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Shaping Tomorrow: Fintech, Leadership, and Competencies for Sustainable Business Performance

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Abstract

This research applies Ecological Modernization Theory (EMT) together with the Resource-Based View (RBV) to investigate the influence of access to finance (AF) and sustainable innovative leadership (SIL) on firms' sustainable performance. It further analyzes the mediating effect of FinTech adoption (FTA) and the conditional role of financial competencies (FC) as a moderated mediator within the context of Pakistani SMEs. Data were gathered from 350 SME executives and examined using Partial Least Squares-Structural Equation Modeling (PLS-SEM). The analysis reveals that both AF and SIL contribute positively to sustainable performance when facilitated through FTA. In addition, FC strengthens the indirect pathway, indicating that financial skills enhance the impact of AF and FTA on sustainable outcomes. The results highlight that AF, SIL, FTA, and FC serve as essential strategic resources that collectively drive environmental (ESP), social (SSP), and financial (FSP) sustainability within organizations. Overall, this study offers practical implications for SME leaders and policymakers by presenting a comprehensive framework that emphasizes FinTech implementation, improvement of governance systems, and the enhancement of financial expertise. Strengthening these areas can expand financial accessibility and support the design of effective training and regulatory strategies for SMEs.

Keywords: Access To Finance; Fintech Adoption; Financial Competencies; Firm's Sustainable Performance; Sustainable Innovation Leadership

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1. Introduction

Small and medium-sized enterprises (SMEs) play a pivotal role in advancing the Sustainable Development Goals (SDGs). They account for nearly 90% of private-sector operations, provide half of global employment, and contribute around 40% of worldwide value creation (Smith et al., 2022; Van Hoang et al., 2023; Xiang, 2023). Their significance has grown as nations confront sustainability-related pressures (Coldwell et al., 2022). Both government and industry-led programs have recently funneled unprecedented capital toward “green” SME initiatives (de Sousa Jabbour et al., 2020). Despite limited regulatory enforcement, SMEs frequently display dedication to sustainability via transparent mechanisms such as CSR websites and sustainability reporting (Zhang et al., 2022). However, financing these efforts is complicated by issues including collateral requirements, high transaction costs, and information asymmetries (Alter & Elekdag, 2020; Brassell & Boschmans, 2019; Falavigna & Ippoliti, 2023; Jun & Ran, 2024; Sanga & Aziakpono, 2023). Digital finance has emerged as a potential solution to narrow these gaps, although the financing challenge remains fundamentally shaped by behavioral decision-making.

Within the Industry 4.0 spectrum, Financial Technology (FinTech) such as peer-to-peer lending and digital factoring directly targets the SME financing shortfall while supporting SDG 9. International panel evidence suggests that peer-to-peer (P2P) platforms reduce collateral requirements by nearly 25% and speed up credit approvals by 40% (Abbasi et al., 2021; World Bank, 2023). Nevertheless, little research has explored how such financing innovations link to SMEs’ triple-bottom-line performance, especially within South Asian manufacturing sectors (Liu, Liu, & Feng, 2024). FinTech is arguably the Industry 4.0 tool most closely aligned with SME finance, though complementary technologies such as IoT monitoring, smart factory dashboards, and collaborative robotics also enhance sustainability by improving efficiency and embedding environmentally responsible practices. Moreover, they promote psychological safety among employees by enabling experimentation. Studies from emerging markets like India, Brazil, and China have linked eco-innovation to firm performance (Ting et al., 2019), while more recent research has shown that circular procurement (Bhatti et al., 2023), sustainability maturity pathways (Salvador et al., 2023), and green entrepreneurial orientations (Xin et al., 2023) each enhance certain sustainability dimensions but often omit finance-related aspects. Consequently, funding constraints continue to limit the expansion of green practices, suggesting that leadership capacity and technological adoption must be jointly considered—an area rarely examined.

Digital instruments such as blockchain-enabled audit trails, AI-based credit scoring, and online lending offer lower-cost liquidity channels that reduce financial risk perceptions (Hendershott et al., 2021; Soni et al., 2022). Yet empirical research on their sustainability impact is limited. Cross-country findings demonstrate that broader credit access and stronger FinTech penetration significantly lower SMEs’ carbon intensity, even within high-emission industries (Liu, Kang, & Wang, 2024; Xu et al., 2023; Xu et al., 2024). This reinforces the central finance–sustainability question addressed in this paper. FinTech adoption is not only a matter of rational cost–benefit calculation; adoption is often shaped by ethical concerns and fears about job security. Such human-related barriers frame the behavioral perspective of this study. For instance, recent industrial–organizational research highlights how “ethical anxiety” regarding algorithmic bias, privacy risks, and technological displacement moderates digital adoption (Wang & Zhang, 2025). Recognizing these concerns adds nuance to the finance sustainability debate.

Accordingly, this study investigates whether FinTech adoption can enhance both profitability and ESG performance while mitigating barriers tied to ethical anxieties.

These psychological dynamics place industrial–organizational (I/O) concepts such as leadership cognition and employee self-efficacy at the core of the analysis. Here, Sustainable Innovative Leadership (SIL) is conceptualized as a leader’s cognitive orientation characterized by future-mindedness, openness to innovation, ethical sensitivity, emotional intelligence, and fostering of psychological safety, thereby channeling digital finance into long-term ESG outcomes (Rehman et al., 2019; Zhu et al., 2024). Empirical work on SIL remains scarce outside advanced economies, a gap this study addresses in the context of Pakistan’s SME sector. Specifically, we examine how access to finance (AF), SIL, FinTech adoption (FTA), and managerial financial competence (FC) collectively influence environmental (ESP), social (SSP), and financial (FSP) performance. Our dataset focuses on SMEs in textiles and automotive components industries central to Pakistan’s economy. For example, textiles account for roughly 56% of national exports, yet SMEs in manufacturing capture only about 14% of bank lending while contributing nearly 20% of industrial CO₂ emissions (PBS, 2023; SBP, 2023; Ullah et al., 2023). We also consider digital culture—supporting experimentation and data-driven learning as a contextual backdrop that enhances SIL and FinTech effects (Wang & Zhang, 2025).

Despite these developments, significant knowledge gaps persist. Most SME studies tend to isolate only one or two pillars of sustainability (Appiah-Kubi et al., 2024; Barbosa et al., 2020; Olah et al., 2020), and systematic evidence on triple-bottom-line outcomes among Asian manufacturing SMEs remains limited (Yadegaridehkordi et al., 2023). Persistent SME financing constraints whether stemming from supply or demand also highlight the underexplored role of managers’ financial competence (Harrison et al., 2022). Furthermore, little is known about how SIL-driven governance mechanisms mitigate financial and operational risks. Against this backdrop, the present study pursues three objectives: (O1) to examine whether AF and SIL improve sustainability outcomes (ESP, SSP, FSP) through FTA; (O2) to test whether FC strengthens the AF → FTA link and its sustainability benefits; and (O3) to provide an integrated EMT–RBV account of how these factors interact in emerging-market SMEs.

