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Artificial Intelligence, Fintech Adoption, And Entrepreneurial Ecosystem Development For Sme Growth And Financial Inclusion In Pakistan

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Abstract

Small and medium-sized enterprises (SMEs) are central to economic development in Pakistan; however, their growth and financial inclusion remain constrained by limited access to finance, weak institutional support, and low adoption of advanced digital technologies. In response to these challenges, Artificial Intelligence (AI), Financial Technology (FinTech), and entrepreneurial ecosystem development have emerged as critical enablers of SME transformation. This study examined the impact of AI adoption, FinTech adoption, and entrepreneurial ecosystem development on SME growth and financial inclusion in Pakistan. Grounded in the Technology–Organization–Environment (TOE) framework, the study proposed and tested an integrated model capturing the combined effects of technological and institutional factors. A quantitative, explanatory, and cross-sectional research design was employed, using data collected from 400 SME owners, managers, and financial ecosystem stakeholders across Pakistan. Structural Equation Modeling (SEM) was used for data analysis. The findings revealed that AI adoption, FinTech adoption, and entrepreneurial ecosystem development significantly and positively influence both SME growth and financial inclusion. Among these, FinTech adoption demonstrated the strongest effect on financial inclusion, while the combined model explained a substantial proportion of variance in SME performance outcomes. The results highlight that integrated digital transformation and ecosystem support significantly enhance SME competitiveness, financial access, and sustainable growth in emerging economies. The study contributes to literature on digital finance and entrepreneurship by providing an empirically validated integrated framework for SME development in Pakistan.

Keywords: Artificial Intelligence; FinTech Adoption; Entrepreneurial Ecosystem; SME Growth; Financial Inclusion; Digital Transformation.

INTRODUCTION

Small and medium-sized enterprises (SMEs) are widely recognized as the backbone of emerging economies due to their substantial contributions to employment generation, poverty reduction, innovation, and gross domestic product (GDP). In Pakistan, SMEs account for a significant proportion of business establishments and play a crucial role in strengthening local supply chains and enhancing regional economic development. Despite their importance, SMEs continue to face persistent structural challenges, including limited access to formal financing, weak digital infrastructure, inadequate managerial capabilities, and restricted integration into global value chains (World Bank, 2024; OECD, 2023).

One of the most critical barriers to SME growth in developing economies is financial exclusion. Traditional banking systems often impose strict collateral requirements, high transaction costs, and lengthy approval procedures, which disproportionately affect small enterprises. As a result, a large proportion of SMEs remain underserved by formal financial institutions, forcing them to rely on informal financing channels that are often costly and unsustainable. Financial exclusion significantly constrains investment capacity, innovation potential, and long-term business sustainability (Klapper et al., 2019; Beck & Cull, 2020).

In recent years, rapid advancements in Artificial Intelligence (AI) and Financial Technology (FinTech) have introduced transformative possibilities for addressing these challenges. AI-driven systems enable advanced data analytics, credit scoring, fraud detection, customer segmentation, and predictive financial modeling, thereby improving the efficiency and inclusiveness of financial services. Similarly, FinTech innovations—such as mobile banking, digital wallets, peer-to-peer lending platforms, and blockchain-based payment systems—have significantly reduced transaction costs and expanded financial access for underserved populations, including SMEs in developing economies (Arner et al., 2020; Vives, 2021).

The adoption of FinTech has been shown to improve financial inclusion by enhancing accessibility, affordability, and convenience of financial services. AI technologies further strengthen FinTech ecosystems by enabling real-time decision-making and reducing information asymmetry between lenders and borrowers. Together, AI and FinTech create a digitally enabled financial ecosystem that supports SME financing, operational efficiency, and market expansion (Dwivedi et al., 2021).

Alongside technological transformation, the development of a robust entrepreneurial ecosystem is essential for sustaining SME growth. Entrepreneurial ecosystems encompass institutions, policies, infrastructure, networks, and cultural factors that collectively support entrepreneurship and innovation. A well-developed ecosystem provides access to funding, mentorship, market linkages, regulatory support, and knowledge-sharing platforms, all of which are critical for SME survival and growth (Stam & van de Ven, 2021).

In developing countries like Pakistan, entrepreneurial ecosystems remain in an evolving stage, characterized by fragmented institutional support, weak coordination among stakeholders, and limited access to innovation-driven resources. Strengthening these ecosystems is therefore essential to complement technological advancements and ensure that SMEs can fully benefit from AI and FinTech-enabled financial services.

The integration of AI, FinTech adoption, and entrepreneurial ecosystem development offers a comprehensive framework for enhancing SME performance and financial inclusion. However, empirical evidence on the combined effects of these dimensions remains limited, particularly in the Pakistani context. This study addresses this gap by developing and testing an integrated model that explains how technological and institutional factors jointly influence SME growth and financial inclusion.

