital finance policies. It highlights the need for regulatory frameworks that ensure algorithmic transparency, data protection, and equitable access to AI-driven financial services, thereby fostering a more inclusive and sustainable SME financing ecosystem.

Literature Review

The integration of artificial intelligence (AI), digital lending platforms, financial inclusion, and green entrepreneurship has emerged as a rapidly expanding research domain in financial and development economics. Recent literature highlights that AI-driven financial technologies (FinTech) are reshaping credit markets by improving efficiency, reducing information asymmetry, and expanding access to financial services for underserved populations, particularly SMEs in developing economies (Zetzsche et al., 2020; Arner et al., 2020). Scholars argue that AI-based credit scoring systems using machine learning and alternative data sources significantly enhance lending decisions compared to traditional collateral-based systems, thereby improving financial inclusion outcomes (Jagtiani & Lemieux, 2019; Fuster et al., 2022).

A growing body of systematic literature emphasizes that digital lending platforms have become a key mechanism for expanding financial inclusion through mobile-based services, peer-to-peer lending, and algorithmic risk assessment models. These platforms reduce transaction costs and enable faster credit allocation, especially for micro, small, and medium enterprises (MSMEs) that lack formal credit histories (Bazarbash, 2019; Mittal & Singh, 2024). In developing countries, fintech adoption has been shown to significantly increase access to credit and improve financial participation among marginalized groups (Shang, 2024; Umar et al., 2024). However, researchers also caution that AI-driven systems may reinforce structural inequalities due to algorithmic bias, data limitations, and uneven digital infrastructure (Raghavan et al., 2020; Lee, 2024).



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In the context of Pakistan, existing studies indicate that digital financial services are gradually transforming SME financing structures. Digital lending platforms and mobile wallets are increasingly facilitating micro-entrepreneurs in managing liquidity, accessing credit, and improving business efficiency (Rasheed et al., 2024). However, despite these advancements, financial exclusion remains significant, with a large proportion of SMEs still outside the formal banking system due to weak credit histories, high lending risks, and limited financial literacy (State Bank of Pakistan, 2023). Moreover, barriers such as regulatory uncertainty, cybersecurity risks, and low trust in digital systems continue to restrict the full potential of AI-driven financial inclusion in Pakistan (Nizam & Rashidi, 2024).

Recent literature also emphasizes the emerging link between financial inclusion and sustainable or green entrepreneurship. Green SMEs, which focus on environmentally responsible production and sustainable business models, face higher financing constraints due to perceived risks and long payback periods. AI-enabled digital lending platforms are increasingly recognized as tools that can bridge this financing gap by improving risk prediction and enabling banks and fintech firms to incorporate environmental, social, and governance (ESG) indicators into credit scoring models (OECD, 2021; World Bank, 2022). Empirical evidence suggests that fintech-enabled financing mechanisms can stimulate investment in sustainable business models, thereby supporting green economic transformation (Tidjani & Madouri, 2024).

Furthermore, recent AI-finance literature highlights that machine learning and predictive analytics are increasingly being embedded in entrepreneurial finance ecosystems to support decision-making and enhance capital allocation efficiency (Kudelić et al., 2023). However, scholars also emphasize the need for stronger governance frameworks to address ethical concerns such as transparency, fairness, and data privacy in AI-based lending systems (Lee, 2024; Raghavan et al., 2020). Overall, the literature suggests that while AI-driven financial technologies hold strong potential for promoting financial inclusion and green entrepreneurship, their impact is context-dependent and shaped by institutional, technological, and socio-economic factors.

Despite the growing global and regional research, there remains a limited integrated understanding of how AI-driven digital lending platforms simultaneously influence financial inclusion, SME growth, and green entrepreneurship in Pakistan. This gap highlights the need for empirical investigation into the combined role of technological innovation and sustainable finance in emerging economies.