Our guiding research questions are:

RQ1. How do AF, SIL, FTA, and FC jointly influence ESP, SSP, and FSP?

RQ2. Does FTA mediate the relationships between AF and sustainability, and SIL and sustainability?

RQ3. Does FC enhance the indirect pathway from AF through FTA to sustainability?

By embedding I/O constructs into an EMT–RBV framework, this study extends leadership–technology scholarship to a resource-constrained emerging-market context. Drawing on Ecological Modernization Theory and the Resource-Based View, we propose an integrated model linking finance access, sustainable innovative leadership, fintech adoption, and financial competencies (e.g., self-efficacy, analytical decision-making) to Pakistani SMEs’ environmental, social, and financial outcomes. Our contributions are fourfold: (i) testing whether FTA alleviates the financial constraints identified by Aftab et al. (2022) and Ullah et al. (2021); (ii) evaluating how SIL directly drives sustainability outcomes across all three dimensions; (iii) positioning FTA as the mediating mechanism between AF, SIL, and performance (Hidayat-ur-Rehman & Alsolamy, 2023); and (iv) examining whether FC amplifies the AF → FTA pathway and its sustainability returns. This multi-level approach provides a nuanced understanding of how internal capabilities and external digital innovations together strengthen SME sustainability.

2. Literature Review and Hypothesis Development

The accelerated growth of digital technologies has significantly enhanced innovation (Usai et al., 2021) and reshaped business models through the adoption of emerging

technologies (Nogueira et al., 2023). Within the Industry 4.0 landscape, Financial Technology (FinTech) has become a disruptive driver, embedding advanced digital solutions into organizational practices and transforming conventional business operations (Karim et al., 2022). At the same time, achieving sustained competitiveness in the modern business environment requires integrating economic, environmental, and social objectives into strategic and decision-making processes (Yadegaridehkordi et al., 2023). While previous studies, such as Yip et al. (2023), highlight that environmental and economic aspects of the triple bottom line (TBL) (Alhaddi, 2015) often receive greater focus than the social dimension, the latter remains underexamined. This gap underscores the need to pay more attention to the social component, alongside ensuring firms' financial growth (Nogueira et al., 2023).

Sustainability, in this sense, strengthens both internal and external environmental practices of firms (Arshad et al., 2023; Dadhich & Hiran, 2022), while social sustainability is reflected in activities such as community capacity building, improving living standards, ensuring workplace safety, and environmental stewardship (Rodríguez-Espíndola et al., 2022). Financial sustainability, meanwhile, is attained through cost reduction in materials and energy usage, minimizing waste, and increasing return on investment (Yadegaridehkordi et al., 2023). To explain these dynamics, several theoretical lenses have been employed in prior research, including stakeholder theory (Le & Ikram, 2022; Singh et al., 2022), upper echelon theory (Madrid-Guijarro & Duréndez, 2024; Xuecheng & Iqbal, 2022), the resource-based view (RBV) (Abbasi Kamardi et al., 2022; Afum et al., 2020; Mokbel Al Koliby et al., 2024; Seraj et al., 2022), and ecological modernization theory (EMT) (Sarkis & Cordeiro, 2012; Weber & Weber, 2020). Among these, RBV and EMT are central to this study, as they provide a useful framework to explore the interaction between technology adoption, leadership, and sustainable performance.

In addition, organizational culture particularly digital culture that embraces experimentation, evidence-based decision-making, and continuous learning serves as an essential enabler of innovation and magnifies the role of leadership and FinTech adoption. Such a culture allows leaders to champion sustainability agendas while ensuring effective integration of digital technologies into business operations (Wang & Zhang, 2025).

Traditionally, RBV has been applied to explain how firms with rare and valuable resources sustain competitive advantage (Barney, 1991). In this study, RBV is extended to analyze intangible resources such as Sustainable Innovative Leadership (SIL) and Financial Competencies (FC) in SMEs. However, recognizing that RBV by itself does not fully capture the external financial barriers SMEs often face, this study complements it with the ecological modernization theory (EMT) to provide a more comprehensive perspective.

The Resource-Based View (RBV) explains firm performance by examining resource heterogeneity within organizations and the immobility of resources across markets, which together generate long-term competitive advantage (Cruz & Haugan, 2019). Such an advantage typically stems from higher profitability, lower operational costs, and improved efficiency (Ruivo et al., 2015; Shan et al., 2019). RBV provides a framework for assessing strategic advantages that arise from valuable, rare, and inimitable resources (Abbasi Kamardi et al., 2022). Recent studies emphasize that both tangible and intangible resources particularly those tied to environmental and sustainability dimensions are crucial in enhancing financial performance and competitive strength (Siddik, Rahman, & Yong, 2023). Financial capital, in particular, plays a key role in optimizing operational processes and supporting sustainability-related initiatives (Bartolacci et al., 2020; Clark et al., 2018; Ziolo et al., 2021). RBV also highlights the role of intangible resources, such as knowledge and expertise, as drivers of unique and durable advantages (Ozdemir et al., 2023).

In this study's context, Sustainable Innovative Leadership (SIL) and Financial Competencies (FC) are conceptualized as intangible, psychologically grounded resources. SIL embodies a forward-looking cognitive orientation, adaptability for innovation, and a values-driven commitment to sustainability—qualities closely tied to psychological aspects of leadership such as ethical judgment, creativity, and openness to change. Nevertheless, even strong leadership does not eliminate potential psychological barriers; employees may still experience ethical anxiety, which can hinder FinTech adoption. Similarly, FC goes beyond technical expertise to include psychological elements like financial self-efficacy (Bandura, 1997), risk assessment capabilities, and decision-making under uncertainty. These psychological dynamics, including ethical anxiety, shape how managers and employees approach FinTech integration and, in turn, influence sustainability outcomes.

Accordingly, SIL and FC are treated here as strategic intangible resources that foster new business opportunities and drive sustainable performance (Farhan, 2024). Using the RBV perspective, this study examines the relationships among access to finance (AF), SIL, FinTech adoption (FTA), FC, and triple-bottom-line performance outcomes environmental (ESP), social (SSP), and financial (FSP).