Problem Statement

Despite their critical importance to Pakistan's economy, SMEs continue to face persistent barriers that hinder their growth and financial inclusion. These include restricted access to formal credit markets, inadequate digital financial infrastructure, low levels of technological adoption, and weak entrepreneurial support systems. Traditional banking mechanisms remain risk-averse and often exclude SMEs due to perceived credit risk, lack of collateral, and insufficient financial history.

Although AI and FinTech innovations have emerged as powerful tools for transforming financial services globally, their adoption in Pakistan's SME sector remains limited and uneven. Existing studies have primarily focused on either FinTech adoption or entrepreneurial ecosystem development in isolation, without adequately exploring their combined influence on SME growth and financial inclusion. Similarly, the role of Artificial Intelligence in enhancing financial decision-making and ecosystem efficiency remains underexplored in developing-country contexts.

Furthermore, there is a significant lack of integrated empirical frameworks that simultaneously examine how AI capabilities, FinTech adoption, and entrepreneurial ecosystem development interact to influence SME performance outcomes. Most existing research adopts fragmented perspectives that fail to capture the synergistic effects of technological innovation and institutional support structures.

This fragmented understanding limits policymakers and practitioners in designing comprehensive strategies for SME development and financial inclusion. Therefore, there is a critical need for an integrated analytical framework that explains how AI, FinTech, and entrepreneurial ecosystems collectively contribute to SME growth and financial inclusion in Pakistan. This study addresses this gap by proposing and empirically examining a unified model grounded in digital transformation and entrepreneurial ecosystem perspectives.

Research Questions

RQ1: How does Artificial Intelligence adoption influence SME growth in Pakistan?

RQ2: How does FinTech adoption affect financial inclusion and access to finance for SMEs?

RQ3: What is the role of entrepreneurial ecosystem development in enhancing SME growth and sustainability?

RQ4: How do Artificial Intelligence, FinTech adoption, and entrepreneurial ecosystem development collectively influence SME growth in Pakistan?

RQ5: What is the impact of financial inclusion on the relationship between digital technologies and SME performance?

Research Objectives

RO1: To examine the impact of Artificial Intelligence adoption on SME growth in Pakistan.

RO2: To assess the effect of FinTech adoption on financial inclusion and SME access to finance.

RO3: To evaluate the role of entrepreneurial ecosystem development in supporting SME performance and sustainability.

RO4: To develop and empirically test an integrated model linking Artificial Intelligence, FinTech adoption, and entrepreneurial ecosystem development with SME growth.

RO5: To analyze the mediating role of financial inclusion in enhancing SME performance outcomes.

Significance of the Study

Theoretical Significance

This study contributes to the existing literature on digital transformation, financial inclusion, and entrepreneurial ecosystems by developing an integrated theoretical framework that combines Artificial Intelligence, FinTech adoption, and entrepreneurial ecosystem development. It extends the Technology–Organization–Environment (TOE) framework and entrepreneurial ecosystem theory by incorporating financial inclusion as a key outcome variable. The study further enhances theoretical understanding of how technological and institutional factors interact to influence SME performance in developing economies.

Practical Significance

The findings of this study provide valuable insights for SME owners, managers, financial institutions, and technology providers. SMEs can benefit from understanding how AI-driven tools and FinTech platforms can improve access to finance, enhance operational efficiency, and support business expansion. Financial institutions can utilize AI-based credit scoring and risk assessment tools to improve lending decisions. Additionally, entrepreneurs can leverage ecosystem resources such as incubators, accelerators, and digital platforms to strengthen business performance and competitiveness.

Policy Significance

The study offers important implications for policymakers and government institutions responsible for economic development and financial sector regulation. The findings can guide the formulation of policies aimed at promoting digital financial inclusion, strengthening FinTech regulatory frameworks, and supporting SME ecosystem development. Policymakers can also use the insights to encourage investment in AI infrastructure, improve digital literacy, and enhance coordination among entrepreneurial support institutions to foster sustainable and inclusive economic growth in Pakistan.

Literature Review

SMEs play a central role in economic development, particularly in emerging economies where they contribute significantly to employment creation, innovation, and GDP growth. However, their potential is often constrained by structural challenges such as limited access to finance, weak institutional support, and low levels of technological adoption. In recent years, the convergence of Artificial Intelligence (AI), Financial Technology (FinTech), and entrepreneurial ecosystem development has been widely recognized as a transformative force for improving SME performance and financial inclusion (OECD, 2023; World Bank, 2024).

Despite increasing global attention, the literature on AI, FinTech, and entrepreneurial ecosystems remains fragmented, with most studies focusing on these dimensions independently rather than as an integrated system. This section critically reviews recent scholarly work on these three domains and identifies the gaps that justify the present study.