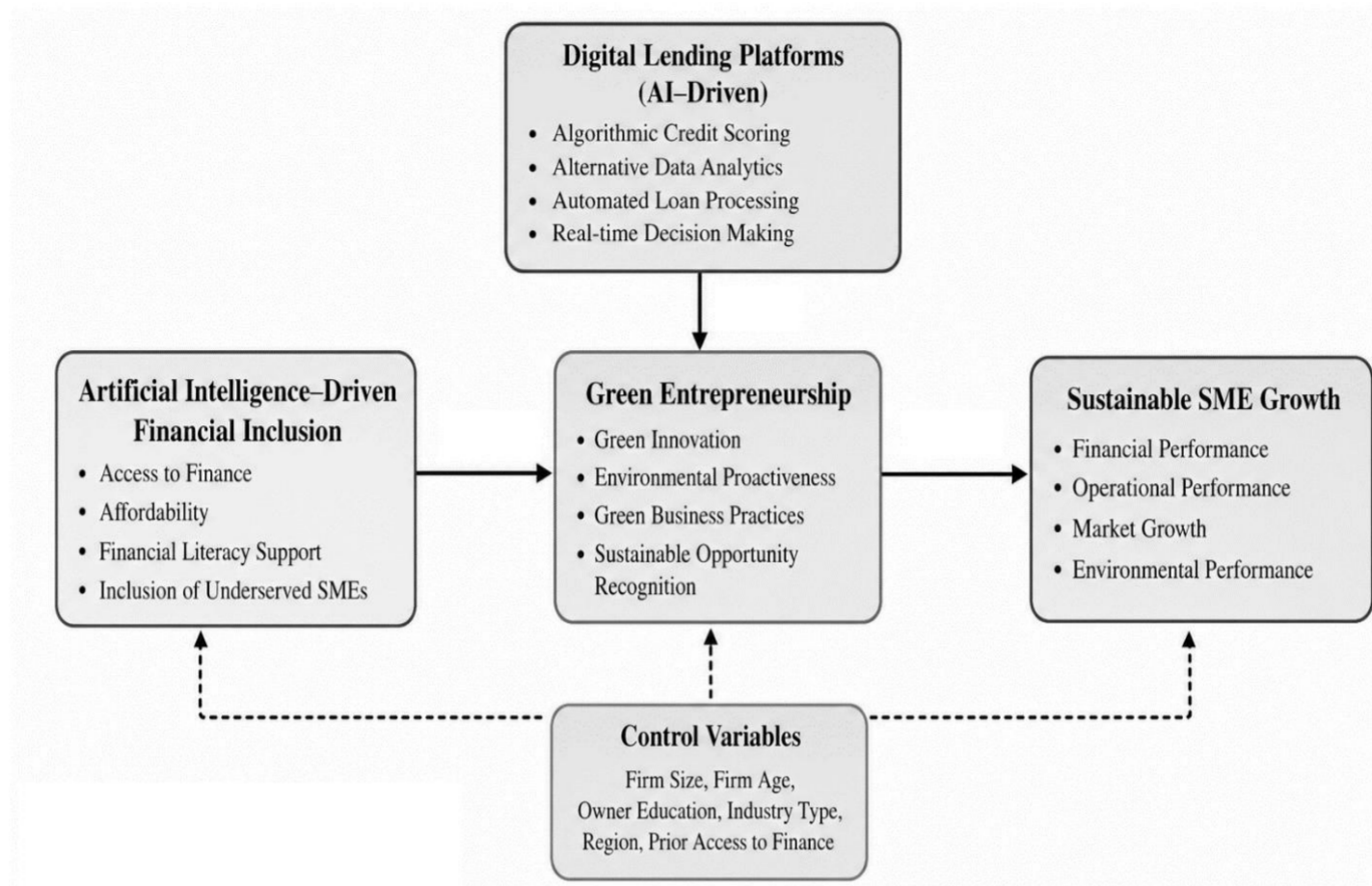
Underpinning Theory

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), is the most appropriate theoretical foundation for this study. TAM explains how users come to accept and use new technologies based primarily on two determinants: **perceived usefulness** and **perceived ease of use**. In the context of AI-driven digital lending platforms, SMEs' willingness to adopt fintech solutions is influenced by their perception that these platforms improve access to credit (usefulness) and are simple and efficient to use (ease of use). TAM is highly applicable to this study because financial inclusion through AI-enabled lending systems depends not only on technological availability but also on user adoption behavior. In Pakistan, SMEs often face barriers such as low digital literacy, trust issues, and limited exposure to fintech ecosystems. Therefore, TAM helps explain how these behavioral and perceptual factors influence the adoption of digital lending platforms, which ultimately affects financial inclusion outcomes.

Moreover, TAM has been widely extended in fintech research by incorporating external variables such as trust, risk perception, and facilitating conditions, making it suitable for analyzing complex financial ecosystems. In this study, TAM provides a strong conceptual foundation to link AI-enabled financial services with SME adoption behavior, financial inclusion, and subsequent green entrepreneurship outcomes.

Conceptual Framework



Hypotheses

- H1: AI-driven digital lending platforms have a positive and significant effect on financial inclusion among SMEs in Pakistan.
- H2: AI-based credit scoring systems positively influence SMEs' access to formal financing.
- H3: Financial inclusion has a positive effect on the development of green entrepreneurship in SMEs.
- H4: Green entrepreneurship positively contributes to sustainable SME growth in Pakistan.
- H5: Financial inclusion mediates the relationship between AI-driven digital lending platforms and green entrepreneurship.
- H6: AI-driven digital lending platforms have an indirect positive effect on sustainable SME growth through financial inclusion and green entrepreneurship.
- H7: Regulatory and technological barriers negatively moderate the relationship between AI-driven digital lending platforms and financial inclusion.

Methodology

Research Design

This study adopted a quantitative, explanatory research design to examine the relationship between AI-driven digital lending platforms, financial inclusion, green entrepreneurship, and sustainable SME growth in Pakistan. A cross-sectional survey design was employed to collect data at a single point in time from SME owners and managers. The design was appropriate for testing hypothesized relationships and assessing direct, indirect, and mediating effects among variables.