Ecological Modernization Theory (EMT) posits that economic progress and ecological sustainability are not contradictory but can reinforce one another (Mol, 2002; Sarkis & Cordeiro, 2012). EMT shifts the view of environmental protection from being a constraint toward being an opportunity, urging firms to restructure their operations through the adoption of advanced technologies (Zhu et al., 2012). Within organizations, this transformation is further supported by Sustainable Innovative Leadership (SIL), which encourages structural and cultural change. By promoting psychological safety (Edmondson, 1999), SIL enables employees to engage in experimentation, including the adoption of FinTech-driven eco-innovation.

Proponents of EMT emphasize that technological advancement is a key enabler of environmental improvements. Innovations such as cleaner production techniques, renewable energy systems, and resource-efficient practices are positioned as mechanisms to align economic expansion with ecological preservation (Weber & Weber, 2020). The theory thus frames technology not only as a driver of productivity but also as an instrument for balancing growth and sustainability (Jänicke, 2020). Early contributors to EMT such as Huber (1982), who highlighted the necessity of structural reforms in production and consumption, and Mol (2002), who extended the theory by integrating globalization and information flows established the foundation for applying EMT in modern sustainability research.

In line with this perspective, this study applies EMT to explain how digital technologies and leadership can jointly advance SMEs' sustainable transformation. Table 1 presents a sustainability matrix for SMEs, outlining the research settings, methodological approaches, analytical techniques, sustainability drivers, and outcome variables across prior studies.

Access to finance refers to the capacity of individuals and firms to obtain financial services at affordable costs, which not only reduces poverty but also enhances living standards and contributes to national economic growth (Khaki & Sangmi, 2017; Sha'ban et al., 2021; Sharma & Chaurasia, 2023). For SMEs, financial accessibility is essential for embedding environmental, social, and economic aspects into strategic operations (Dzomonda, 2022). However, psychological barriers, such as ethical concerns, may emerge when adopting new technologies like FinTech, limiting the extent to which firms utilize available funding for innovative strategies (Prastyanti et al., 2023). These barriers can discourage SMEs from experimenting with financial innovations despite the potential benefits.

Institutional quality is another decisive factor. Strong institutional frameworks facilitate easier access to credit, while weaker systems often exacerbate information asymmetry, raise transaction costs (Kersten et al., 2017), and ultimately restrict credit availability (Ma et al., 2019). Many SMEs still rely on self-financing or face high interest rates, which constrain their adoption of sustainable technologies, including FinTech-based solutions (Aiello et al., 2020). Yet, financial resources remain the cornerstone for enabling sustainable policies (Zhang & Wei, 2021). Firms that strategically integrate sustainability are generally more attractive to investors, thereby improving their financial capacity to pursue long-term sustainability goals (Aristei & Gallo, 2021).

Recent empirical evidence supports this finance–sustainability linkage. A cross-country dataset of 5,154 manufacturing firms across 39 economies shows that easing credit constraints raises total factor energy-efficiency scores by around 7%, confirming that diversified funding accelerates Scope-1 emission reductions (Zhang et al., 2025). Similarly, OECD’s *Financing SMEs and Enterprises 2023* survey finds that SMEs maintaining multiple banking relationships invest 25% more in low-carbon technologies compared to those dependent on a single bank (OECD, 2023). From an emerging-economy perspective, panel data covering 279 Chinese cities (2011–2019) indicate that deeper penetration of digital finance boosts green patenting by approximately 8%, with stronger effects in regions with robust environmental regulations (Hu et al., 2022). Furthermore, Ullah et al. (2021) emphasize that access to both internal and external capital directly enhances firms’ ability to sustain their practices.

Grounded in RBV and EMT, this study formulates the following hypotheses:

H1a. Improved financial access positively influences a firm’s environmental sustainability performance.

H1b. A firm’s social sustainability initiatives positively influence its social sustainability performance.

H1c. Access to finance positively influences a firm’s financial sustainability performance.

Table 1. Sustainability Matrix in SMEs

Research	Context	Research method	Sustainability drivers	Dependent Variables
Alraja et al. (2022).	SMEs from Oman	PLS-SEM	Technological factors, organizational factors, and environmental factors	Sustainable Performance
Malesios et al. (2021)	SMEs in Europe and Asia	Systematic literature review	Environmental practices, social practices, and economic practices	Sustainable Performance
Choudhary et al. (2019)	Manufacturing UK	Case study methodology	Implementation of lean green practices	Sustainability performance indicators
Nor-Aishah et al. (2020)	SME- Malaysia	Quantitative research method	Entrepreneurial leadership & bricolage	Sustainable performance
Oduro (2024)	Globally	Meta-analysis approach	Eco-process, eco-product, eco-organization, eco-marketing innovations	Sustainable performance

Research	Context	Research method	Sustainability drivers	Dependent Variables
Omar, Al-shari, et al. (2024)	SME-Pakistan	SPSS, PLS-SEM	Green manufacturing practices	Corporate sustainable performance
Pett et al., 2025	SME-France, India, USA	PLS-SEM	Empowering leadership, knowledge transfer	Sustainable performance

Sustainable innovative leadership (SIL) is central to advancing corporate sustainability as it integrates long-term ecological, social, and economic objectives into organizational strategies. Leaders with a sustainability-driven orientation typically exhibit a forward-looking cognitive style characterized by innovation, ethical commitment, and adaptive capabilities. These attributes enable firms to achieve the triple bottom line (TBL) outcomes environmental sustainability performance (ESP), social sustainability performance (SSP), and financial sustainability performance (FSP) (Khan, Saqib, et al., 2023). Such leaders cultivate employee empowerment, promote collaborative innovation, and institutionalize sustainability within organizational culture, thereby facilitating the diffusion of environmentally friendly practices and technologies (Zada et al., 2024).

In addition, SIL fosters psychological safety and proactive behavior, aligning day-to-day operations with eco-innovation and social responsibility initiatives, which strengthens ESP and SSP (Rosario & Boechat, 2025). From a financial perspective, SIL enables firms to reduce costs and optimize resources through strategic foresight and investments in resilient capabilities, enhancing FSP even under uncertain conditions (Khan, Saqib, et al., 2023).

Cross-national empirical studies reinforce these claims. Evidence from a 243-firm sample across six EU countries indicates that green-oriented leadership raises environmental and social KPIs by 26% through eco-innovation practices (Juracka et al., 2024). Likewise, research on 60 Indonesian medium-sized contractors demonstrates that leaders who combine green HR incentives, a culture of continuous learning, and cost-efficient digital tools significantly improve both environmental and financial outcomes in the construction sector (Kutu' Kampilong et al., 2025).