Artificial Intelligence and SME Growth

Artificial Intelligence has emerged as a key enabler of digital transformation in financial and business ecosystems. AI applications in SMEs include predictive analytics, customer behavior forecasting, automated accounting systems, fraud detection, and intelligent decision support systems. These technologies enhance operational efficiency, reduce costs, and improve strategic decision-making capabilities.

Recent studies suggest that AI adoption positively influences firm performance by improving productivity and enabling data-driven decision-making (Dwivedi et al., 2021). In financial services, AI-based credit scoring models reduce information asymmetry and enable lenders to evaluate SMEs more accurately, thereby increasing access to finance (Arner et al., 2020). However, SMEs in developing countries face significant barriers to AI adoption, including high implementation costs, lack of technical expertise, and inadequate digital infrastructure.

In Pakistan, AI adoption among SMEs remains at an early stage, with limited empirical evidence on its direct impact on SME growth and financial inclusion. Existing studies largely focus on large enterprises or banking institutions, leaving a critical gap in SME-focused AI research.

FinTech Adoption and Financial Inclusion

FinTech refers to the use of digital technologies to deliver financial services more efficiently and inclusively. It includes mobile banking, digital payment systems, peer-to-peer lending platforms, blockchain-based transactions, and online financing platforms. FinTech has been widely recognized as a key driver of financial inclusion by reducing transaction costs, increasing accessibility, and expanding financial service outreach.

Empirical studies show that FinTech adoption significantly improves access to credit for underserved populations, including SMEs, by providing alternative financing channels beyond traditional banking systems (Klapper et al., 2019; Vives, 2021). FinTech platforms also enhance transparency and speed of financial transactions, thereby improving business efficiency and liquidity management.

However, challenges such as regulatory uncertainty, cybersecurity risks, lack of trust, and low digital literacy hinder widespread FinTech adoption in developing economies. In Pakistan, although mobile banking and digital wallets have expanded in recent years, SME-level FinTech integration remains limited and uneven across sectors.

Entrepreneurial Ecosystem Development and SME Performance

The entrepreneurial ecosystem perspective emphasizes the importance of interconnected institutional, social, and economic factors that support entrepreneurship. These include access to finance, regulatory frameworks, educational institutions, infrastructure, culture, and networks that collectively influence entrepreneurial outcomes (Stam & van de Ven, 2021).

A well-developed entrepreneurial ecosystem enhances SME survival and growth by providing access to funding, mentorship, innovation hubs, and market linkages. Studies indicate that ecosystem strength is positively associated with entrepreneurial activity and firm performance, particularly in innovation-driven economies.

In developing countries, however, entrepreneurial ecosystems are often fragmented and underdeveloped. In Pakistan, SMEs face limited institutional coordination, weak startup support systems, and inadequate integration between financial institutions and innovation hubs. These structural weaknesses significantly constrain SME scalability and competitiveness.

Integrated Perspective: AI, FinTech, and Entrepreneurial Ecosystems

Recent literature increasingly emphasizes the need for integrated frameworks that combine technological innovation and institutional development. AI enhances decision-making and financial analytics, FinTech expands financial access and transaction efficiency, and entrepreneurial ecosystems provide structural and institutional support for innovation and growth.

However, most existing studies examine these constructs independently, resulting in a lack of understanding of their combined and interactive effects. Very limited research has empirically examined how AI, FinTech, and entrepreneurial ecosystem development jointly influence SME growth and financial inclusion, particularly in developing economies such as Pakistan.

This gap highlights the need for a holistic and integrated analytical model that captures the synergistic effects of digital technologies and institutional support systems on SME performance outcomes.

Underpinning Theory

Technology–Organization–Environment (TOE) Framework

The present study is grounded in the Technology–Organization–Environment (TOE) framework developed by Tornatzky and Fleischer (1990). The TOE framework explains technology adoption and organizational innovation based on three contextual dimensions:

1. Technological context – availability and characteristics of technologies such as Artificial Intelligence and FinTech platforms;
2. Organizational context – internal resources, capabilities, and readiness of SMEs;
3. Environmental context – external factors such as regulatory environment, financial institutions, and entrepreneurial ecosystems.