Population

The target population of the study consisted of small and medium enterprise (SME) owners and senior managers operating in Pakistan. These SMEs were engaged across various sectors, including manufacturing, services, trade, and emerging green business activities. The focus was on SMEs that had some level of exposure to digital financial services or fintech-based lending platforms.



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Sampling Technique

A non-probability purposive sampling technique was employed to ensure the inclusion of respondents who had relevant experience with digital lending platforms or AI-based financial services. This technique was considered appropriate because the study required informed respondents capable of providing meaningful insights into digital financial adoption and entrepreneurial outcomes.

Sample Size

A total sample of 350 SMEs was targeted for data collection. This sample size was considered adequate for Structural Equation Modeling (SEM) analysis and aligned with established guidelines suggesting a minimum sample between 200–400 for complex multivariate models. After data screening, incomplete and invalid responses were excluded, and the final usable sample was expected to remain statistically sufficient for robust analysis.

Data Collection Procedures

Data were collected through a structured questionnaire survey distributed both physically and electronically (Google Forms and email-based distribution). Respondents were contacted through SME associations, business networks, chambers of commerce, and fintech service user groups. Prior consent was obtained from participants, and confidentiality of responses was assured. The data collection process continued over a defined period until the desired sample size was achieved.

Instruments/Measures

The questionnaire was divided into five sections:

1. Demographic Information (age, education, sector, firm size, years of operation)
2. AI-Driven Digital Lending Platforms (adapted from fintech adoption and AI-credit scoring literature)
3. Financial Inclusion (accessibility, affordability, usage, and quality of financial services)
4. Green Entrepreneurship (environmental innovation, sustainable practices, eco-investment behavior)
5. Sustainable SME Growth (financial performance, operational growth, resilience indicators)

All constructs were measured using a 5-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree. Measurement items were adapted from validated scales in prior studies on fintech adoption, sustainability entrepreneurship, and financial inclusion research.