The literature thus highlights SIL as a distinctive managerial capability that not only shapes organizational behavior but also positions innovation and sustainability as mutually reinforcing drivers of firm performance across all three dimensions. Based on this reasoning, the following hypotheses are proposed:

H2a. Sustainable innovative leadership positively influences environmental sustainability performance.

H2b. Sustainable innovative leadership positively influences social sustainability performance.

H2c. Sustainable innovative leadership positively influences financial sustainability performance.

In today's dynamic and uncertain business landscape, particularly for SMEs, access to finance (AF) has become a critical enabler of growth, sustainability, and long-term

competitiveness. Sustainable finance frameworks are increasingly recognized as tools that not only expand financing channels but also mitigate risks and foster innovation for globally competitive SMEs (Oyewole et al., 2024). Nevertheless, the literature consistently emphasizes persistent financing barriers, especially in emerging economies (Amin & Motta, 2023; Soni et al., 2023). These constraints often stem from information asymmetries between borrowers and lenders and limited availability of affordable credit (Frag & Johan, 2022; Motta & Sharma, 2020). Restricted financial access can also create psychological barriers that discourage SMEs from adopting innovative solutions such as FinTech, thereby constraining growth and long-term transformation (Ermawati, 2025). Ultimately, these challenges increase the risk of operational failure and contribute to the high mortality rates of SMEs worldwide (Moscalu et al., 2020; Vnukova, 2020).

FinTech has emerged as a transformative solution to these challenges, particularly by improving credit accessibility for SMEs and underserved groups (Abbasi et al., 2021; Enshassi et al., 2024). Leveraging big data analytics, FinTech platforms enhance the precision of credit risk assessments, thereby facilitating lending decisions and enabling SMEs to secure financing more effectively (Abbasi et al., 2021). Moreover, advances in digital financial technologies improve credit market data sharing (Chu & Wei, 2024), while broader access to lender information reduces due diligence costs, borrowing uncertainties, and credit risks (Sanga & Aziakpono, 2023).

Grounded in RBV and EMT, this study therefore proposes the following hypothesis:

H3. The adoption of FinTech solutions is positively associated with improved financial accessibility for SMEs.

The acceleration of digital technologies presents firms with both opportunities and risks. On one hand, cybersecurity incidents have intensified (Bajwa et al., 2023), and unchecked digital expansion can heighten environmental pressures, particularly in regions such as ASEAN (Bajwa, Fu, Bajwa, Rehman, & Abbas, 2025) and Pakistan (Khan & Chaudhry, 2024). On the other hand, FinTech has emerged as a strategic enabler for firms operating in these complex environments (Offiong et al., 2025). Through the integration of artificial intelligence (AI), the Internet of Things (IoT), machine learning, and blockchain technologies, FinTech reduces transaction costs, broadens financial inclusion, and enhances risk management practices (Andronie et al., 2024; Bhat et al., 2023). While initially developed as back-office banking tools (Almansour, 2023), FinTech has since transformed global financial markets (Verma et al., 2023) and increasingly contributes to sustainable initiatives such as renewable energy and environmental restoration (Shi & Yang, 2025; Sreenu, 2024).

For SMEs key drivers of economic development in emerging economies the adoption of FinTech is no longer optional but essential to maintain competitiveness (Pawar & Sangvikar, 2019). Leadership plays a decisive role in this transition. Sustainable innovative leadership (SIL), characterized by long-term orientation, ethical grounding, and strategic integration of new technologies, enables firms to strengthen resilience while accelerating technology adoption (Sokolic et al., 2024; Suriyankietkaew et al., 2022). Empirical studies confirm that SIL amplifies the benefits of FinTech by fostering cost efficiency, differentiation, and operational effectiveness (Klewitz & Hansen, 2014). Based on this theoretical foundation, the following hypothesis is proposed:

H4. Sustainable innovative leadership is positively associated with FinTech adoption within firms.

FinTech leverages cutting-edge digital innovations from mobile-based payment platforms (Bajwa, Fu, Bajwa, Ahmad, & Mahmood, 2025) to blockchain-driven solutions

(Li et al., 2020) to transform traditional business models, enhance environmental sustainability, and mitigate ecological impacts in resource-intensive industries (Jia et al., 2024; Siddik, Rahman, & Yong, 2023). When combined with Sustainable Innovative Leadership (SIL), FinTech adoption not only improves efficiency but also aligns corporate strategies with long-term ecological and social goals. Leaders who establish psychologically safe workplaces empower employees to embrace FinTech tools, thereby reinforcing environmental accountability and social responsibility (Chueca Vergara & Ferruz Agudo, 2021; Sun et al., 2023).

Although a considerable body of research highlights FinTech's role in strengthening financial outcomes (Alkhawaldeh et al., 2023; Croutzet & Dabbous, 2021; Ramamohan et al., 2021), fewer studies examine its direct contribution to financial sustainability defined as the ability to maintain long-term fiscal resilience (Anifa et al., 2022; Dharmayanti et al., 2023; Gomber et al., 2018). Drawing upon the Resource-Based View (RBV) and Ecological Modernization Theory (EMT), this study argues that FinTech adoption, facilitated by SIL, reinforces firms' resilience across environmental, social, and financial dimensions. Accordingly, the following hypotheses are advanced:

- H5a.** FinTech adoption is positively associated with a firm's environmental sustainability.
- H5b.** FinTech adoption is positively associated with a firm's social sustainability.
- H5c.** FinTech adoption is positively associated with a firm's financial sustainability.

Small and Medium Enterprises (SMEs) are crucial for job creation and export promotion within national economies (Aftab et al., 2022; Matloob et al., 2025). However, SMEs and MSMEs in developing markets often face severe credit access constraints, forcing reliance on personal capital or costly informal lending (Martinez-Cillero et al., 2023; Mushtaq et al., 2022). The persistent problem of information asymmetry in SME financing has been well-documented (Croce et al., 2025; Sanga & Aziakpono, 2023). Innovative financing mechanisms such as government-supported schemes with implicit guarantees have been suggested as ways to lower default risks, reduce interest rates, and expand financial access (Hossain et al., 2023).

Improved Access to Finance (AF) enhances firms' ability to leverage digital financial platforms, thereby contributing positively to sustainability performance (Ratnawati et al., 2024; Zhou & Pacala, 2025). Emerging financing models, such as peer-to-peer (P2P) and business-to-business (B2B) lending, streamline capital flows and promote sustainability-related investments, including renewable energy projects (Ma, 2023; Teichmann et al., 2024). Moreover, such innovations facilitate funding for environmental, social, and governance (ESG) initiatives, strengthening environmental sustainability outcomes (Du et al., 2022).