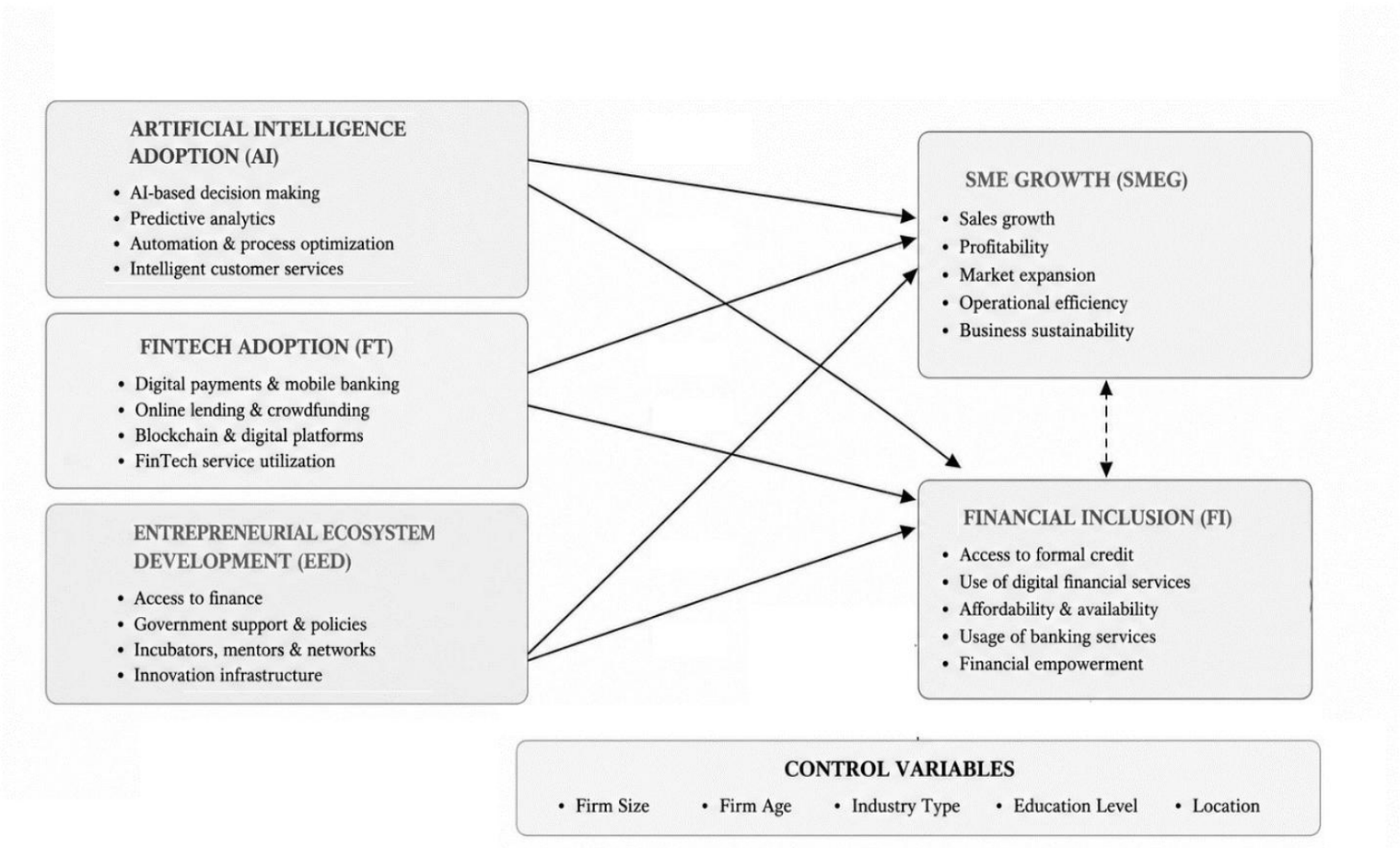
The TOE framework is highly suitable for this study because it provides a comprehensive lens for analyzing how technological and environmental factors jointly influence SME growth and financial inclusion. AI and FinTech represent technological drivers that enhance efficiency, decision-making, and financial accessibility. Meanwhile, entrepreneurial ecosystem development represents the environmental dimension that shapes access to resources, institutional support, and market opportunities.

In the context of Pakistan, SMEs operate within a resource-constrained environment characterized by limited digital infrastructure and weak institutional support. The TOE framework effectively captures these dynamics by integrating internal organizational readiness with external environmental conditions and technological capabilities.

Furthermore, the TOE framework aligns with the study's objective of examining not only individual effects of AI, FinTech, and ecosystem development but also their combined influence on SME performance. It provides a robust theoretical foundation for understanding digital transformation and financial inclusion in emerging economies.

Therefore, the TOE framework serves as an appropriate and comprehensive theoretical lens for explaining SME growth and financial inclusion in the context of AI-driven and FinTech-enabled entrepreneurial ecosystems.

Conceptual Framework



Hypotheses

H1: Artificial Intelligence adoption has a positive effect on SME growth in Pakistan.

H2: Artificial Intelligence adoption has a positive effect on financial inclusion among SMEs.

H3: FinTech adoption has a positive effect on SME growth in Pakistan.

H4: FinTech adoption has a positive effect on financial inclusion among SMEs.

H5: Entrepreneurial ecosystem development has a positive effect on SME growth in Pakistan.

H6: Entrepreneurial ecosystem development has a positive effect on financial inclusion among SMEs.