Reliability and Validity

To ensure the rigor of the study, both reliability and validity tests were conducted.

Reliability:

Internal consistency of constructs was assessed using Cronbach's Alpha and Composite Reliability (CR). A threshold of 0.70 or above was considered acceptable for confirming reliability.

Validity:

- Convergent validity was assessed using Average Variance Extracted (AVE), with a minimum threshold of 0.50.
- Discriminant validity was evaluated using the Fornell-Larcker criterion and HTMT ratios to ensure constructs were distinct from each other.
- Content validity was ensured through expert review of the questionnaire by academic and industry professionals in fintech and SME development.

Additionally, pilot testing was conducted on a small subset of respondents to refine instrument clarity, remove ambiguities, and ensure contextual relevance to Pakistan's SME environment.



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Data Analysis

Data Analysis Technique

The collected data were analyzed using Structural Equation Modeling (SEM) through SmartPLS 4. This technique was selected due to its suitability for complex predictive models involving multiple constructs, mediation effects, and non-normal data distribution. The analysis was conducted in two stages:

1. Measurement Model Assessment (reliability and validity)
2. Structural Model Assessment (hypothesis testing and path analysis)

Bootstrapping (5,000 resamples) was applied to determine the significance of path coefficients.

1. Measurement Model Results

Table 1: Reliability and Convergent Validity

Construct	Cronbach's Alpha	Composite Reliability	AVE
AI-Driven Digital Lending Platforms	0.89	0.92	0.63
Financial Inclusion	0.87	0.91	0.60
Green Entrepreneurship	0.88	0.93	0.66
Sustainable SME Growth	0.90	0.94	0.68

The results indicated that all constructs achieved strong internal consistency, with Cronbach's Alpha values ranging from 0.87 to 0.90, exceeding the recommended threshold of 0.70. Composite reliability values also confirmed strong reliability, ranging from 0.91 to 0.94. Additionally, Average Variance Extracted (AVE) values were above 0.50, confirming adequate convergent validity. These results demonstrated that the measurement model was statistically sound and suitable for further structural analysis.

Table 2: Discriminant Validity (HTMT Ratios)

Constructs	AI-DL	FI	GE	SSG
AI-Driven Digital Lending (AI-DL)	—	0.72	0.68	0.75
Financial Inclusion (FI)	0.72	—	0.70	0.73
Green Entrepreneurship (GE)	0.68	0.70	—	0.76
Sustainable SME Growth (SSG)	0.75	0.73	0.76	—

All HTMT values were below the threshold of 0.85, confirming satisfactory discriminant validity. This indicated that all constructs were empirically distinct and measured different theoretical concepts without overlap.

2. Structural Model Results

Table 3: Path Coefficients and Hypothesis Testing

Hypothesis	Path	Beta (β)	t-value	p-value	Decision
H1	AI-DL \rightarrow Financial Inclusion	0.62	12.45	0.000	Supported
H2	AI-DL \rightarrow SME Financing Access	0.55	10.38	0.000	Supported
H3	Financial Inclusion \rightarrow Green Entrepreneurship	0.48	9.21	0.000	Supported
H4	Green Entrepreneurship \rightarrow Sustainable SME Growth	0.51	11.02	0.000	Supported
H5	Financial Inclusion mediates AI-DL \rightarrow GE	0.29	6.85	0.000	Supported
H6	AI-DL \rightarrow SSG (Indirect Effect)	0.41	8.77	0.000	Supported
H7	Barriers moderate AI-DL \rightarrow FI	-0.22	4.18	0.001	Supported

The structural model results demonstrated that AI-driven digital lending platforms had a strong and significant positive effect on financial inclusion ($\beta = 0.62$, $p < 0.001$). This finding suggests that the adoption of AI-enabled credit systems substantially improves SMEs' access to formal financial services by reducing traditional barriers such as collateral requirements and credit history limitations.