The expansion of FinTech also addresses financial exclusion by making credit more affordable and accessible, lowering borrowing costs, and improving credit terms (Eça et al., 2021; Li, Lu, & Yin, 2023; Rizwan & Mustafa, 2022; Tidjani & Madouri, 2024). Previous empirical studies link FinTech-enabled AF to sustainable practices across environmental, social, and governance dimensions (Min et al., 2023; Ullah et al., 2021). However, most of this evidence stems from cross-sectional research, with limited longitudinal or mixed-method investigations. This highlights the need for deeper exploration of how FinTech-mediated AF directly strengthens sustainability outcomes in all three domains—environmental, social, and financial.

Grounded in the RBV resource orchestration framework (Teece, 2007) and EMT's socio-technical transition perspective, we propose:

- H6a.** FinTech adoption mediates the relationship between access to finance and environmental sustainability.
- H6b.** FinTech adoption mediates the relationship between access to finance and social sustainability.
- H6c.** FinTech adoption mediates the relationship between access to finance and financial sustainability.

FinTech has emerged as a critical enabler of sustainability and competitive advantage for firms. Building on early insights from Al Doghan and Chong (2023), recent studies by Alsadoun and Alrobai (2024), Bhuiyan et al. (2024), and Hidayat-ur-Rehman and Hossain (2024) affirm FinTech's positive influence on environmental performance. These works highlight FinTech's role in promoting green finance, advancing eco-innovation, and enhancing operational efficiency, thereby strengthening sustainability outcomes across diverse industries.

Nevertheless, corporate-level analyses reveal a more complex relationship between FinTech adoption and performance outcomes. For instance, Moreira-Santos et al. (2022) demonstrate that FinTech significantly reduces carbon footprints and operational costs in resource-intensive industries, while also improving service attractiveness and financial resilience. Conversely, Menne et al. (2022) contend that FinTech often prioritizes short-term financial gains by aligning SMEs more closely with market demands and evolving sustainability expectations.

Recent literature also emphasizes leadership as a decisive factor in successful FinTech adoption. Studies by Baba et al. (2023), Zhang (2024), and Tian et al. (2023) illustrate how creative, transformational, and supportive leadership styles enhance employee motivation, technological acceptance, and green innovation. Strategic leadership fosters innovation capacity, digital competitiveness, and sustainability by cultivating risk tolerance, strategic alignment, and robust cybersecurity practices (Von Solms & Langerman, 2022).

The concept of Sustainable Innovative Leadership (SIL) underscores embedding sustainability into organizational culture by balancing short-term economic imperatives with long-term environmental, social, and financial objectives. SIL strengthens stakeholder engagement across these dimensions (Jayashree et al., 2022), while its behavioral practices enhance employee adaptability, engagement, and resilience in uncertain contexts (Toseef et al., 2022). Such leadership mitigates financial risks and elevates firm performance through stronger employee commitment and innovative capacity (Xin et al., 2024).

Despite these insights, the mechanisms through which SIL enhances environmental, social, and financial sustainability via FinTech adoption remain underexplored. Accordingly, this study proposes:

- H7a.** FinTech adoption mediates the relationship between SIL and a firm's environmental sustainability outcomes.
- H7b.** FinTech adoption mediates the relationship between SIL and a firm's social sustainability outcomes.
- H7c.** FinTech adoption mediates the relationship between SIL and a firm's financial sustainability outcomes.

Financial competence (FC) is a critical determinant of a firm's creditworthiness, equipping managers with the expertise needed for precise financial forecasting, efficient liquidity management, and effective risk mitigation (Haiduchok, 2025). The capacity to assess trade receivables and set optimal credit limits largely depends on managerial

financial acumen, which helps reduce default risk and ensures smooth capital flow (Ilieva & Tsonkova, 2024). Beyond these operational roles, FC is pivotal for sustaining broader financial resilience, enabling managers to interpret both internal and external indicators effectively, thereby influencing long-term capital access and funding strategies (Qian et al., 2023; Siddik, Yong, & Rahman, 2023).

Financial competence, therefore, transcends technical skill, functioning as a strategic capability that underpins stability, informed decision-making, and sustainable growth. Ismanto et al. (2022) classify innovation into exploitative and explorative dimensions, noting that FC develops through the effective application of knowledge and skills. As an individual-level resource, FC directly reflects managerial proficiency in financial decision-making (Ye & Kulathunga, 2019).

From a Resource-Based View (RBV) perspective, strategic advantages and firm success hinge on effective utilization of tangible and intangible resources, including innovation capabilities, knowledge, and intellectual property (Cataltepe et al., 2022; Al-Jubouri, 2019). Prior studies highlight FC's relevance for sustainable financial management and overall corporate sustainability performance, encompassing environmental, social, and economic dimensions (Korutaro Nkundabanyanga et al., 2014; Ullah et al., 2021). Empirical evidence indicates that inadequate financial literacy among SME leaders restricts their ability to overcome financing barriers crucial for green and sustainable initiatives (Caldera et al., 2019; Ratnawati et al., 2024).

SMEs with highly financially competent managers demonstrate greater efficacy in accessing and deploying financial resources, enhancing decision-making processes vital for sustainability (Lasmi, 2024). FC also enables the strategic alignment of diverse funding sources, including debt, equity, and internal financing (Omar, Messaadia, & Elmezughi, 2024). Managers with strong FC signal firm quality more clearly, reduce information asymmetries, and navigate financing constraints more effectively, thereby facilitating FinTech adoption and improving sustainability outcomes (Zahid et al., 2024).

Consequently, this study proposes that financial competence moderates the indirect relationship between access to finance and sustainable performance via FinTech adoption. By enhancing managerial capabilities, FC strengthens SMEs' ability to leverage digital financial tools, overcome traditional financing challenges, and achieve sustainability objectives. Drawing on moderated-mediation logic (Preacher & Hayes, 2008), the following hypothesis is formulated:

H8. Financial competence moderates the mediated relationship between access to finance and sustainable performance via FinTech adoption, such that higher financial competence amplifies this indirect effect.

The study's conceptual framework is presented in Figure 1, illustrating the hypothesized relationships among key constructs, including access to finance (AF), sustainable innovative leadership (SIL), FinTech adoption (FTA), managerial financial competence (FC), and the firm's environmental (ESP), social (SSP), and financial sustainability performance (FSP). The framework depicts both direct and indirect pathways, highlighting FinTech adoption as a mediator and financial competence as a moderator within the AF → FTA → sustainability pathway. This model integrates insights from the Resource-Based View (RBV) and Ecological Modernization Theory (EMT), providing a holistic perspective on how internal capabilities and external financial tools jointly influence SMEs' triple-bottom-line outcomes.