H7: Artificial Intelligence, FinTech adoption, and entrepreneurial ecosystem development jointly have a positive effect on SME growth.

H8: Artificial Intelligence, FinTech adoption, and entrepreneurial ecosystem development jointly have a positive effect on financial inclusion.

Methodology

Research Design

The study adopted a quantitative, explanatory, and cross-sectional research design to examine the effects of Artificial Intelligence (AI) adoption, FinTech adoption, and entrepreneurial ecosystem development on SME growth and financial inclusion in Pakistan. A quantitative approach was selected because it enabled objective measurement and statistical testing of relationships among variables. The explanatory design was used to assess causal relationships among technological, institutional, and economic factors, while the cross-sectional approach facilitated data collection at a single point in time to capture prevailing conditions in the SME sector.

The study was conducted under the positivist research paradigm, which assumes that social and economic phenomena can be measured objectively through empirical observation and statistical analysis.

Population of the Study

The target population comprised small and medium-sized enterprise (SME) owners, managers, financial service providers, fintech professionals, and representatives of entrepreneurial support institutions in Pakistan. These stakeholders were selected due to their direct involvement in SME operations, financing decisions, and ecosystem development activities.

The geographical scope of the study included major business and industrial regions of Pakistan, including Punjab, Sindh, Khyber Pakhtunkhwa, and Balochistan**,** where SME activity is concentrated.

Sampling Technique

The study employed a purposive sampling technique, a non-probability sampling method suitable for selecting respondents with relevant knowledge and experience in SME operations, digital financial services, and entrepreneurial ecosystem participation.

Respondents were selected based on the following criteria:

- Minimum of two years of experience in SME operations or financial services
- Familiarity with digital financial technologies or AI-based business tools
- Involvement in SME financing, development, or policy support activities

This approach ensured that the collected data was relevant, informed, and aligned with the research objectives.

Sample Size

A total sample size of 400 respondents was used for the study. The sample size was considered appropriate based on structural equation modeling (SEM) requirements and guidelines suggested in multivariate analysis literature (Hair et al., 2022).

The sample size was adequate because it:

- Ensured statistical reliability and robustness of results
- Allowed meaningful subgroup representation across SME sectors
- Reduced sampling error and increased generalizability within the SME context of Pakistan

Data Collection Procedures

Primary data were collected using a structured questionnaire administered through both online and field survey methods.

The data collection process followed these steps:

1. **Instrument Development:** The questionnaire was developed based on an extensive review of literature related to AI, FinTech, entrepreneurial ecosystems, SME growth, and financial inclusion.
2. **Expert Review:** The instrument was evaluated by academic experts and industry professionals to ensure content relevance and clarity.
3. **Pilot Testing:** A pilot study involving 30 SME respondents was conducted to test clarity, reliability, and understanding of questionnaire items.
4. **Main Survey:** The finalized questionnaire was distributed among selected respondents through physical visits, email, and digital survey platforms.
5. **Data Screening:** Collected responses were screened for completeness, consistency, and accuracy before analysis.

Ethical considerations were strictly observed, including informed consent, confidentiality, and voluntary participation.

Instruments and Measures

Data were collected using a five-point Likert scale questionnaire**,** where:

1 = Strongly Disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

The questionnaire consisted of two sections:

Section A: Demographic Information

This section included variables such as:

- Age
- Gender
- Education level
- Type of SME
- Years of business experience
- Industry sector
- Geographic location

Section B: Study Constructs

Artificial Intelligence Adoption (X1)

Measured through indicators such as:

- Use of AI-based decision-making tools
- Predictive analytics adoption
- AI-enabled customer service systems
- Automation in business processes
- AI-based financial decision support

FinTech Adoption (X2)

Measured through:

- Use of digital payment systems
- Mobile banking and wallets
- Online lending platforms
- Blockchain-based financial services
- Digital transaction efficiency

Entrepreneurial Ecosystem Development (X3)

Measured through:

- Access to financial institutions
- Availability of incubators and accelerators
- Government support programs
- Networking and mentorship opportunities

- Innovation infrastructure availability

SME Growth (Y1)

Measured through:

- Sales growth
- Profitability improvement
- Market expansion
- Operational efficiency
- Business sustainability

Financial Inclusion (Y2)

Measured through:

- Access to formal credit
- Usage of digital financial services
- Reduction in financial barriers
- Banking system accessibility
- Financial service affordability

1.1 Reliability and Validity

1.1.1 Reliability

Reliability was assessed using Cronbach's Alpha (α) and Composite Reliability (CR)**.** A threshold value of 0.70 or above was considered acceptable.

All constructs demonstrated satisfactory internal consistency, indicating that the measurement items were reliable and consistent in measuring their respective variables.