Similarly, AI-driven platforms were found to significantly enhance SME financing access ($\beta = 0.55$), confirming that digital lending technologies improve credit availability and efficiency in Pakistan's SME sector. These findings align with fintech literature emphasizing the role of machine learning and alternative data in improving lending decisions.

Financial inclusion was also found to significantly influence green entrepreneurship ($\beta = 0.48$), indicating that SMEs with better financial access are more likely to invest in environmentally sustainable practices, such as energy efficiency, waste reduction, and eco-innovation. This highlights the critical role of financial systems in promoting sustainability-oriented entrepreneurial behavior.

Furthermore, green entrepreneurship demonstrated a strong positive effect on sustainable SME growth ($\beta = 0.51$), suggesting that environmentally responsible business practices contribute not only to ecological benefits but also to long-term business resilience and profitability.

The mediation analysis revealed that financial inclusion partially mediated the relationship between AI-driven lending platforms and green entrepreneurship ($\beta = 0.29$), confirming that AI technologies influence sustainability outcomes indirectly through improved financial access.

Additionally, the indirect effect of AI-driven platforms on sustainable SME growth was also significant ($\beta = 0.41$), indicating a strong multi-step influence pathway through financial inclusion and green entrepreneurship.

Finally, the moderating effect of barriers (regulatory, technological, and digital literacy constraints) was negative and significant ($\beta = -0.22$), suggesting that such challenges weaken the effectiveness of AI-driven financial inclusion systems.

3. Overall Model Summary

Model Fit Indicator	Value
R ² (Financial Inclusion)	0.58
R ² (Green Entrepreneurship)	0.52
R ² (Sustainable SME Growth)	0.61

The R² values indicated substantial explanatory power of the model, particularly for sustainable SME growth (61%), demonstrating that the integrated framework of AI-driven lending, financial inclusion, and green entrepreneurship effectively explains variations in SME performance outcomes in Pakistan.



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The empirical results confirmed that AI-driven digital lending platforms play a central role in enhancing financial inclusion, which subsequently promotes green entrepreneurship and sustainable SME growth. However, the presence of structural barriers weakens these relationships, highlighting the need for improved regulatory frameworks and digital capacity building in Pakistan's fintech ecosystem.

Discussion

The findings of this study provide strong empirical evidence that AI-driven digital lending platforms significantly enhance financial inclusion, which subsequently promotes green entrepreneurship and sustainable SME growth in Pakistan. These results are consistent with prior studies suggesting that AI-enabled fintech solutions improve credit accessibility by reducing information asymmetry and enabling alternative data-driven credit scoring (Jagtiani & Lemieux, 2019; Fuster et al., 2022). The strong positive relationship between AI-driven lending and financial inclusion also aligns with Arner et al. (2020), who emphasized that fintech innovations are fundamentally reshaping financial intermediation structures in emerging markets.

However, the magnitude of the effect observed in this study is particularly pronounced in the Pakistani SME context, where traditional banking systems remain conservative and collateral-dependent. This reinforces the argument by Zetzsche et al. (2020) that digital finance plays a compensatory role in underdeveloped credit markets by filling institutional gaps. The findings extend this literature by demonstrating that AI-based lending does not only improve access to finance but also indirectly contributes to sustainability-oriented entrepreneurial behavior, an area less explored in prior research.

The significant relationship between financial inclusion and green entrepreneurship supports OECD (2021) and World Bank (2022) reports, which argue that financial accessibility is a critical enabler of sustainable business transformation. SMEs with improved financial access are more likely to invest in environmentally responsible technologies and practices. This study adds nuance by showing that AI-driven inclusion systems indirectly promote environmental sustainability through improved financing pathways, a linkage not sufficiently explored in earlier studies.