3. Research Methods

the study within the context of Pakistani SMEs and sequentially details the research design, including sampling procedures, measurement instruments, data diagnostics, and analytical techniques used to test the eight proposed hypotheses. The sub-sections (3.1–3.5) address, in order, the study's context ("where"), target population ("who"), variables and instruments ("what"), data quality assessments ("is the data sound?"), and the statistical modeling approach employed ("how it was analyzed").

Pakistan hosts approximately 5.2 million small and medium enterprises (SMEs), which account for around 25 % of the nation's manufactured exports and contribute roughly 30 % to its GDP, underscoring their central role in the country's economic development (Naveed et al., 2022). The Small and Medium Enterprise Development Authority (SMEDA), established in 1998, supports the sector's growth and formalization. According to SMEDA (2023), SMEs are categorized as small enterprises (SE) with annual revenues up to PKR 150 million, and medium enterprises with revenues ranging between PKR 150 million and PKR 800 million. Alternative definitions, such as those by Ahmad et al. (2021), classify SMEs as firms with no more than 250 employees, paid-up capital not exceeding PKR 25 million, and annual revenues capped at PKR 250 million, reflecting slight variations in regulatory criteria.

Data were collected from 350 SMEs across key industries such as textiles and automobile spare parts manufacturing, chosen for their economic significance and propensity for FinTech adoption. Respondents were senior executives and managers with comprehensive knowledge of their firms' operations and performance. A structured questionnaire, based on previously validated scales from peer-reviewed literature, was employed as the primary instrument for data collection, and analyses were conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM).

To maximize response rates, data were gathered through in-person interviews and questionnaire distribution. Given the resource-intensive nature of face-to-face collection, the study focused on major industrial hubs, including Lahore, Faisalabad, and Karachi, capturing a representative cross-section of SMEs. The sample comprised primarily upper- and middle-level managers directly involved in operational decision-making.

Initially, 500 SMEs were contacted, with 420 agreeing to participate, yielding an 84 % response rate. Comparison of early- and late-wave respondents revealed no significant differences in demographics (X^2 and t -tests, $p > 0.10$), indicating minimal non-response bias (Armstrong & Overton, 1977). Data were collected between January and July 2024. After screening for missing values, outliers, and response consistency, the final dataset included 350 responses. Among these, 47 % of SMEs employed 101–250 staff, while 39 % had over 500 employees. Most respondents held master's degrees (71 %), followed by bachelor's degrees (23 %), and occupied senior positions such as CFO (21 %), General Manager (28 %), CEO (14 %), and Senior Manager (37 %). Male respondents predominated (85 %). FinTech adoption was prevalent, with 85 % of SMEs using it for transactions including bill payments, fund transfers, internet banking, and e-commerce (see Table 3).

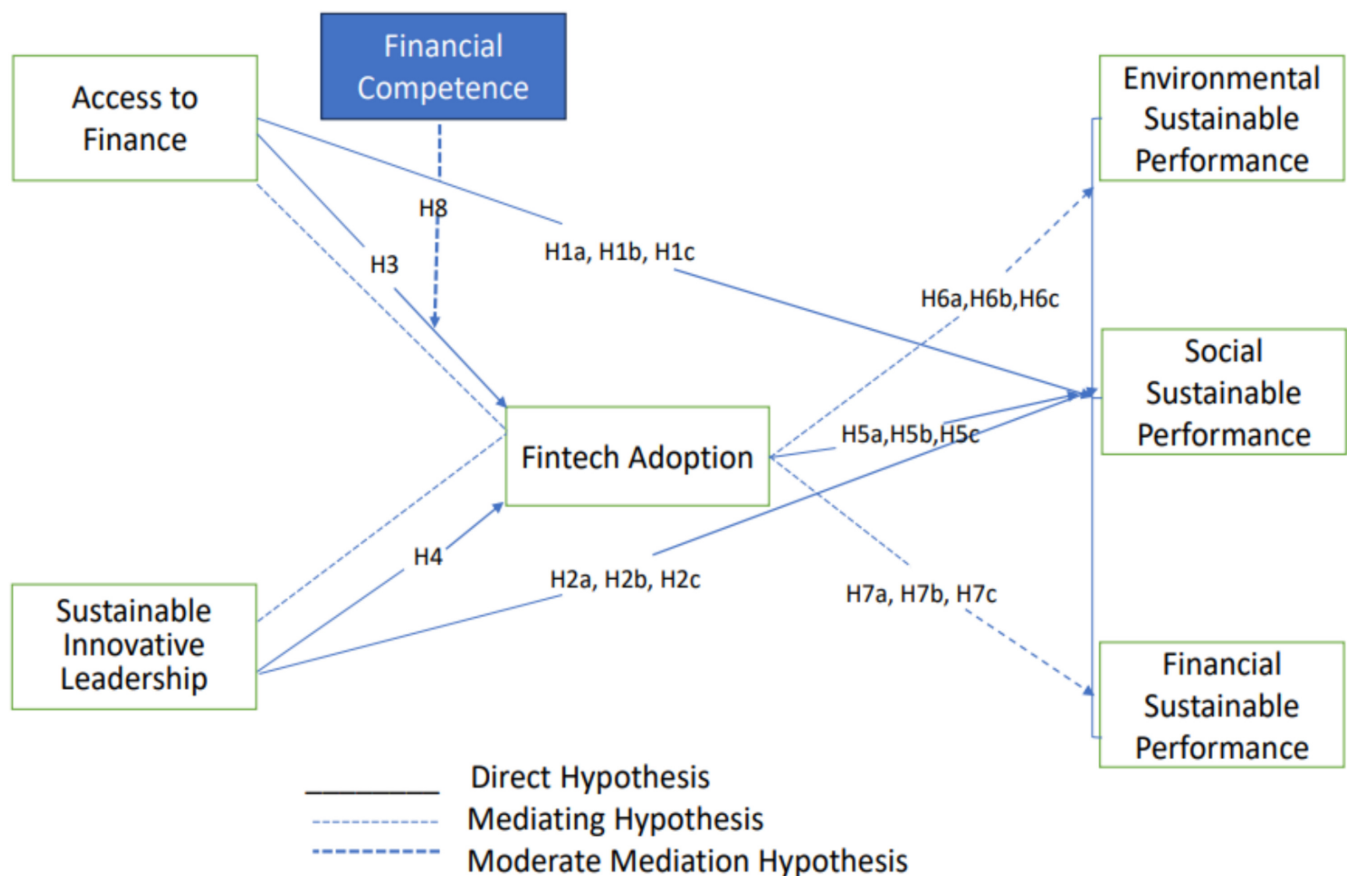


Figure 1. Conceptual model

A two-stage stratified purposive sampling strategy was adopted. Initially, the most recent SMEDA Industrial Directory (SMEDA, 2023) was organized by sector (textiles and automotive components) and SME size category (small vs. medium). Within each stratum, firms were randomly chosen until proportional quotas mirrored the national SME distribution. This approach ensures balanced representation while remaining feasible, given the absence of a complete probability frame for Pakistan's approximately 5.2 million SMEs (Etikan et al., 2016).