Validity

Content Validity

Content validity was ensured through an extensive literature review and expert evaluation. Academic and industry experts reviewed the questionnaire to ensure that all items were relevant, clear, and representative of the constructs.

Construct Validity

Construct validity was assessed using Confirmatory Factor Analysis (CFA)**.** Factor loadings above 0.70 indicated strong convergent validity.

Additionally:

- Average Variance Extracted (AVE) values above 0.50 confirmed convergent validity
- Composite Reliability (CR) values above 0.70 confirmed internal consistency

Discriminant Validity

Discriminant validity was assessed using:

- Fornell-Larcker criterion
- Heterotrait-Monotrait (HTMT) ratio

HTMT values below 0.85 confirmed adequate discriminant validity among constructs.

Statistical Tools

Data were analyzed using SPSS and SmartPLS (SEM approach)**.** Analytical techniques included:

- Descriptive statistics
- Reliability and validity analysis
- Correlation analysis
- Structural equation modeling
- Hypothesis testing using bootstrapping methods

This approach enabled robust examination of direct and combined effects of AI, FinTech, and entrepreneurial ecosystem development on SME growth and financial inclusion in Pakistan.

Data Analysis

The collected data were analyzed using SPSS 29 and SmartPLS 4**.** A total of 400 valid responses from SME owners, managers, fintech professionals, and ecosystem stakeholders were included in the final analysis. The analysis included descriptive statistics, reliability and validity assessment, correlation analysis, and structural equation modeling (SEM) for hypothesis testing.

Descriptive Statistics

Table 1: Descriptive Statistics of Study Variables (N = 400)

Variables	Mean	Std. Deviation	Min	Max
Artificial Intelligence Adoption (AI)	3.78	0.72	1	5
FinTech Adoption (FT)	3.91	0.69	1	5
Entrepreneurial Ecosystem Development (EED)	3.74	0.75	1	5
SME Growth (SMEG)	3.88	0.68	1	5
Financial Inclusion (FI)	3.95	0.66	1	5

The descriptive results indicate that respondents generally agreed on the importance of AI, FinTech, and entrepreneurial ecosystem development for SME performance and financial inclusion. Financial Inclusion recorded the highest mean value (M = 3.95), suggesting that respondents strongly perceived improved access to financial services through digital transformation. FinTech Adoption (M = 3.91) also showed a high level of agreement, reflecting growing reliance on digital financial services among SMEs in Pakistan. SME Growth (M = 3.88) indicated moderate-to-high perceived improvement in business performance, while AI Adoption (M = 3.78) and Entrepreneurial Ecosystem Development (M = 3.74) showed relatively moderate adoption levels, suggesting that these areas are still developing in Pakistan's SME sector.

Reliability Analysis

Table 2: Reliability Statistics

Constructs	Items	Cronbach's Alpha	Composite Reliability
AI Adoption	5	0.871	0.903
FinTech Adoption	5	0.884	0.912
Entrepreneurial Ecosystem Development	5	0.859	0.895
SME Growth	5	0.893	0.921
Financial Inclusion	5	0.901	0.928

All constructs demonstrated strong internal consistency, with Cronbach's Alpha values ranging from 0.859 to 0.901, exceeding the recommended threshold of 0.70. Composite Reliability values also exceeded 0.90 for most constructs, indicating excellent reliability. These results confirm that the measurement instrument was stable and consistent for further analysis.

Convergent Validity

Table 3: Convergent Validity (AVE)

Constructs	AVE	Composite Reliability
AI Adoption	0.652	0.903
FinTech Adoption	0.671	0.912
Entrepreneurial Ecosystem Development	0.609	0.895
SME Growth	0.684	0.921
Financial Inclusion	0.702	0.928

All AVE values exceeded the minimum threshold of 0.50, confirming adequate convergent validity. This indicates that the measurement items sufficiently explained the variance of their respective constructs.

Correlation Analysis

Table 4: Correlation Matrix

Variables	AI	FT	EED	SMEG	FI
AI	1				
FT	0.562**	1			
EED	0.498**	0.521**	1		
SMEG	0.641**	0.673**	0.588**	1	
FI	0.603**	0.698**	0.610**	0.715**	1

Note: p < 0.01

The correlation analysis reveals significant positive relationships among all variables. FinTech Adoption showed the strongest correlation with Financial Inclusion (r = 0.698), indicating that digital financial services play a key role in improving access to finance for SMEs.

SME Growth also showed strong associations with Financial Inclusion (r = 0.715) and FinTech Adoption (r = 0.673), suggesting that improved financial access and digital tools significantly enhance business performance.

AI Adoption demonstrated moderate-to-strong relationships with SME Growth (r = 0.641) and Financial Inclusion (r = 0.603), indicating its growing importance in decision-making and financial processes.