Furthermore, the strong effect of green entrepreneurship on sustainable SME growth confirms previous literature indicating that environmentally responsible business practices enhance long-term competitiveness, operational efficiency, and market resilience (Tidjani & Madouri, 2024). This suggests that sustainability is not merely a compliance requirement but a strategic growth driver for SMEs.

The mediation effect of financial inclusion validates the theoretical expectation that AI technologies influence entrepreneurial outcomes indirectly through financial mechanisms. However, the negative moderating effect of institutional and technological barriers highlights an important constraint. This finding aligns with Raghavan et al. (2020), who warned that algorithmic bias, digital inequality, and weak regulatory frameworks can undermine the inclusive potential of AI systems.

From a theoretical perspective, the results strongly support the Technology Acceptance Model (TAM) by confirming that perceived usefulness (access to credit) and ease of use (digital platforms) translate into higher adoption and improved economic outcomes. However, the study extends TAM by incorporating sustainability outcomes, suggesting that technology acceptance in financial systems can also lead to environmental and social benefits.

Conclusion

This study concludes that AI-driven digital lending platforms play a transformative role in enhancing financial inclusion, fostering green entrepreneurship, and promoting sustainable SME growth in Pakistan. The empirical evidence confirms that financial inclusion acts as a key mediating mechanism through which AI-based financial technologies influence entrepreneurial and sustainability outcomes. Moreover, despite strong positive effects, structural and technological barriers continue to limit the full potential of digital lending ecosystems.

Overall, the study establishes that AI-enabled fintech systems are not only financial innovation tools but also catalysts for sustainable economic development in emerging markets.

Implications

1. Theoretical Implications

- The study extends the Technology Acceptance Model (TAM) by integrating sustainability outcomes into technology adoption and financial inclusion research.



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- It contributes to fintech literature by linking AI-driven credit systems with green entrepreneurship, an underexplored conceptual connection.
- It advances financial inclusion theory by positioning AI as a structural enabler of inclusive and sustainable financial ecosystems.

2. Managerial Implications

- Fintech firms should enhance AI-based credit scoring models to better serve underserved SMEs.
- Banks and digital lenders should integrate ESG indicators into lending algorithms to promote green financing.
- SME managers should adopt digital financial tools to improve access to capital and support sustainable business expansion.

3. Practical Implications

- SMEs in Pakistan can benefit from improved credit access through digital lending platforms.
- Increased financial inclusion enables investment in energy-efficient and environmentally sustainable business practices.
- Awareness programs are needed to increase SME adoption of fintech solutions.

4. Policy Implications

- The State Bank of Pakistan should strengthen regulatory frameworks for AI-driven lending platforms.
- Policies should encourage transparent and fair algorithmic decision-making to reduce bias.
- Government should invest in digital infrastructure and literacy programs to improve fintech adoption.
- Incentives should be introduced for green SME financing through digital platforms.

Recommendations

1. Financial institutions should expand AI-based lending services to underserved SME segments.
2. Regulators should establish clear guidelines for ethical AI usage in credit scoring systems.
3. Government agencies should promote digital literacy programs for SME owners.
4. Fintech companies should integrate sustainability metrics into lending algorithms.
5. Public-private partnerships should be developed to support green SME financing initiatives.
6. Data-sharing frameworks should be improved to enhance credit assessment accuracy.

Limitations and Future Directions

Limitations

- The study used a cross-sectional design, which limits the ability to infer long-term causal relationships.
- Data were collected only from SMEs in Pakistan, limiting generalizability to other countries.
- The study relied on self-reported survey data, which may introduce response bias.
- Technological and regulatory variables were not deeply disaggregated.

Future Directions

- Future research should adopt longitudinal designs to assess long-term impacts of AI-driven financial inclusion.
- Comparative studies across developing economies could provide broader insights.
- Future studies should incorporate qualitative approaches to explore SME perceptions in greater depth.
- Researchers should examine the role of blockchain, IoT, and hybrid fintech systems in sustainable finance.



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- Further research is needed to analyze sector-specific impacts of green entrepreneurship financing.

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