A preliminary power analysis using G*Power ($f^2 = 0.15$, $\alpha = 0.05$, $1 - \beta = 0.80$) indicated a minimum required sample of 119 participants. With 350 completed responses, the study comfortably exceeds this threshold, providing sufficient statistical power to test even the most complex paths in the structural model (Cohen, 2013). With the sample established, the next section describes the measurement of each construct.

The study measured sustainable performance across three dimensions: Environmental Sustainability Performance (ESP), Social Sustainability Performance (SSP), and Financial Sustainability Performance (FSP), following the frameworks suggested by Alsayegh et al. (2020). Each dimension was captured using multi-item scales adapted from prior validated research to ensure strong reliability and construct validity. Respondents rated items on a 5-point Likert scale, where 1 indicated "Strongly disagree" and 5 indicated "Strongly agree."

ESP was evaluated using five items reflecting waste minimization, emission reduction, and energy efficiency (Sajan et al., 2017; Yadegaridehkordi et al., 2023). SSP consisted of five items measuring aspects such as stakeholder well-being, community health, and workplace safety (Siddik, Rahman, & Yong, 2023). FSP was assessed with four items focusing on cost optimization and improved investment returns (Yadegaridehkordi et al., 2023; Zhu et al., 2008).

This study examines the impact of two independent variables on sustainable performance: Access to Finance (AF) and Sustainable Innovative Leadership (SIL). SIL is conceptualized as a strategic capability that promotes innovation and supports long-term sustainability within SMEs. Its measurement was adapted from the scale developed by Li, Gao, et al. (2023) to align with the decision-making practices of SME managers.

FinTech adoption serves as a mediator in this study, connecting Access to Finance (AF) with sustainability outcomes. It is theorized to convert enhanced financial resource availability into tangible practices that support environmental, social, and financial sustainability.

This study incorporates financial competence (FC) as a moderator in the mediated relationship between Access to Finance (AF) and FinTech adoption (FTA). FC was measured using adapted items from Ye and Kulathunga (2019), reflecting its pivotal role in shaping managerial decisions regarding the allocation and utilization of financial resources. A summary of the measurement scales for all constructs is provided in Table 2.

Table 2. Measurement Constructs

Construct	Dimensions	No of Items	Source
Financial Access	Financial Ease Sufficient Loans	7	Wasiuzzaman (2019)
	Affordable Services		
	Diverse Financial Services		
	Repeated Financial Ability		
	Finance Drives Sustainability		
	Work Motivation Eco-friendly Strategies		
	Information Sharing		
Sustainable Innovative Leadership	Innovation	8	Borah et al. (2022) Yadegaridehkordi et al. (2023)
	Encouragement		
	Sustainable		
	Understanding Confident		
	Leadership		
	Mentorship		
	Leadership		
FinTech Adoption	Innovative Ideas	9	Salvador et al. (2023); Siddik, Rahman, & Yong (2023)
	FinTech Opportunities		
	FinTech Channels		
	FinTech Embraced		
	FinTech Innovation		
	Supportive Regulations		
	Manageable Adoption		
Financial Competencies	Tech Management	6	Ye & Kulathunga (2019)
	FinTech Enhancement		
	FinTech Utilization		
	Financial Evaluation		
	Monthly Statements		
	Record Management		
	Loan Documentation		
	Interest Calculation		
	Bank Negotiation		

Construct	Dimensions	No of Items	Source
Environmental Sustainable Performance	Waste Reduction	5	Sajan et al. (2017); Yadegaridehkordi et al. (2023)
	Enhanced Compliance		
	Emission Reduction		
	Material Reduction		
	Energy Reduction		
Social Sustainable Performance	Enhanced Stakeholder Welfare	5	Siddik, Rahman, & Yong (2023)
	Community Health Improvement		
	Environmental Safety Improvement		
	Occupational Safety Improvement		
Financial Sustainable Performance	Community Rights Protection	4	Yadegaridehkordi et al. (2023); Zhu et al. (2008)
	Material Cost Reduction		
	Energy Expenditure Reduction		
	Reduced Waste Fees		
	Enhanced Investment Return		

Source: Author himself; *Rated on a 5-point Likert scale.

Table 3. Sample descriptive statistics.

Variables	Categories	Frequency	Percentage
Firm Size	1–100	50	14
	101–250	165	47
	Above 250	135	39
Firm Age	Newly established (1–3 years)	34	9
	Moderately established (3–5 years)	81	23
	Well-established (Over 5 years)	238	68
Qualification	Bachelor	80	23
	Master	247	71
	PhD	26	6
Job Title	CEO/Chairman	50	14
	CFO/Finance Director	71	21
	Director/General Manager	99	28
	Senior Manager	130	37
Gender	Male	278	79
	Female	72	21
Fintech Adoption	Yes	298	85
	No	52	15

Source: Author calculation

Table 4. Measurement model constructs.

Construct	Code	Loading	Outer Weights	P-value	CA	CR	AVE
AF					0.911	0.904	0.613
	AF1	0.764	0.198	<0.000			
	AF2	0.814	0.211	<0.000			