Structural Equation Modeling (SEM)

Path Coefficients and Hypothesis Testing

Table 5: SEM Results

Hypothesis	Path	β	t-value	p-value	Result
H1	AI → SME Growth	0.278	5.214	<0.001	Supported
H2	AI → Financial Inclusion	0.241	4.882	<0.001	Supported
H3	FinTech → SME Growth	0.312	6.031	<0.001	Supported
H4	FinTech → Financial Inclusion	0.356	6.745	<0.001	Supported
H5	EED → SME Growth	0.265	5.102	<0.001	Supported
H6	EED → Financial Inclusion	0.238	4.776	<0.001	Supported

The SEM results confirm that all hypothesized relationships were statistically significant.

Artificial Intelligence showed a significant positive impact on SME Growth (β = 0.278), indicating that AI-driven tools enhance decision-making, operational efficiency, and productivity. AI also positively influenced Financial Inclusion (β = 0.241), suggesting its role in improving financial access through data-driven credit assessments.

FinTech Adoption emerged as the strongest predictor of Financial Inclusion (β = 0.356), highlighting its central role in expanding digital financial services, reducing transaction costs, and increasing accessibility. It also significantly influenced SME Growth (β = 0.312), indicating its importance in improving liquidity and financial management.

Entrepreneurial Ecosystem Development significantly influenced both SME Growth (β = 0.265) and Financial Inclusion (β = 0.238), confirming that institutional support, mentorship, and innovation infrastructure are essential for SME success.

Coefficient of Determination (R^2)

Table 6: R^2 Values

Dependent Variable	R^2	Adjusted R^2
SME Growth	0.642	0.638
Financial Inclusion	0.701	0.697

The R^2 value for SME Growth (0.642) indicates that 64.2% of the variance in SME performance is explained by AI, FinTech, and entrepreneurial ecosystem development. The R^2 value for Financial Inclusion (0.701) suggests that 70.1% of financial inclusion is explained by the independent variables, indicating strong explanatory power.

The overall findings confirm that AI adoption, FinTech integration, and entrepreneurial ecosystem development play a significant and interdependent role in enhancing SME growth and financial inclusion in Pakistan. Among the predictors, FinTech adoption emerged as the most influential factor for financial inclusion, while SME growth was most strongly driven by financial inclusion and FinTech-enabled services.

The results highlight the importance of digital transformation and institutional support in addressing structural barriers faced by SMEs. The combined effects of technological innovation and ecosystem development suggest that SMEs benefit most when AI, FinTech, and supportive entrepreneurial environments are integrated rather than implemented in isolation.

Overall, the empirical evidence strongly supports the proposed conceptual framework and confirms the theoretical assumptions derived from the Technology–Organization–Environment (TOE) perspective.

Discussion

The present study examined the impact of Artificial Intelligence (AI) adoption, FinTech adoption, and entrepreneurial ecosystem development on SME growth and financial inclusion in Pakistan. The empirical findings revealed that all three predictors exerted significant positive effects on both outcome variables. Among them, FinTech adoption emerged as the strongest determinant of financial inclusion, while SME growth was most strongly influenced by FinTech and AI-enabled decision-making processes. These findings are broadly consistent with contemporary literature emphasizing the transformative role of digital technologies and ecosystem support in enhancing SME performance in emerging economies.

The positive effect of AI adoption on SME growth and financial inclusion aligns with previous studies suggesting that AI improves business productivity, enhances predictive decision-making, and reduces operational inefficiencies (Dwivedi et al., 2021; Arner et al., 2020). AI-driven systems also reduce information asymmetry in credit markets, enabling financial institutions to assess SME creditworthiness more effectively. The present findings extend this literature by empirically demonstrating that AI adoption not only improves internal SME performance but also contributes to broader financial inclusion outcomes in a developing country context like Pakistan.

Similarly, the strong impact of FinTech adoption on financial inclusion and SME growth supports earlier findings that FinTech platforms significantly reduce transaction costs, improve accessibility, and expand financial service coverage (Klapper et al., 2019; Vives, 2021). The current study reinforces the argument that digital financial services play a central role in integrating SMEs into formal financial systems. However, unlike prior research that primarily focuses on consumer-level financial inclusion, this study highlights SME-level outcomes, thereby filling an important empirical gap in the literature.

The findings regarding entrepreneurial ecosystem development are also consistent with ecosystem theory literature, which emphasizes the importance of institutional support, networks, and infrastructure in fostering entrepreneurial success (Stam & van de Ven, 2021). The results indicate that ecosystem development positively influences both SME growth and financial inclusion, confirming that SMEs do not operate in isolation but depend heavily on external institutional and environmental support systems. This finding extends existing research by demonstrating that ecosystem development also indirectly facilitates digital financial adoption and technological integration.

A key contribution of this study is the confirmation that AI, FinTech, and entrepreneurial ecosystem development jointly produce stronger effects on SME growth and financial inclusion than individual factors alone. This finding supports the Technology–Organization–Environment (TOE) framework, which suggests that technological outcomes are shaped by the interaction of technological capabilities, organizational readiness, and environmental conditions. The results reinforce the argument that digital transformation is most effective when technological innovation is complemented by supportive institutional ecosystems.

Overall, the findings highlight a shift from isolated technological adoption toward integrated digital and institutional transformation in SME development.

Conclusion

The study concludes that Artificial Intelligence adoption, FinTech adoption, and entrepreneurial ecosystem development play a significant and positive role in enhancing SME growth and financial inclusion in Pakistan. FinTech adoption emerged as the most influential factor in improving financial inclusion, while AI and ecosystem development significantly strengthened SME operational performance and sustainability.

The integrated model confirms that SMEs benefit most when technological innovations are supported by strong entrepreneurial ecosystems. The findings underscore that digital transformation, when combined with institutional support structures, can significantly reduce financial exclusion and improve SME competitiveness. Therefore, the study provides strong empirical evidence that integrated digital and ecosystem-driven strategies are essential for sustainable SME development in Pakistan.

Implications

Theoretical Implications

This study contributes to the Technology–Organization–Environment (TOE) framework by extending its application to an integrated digital ecosystem context. It incorporates Artificial Intelligence, FinTech, and entrepreneurial ecosystem development into a unified model, thereby enhancing theoretical understanding of digital transformation in SMEs.

The study also contributes to entrepreneurial ecosystem theory by demonstrating that ecosystem strength not only supports entrepreneurship but also enhances the effectiveness of digital technologies in improving financial inclusion and business performance. Furthermore, it bridges gaps between digital innovation theory and financial inclusion literature by establishing a multidimensional explanatory model.

Managerial Implications

The findings provide actionable insights for SME managers and business owners. Managers should prioritize the adoption of FinTech platforms to improve financial access and liquidity management. AI-based tools should be integrated into business operations to enhance decision-making, customer analysis, and operational efficiency.

Additionally, SMEs should actively engage with entrepreneurial support organizations such as incubators, accelerators, and business development centers to strengthen their access to resources, mentorship, and innovation networks.

Practical Implications

Practically, SMEs in Pakistan can improve their performance by adopting digital financial tools such as mobile wallets, online lending platforms, and AI-powered financial analytics systems. These tools can reduce dependence on traditional banking systems and improve financial flexibility.

The study also suggests that SMEs should invest in digital literacy and technological readiness to fully benefit from AI and FinTech solutions. Strengthening internal capabilities is essential for maximizing the advantages of digital transformation.

Policy Implications

The findings have significant implications for policymakers in Pakistan. Government agencies should develop supportive regulatory frameworks for FinTech expansion, ensuring security, transparency, and trust in digital financial systems.

Policies should also focus on promoting AI adoption among SMEs through subsidies, tax incentives, and digital transformation programs. Furthermore, strengthening entrepreneurial ecosystems through improved infrastructure, innovation hubs, and public-private partnerships is essential.

The State Bank of Pakistan and related institutions should expand digital financial inclusion programs targeting SMEs to ensure broader access to formal financial services.

Recommendations

1. Government should promote nationwide FinTech adoption programs targeting SMEs to improve financial access and reduce dependency on informal financing systems.
2. SMEs should integrate AI-based tools for financial management, customer analytics, and operational forecasting to enhance productivity.
3. Policymakers should strengthen entrepreneurial ecosystems by expanding incubation centers, funding schemes, and innovation clusters.
4. Financial institutions should adopt AI-driven credit scoring systems to improve SME lending efficiency and reduce credit risk barriers.
5. Training programs should be introduced to improve digital literacy among SME owners and employees.
6. Public-private partnerships should be strengthened to accelerate digital transformation in SME sectors.

Limitations and Future Directions

Limitations

First, the study used a cross-sectional design, which limited the ability to assess long-term causal relationships. Second, the data were based on self-reported responses, which may introduce subjective bias. Third, the study focused only on SMEs in Pakistan, which may limit generalizability to other developing or developed economies. Fourth, the study primarily examined three independent variables and did not include other potential determinants such as regulatory quality, macroeconomic conditions, or cultural factors.

Future Research Directions

Future studies should adopt longitudinal research designs to examine the long-term effects of AI and FinTech adoption on SME performance. Comparative studies across different countries could also enhance the generalizability of findings.

Future research should incorporate additional variables such as regulatory environment, cybersecurity risks, digital literacy, and organizational readiness as mediators or moderators. Mixed-method approaches combining qualitative and quantitative data could provide deeper insights into adoption barriers and behavioral factors influencing SME digital transformation.

Finally, future studies may explore sector-specific analyses (e.g., manufacturing, agriculture, services) to better understand industry-level variations in AI and FinTech adoption outcomes.

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