Construct	Code	Loading	Outer Weights	P-value	CA	CR	AVE
SIL	AF3	0.705	0.183	<0.000	0.883	0.883	0.557
	AF4	Dropped	Dropped	–			
	AF5	0.735	0.191	<0.000			
	AF6	0.704	0.183	<0.000			
	AF7	0.948	0.246	<0.000			
	SIL1	0.746	0.210	<0.000			
	SIL2	0.822	0.231	<0.000			
	SIL3	Dropped	Dropped	–			
	SIL4	0.701	0.197	<0.000			
	SIL5	0.761	0.214	<0.000			
FTA	SIL6	0.720	0.203	<0.000	0.925	0.925	0.675
	SIL7	Dropped	Dropped	–			
	SIL8	0.723	0.203	<0.000			
	FTA1	0.783	0.186	<0.000			
	FTA2	Dropped	Dropped	–			
	FTA3	0.761	0.181	<0.000			
	FTA4	Dropped	Dropped	–			
	FTA5	Dropped	Dropped	–			
	FTA6	0.838	0.199	<0.000			
	FTA7	0.835	0.199	<0.000			
FC	FTA8	0.941	0.224	<0.000	0.894	0.895	0.680
	FTA9	0.756	0.180	<0.000			
	FC1	0.769	0.268	<0.000			
	FC2	Dropped	Dropped	–			
	FC3	0.871	0.303	<0.000			
	FC4	0.800	0.279	<0.000			
	FC5	Dropped	Dropped	–			
	FC6	0.855	0.298	<0.000			
	ESP				0.847	0.847	0.525
	ESP1	0.715	0.251	<0.000			
SSP	ESP2	0.717	0.251	<0.000			
	ESP3	0.709	0.249	<0.000			
	ESP4	0.758	0.266	<0.000			
	ESP5	0.722	0.253	<0.000			
	SSP				0.891	0.890	0.670
	SSP1	0.850	0.299	<0.000			
	SSP2	Dropped	Dropped	–			
	SSP3	0.821	0.289	<0.000			
	SSP4	0.812	0.286	<0.000			

Construct	Code	Loading	Outer Weights	P-value	CA	CR	AVE
FSP	SSP5	0.791	0.279	<0.000	0.864	0.865	0.681
	FSP1	0.778	0.355	<0.000			
	FSP2	0.843	0.384	<0.000			
	FSP3	Dropped	Dropped	–			
	FSP4	0.851	0.388	<0.000			

Note: CA = Cronbach Alpha >0.70, CR = Composite Reliability >0.70, AVE = Average Variance Extract >0.50. ***p < 0.001

Table 5. Heterotrait- Monotrait ratio (HTMT)

	AF	ESP	FTA	FC	FSP	SIL	SSP
AF							
ESP	0.594						
FTA	0.550	0.695					
FC	0.215	0.446	0.591				
FSP	0.573	0.602	0.718	0.472			
SIL	0.494	0.663	0.609	0.399	0.613		
SSP	0.531	0.669	0.741	0.623	0.724	0.745	

HTMT values < 0.85; AF = Access to finance; SIL = Sustainable innovative leadership; FTA = FinTech adoption; ESP = Environmental sustainable performance; SSP = Social sustainable performance; FSP = Financial sustainable performance.

Table 6. Discriminant Validity (Fornell-Larcker criterion)

	AF	ESP	FTA	FC	FSP	SIL	SSP
AF	0.783						
ESP	0.600	0.725					
FTA	0.562	0.697	0.821				
FC	0.225	0.445	0.591	0.825			
FSP	0.585	0.602	0.719	0.470	0.825		
SIL	0.505	0.663	0.611	0.398	0.613	0.746	
SSP	0.543	0.669	0.743	0.621	0.725	0.745	0.819

Table 7. Model fit

Construct	R ²	Adj. R ²	f ²	VIF
ESP	0.610	0.606	0.193	1.850
SSP	0.691	0.688	0.376	1.850
FSP	0.594	0.591	0.286	1.850
FTA	0.616	0.612	0.229	1.520

Table 8. Path Coefficient and Hypothesis

Hypothesis	Relationship	β	Mean	SD	t-value / Decision
H1a	AF $\rightarrow$ ESP	0.114	0.114	0.041	2.801** / Supported
H1b	AF $\rightarrow$ SSP	0.131	0.132	0.048	2.748** / Supported
H1c	AF $\rightarrow$ FSP	0.142	0.144	0.040	3.507*** / Supported
H2a	SIL $\rightarrow$ ESP	0.103	0.103	0.045	2.294* / Supported
H2b	SIL $\rightarrow$ SSP	0.118	0.117	0.045	2.608** / Supported
H2c	SIL $\rightarrow$ FSP	0.128	0.130	0.048	2.663** / Supported
H3	AF $\rightarrow$ FTA	0.306	0.309	0.061	5.060*** / Supported
H4	SIL $\rightarrow$ FTA	0.277	0.278	0.080	3.469*** / Supported
H5a	FTA $\rightarrow$ ESP	0.373	0.370	0.113	3.314*** / Supported
H5b	FTA $\rightarrow$ SSP	0.427	0.425	0.120	3.565*** / Supported
H5c	FTA $\rightarrow$ FSP	0.464	0.468	0.099	4.692*** / Supported

Table 9. Mediation relationship (FinTech adoption)

Hypothesis	Relationship	β	Mean	SD	t-value / Decision
H6a	AF $\rightarrow$ FTA $\rightarrow$ ESP	0.114	0.114	0.041	2.801** / Partial Mediation
H6b	AF $\rightarrow$ FTA $\rightarrow$ SSP	0.131	0.132	0.048	2.748** / Partial Mediation
H6c	AF $\rightarrow$ FTA $\rightarrow$ FSP	0.142	0.144	0.040	3.507*** / Partial Mediation
H7a	SIL $\rightarrow$ FTA $\rightarrow$ ESP	0.103	0.103	0.045	2.294* / Partial Mediation
H7b	SIL $\rightarrow$ FTA $\rightarrow$ SSP	0.118	0.117	0.045	2.608** / Partial Mediation
H7c	SIL $\rightarrow$ FTA $\rightarrow$ FSP	0.128	0.130	0.048	2.663** / Partial Mediation

Table 10. Moderated mediation (Financial competencies)

Hypothesis	Relationship	β	Mean	SD	t-value	Decision
H8	FC $\times$ AF $\rightarrow$ FTA $\rightarrow$ ESP	0.033	0.034	0.017	1.975*	Moderated Mediation
	FC $\times$ AF $\rightarrow$ FTA $\rightarrow$ SSP	0.037	0.039	0.020	1.888	Moderated Mediation
	FC $\times$ AF $\rightarrow$ FTA $\rightarrow$ FSP	0.040	0.043	0.019	2.088*	Moderated Mediation

All survey instruments were subjected to a forward-back translation process (Brislin, 1980) and subsequently evaluated by a panel of five experts, comprising two academics and three SME executives. Content validity indices (CVI) for each construct exceeded 0.90, confirming strong content coverage. A pilot study involving 25 managers yielded Cronbach's alpha values between 0.79 and 0.92, prompting only minor wording refinements. These procedures collectively ensured face validity, content validity, and preliminary reliability prior to the main data collection.

. Preliminary diagnostics Before model estimation, we screened the 350 responses for common-method bias and assumption violation. To limit common method bias up front, we guaranteed respondent anonymity, separated predictor and outcome items in different parts of the questionnaire, and reversed a few scale directions (Podsakoff et al., 2012). Harman's single-factor test explained 32.4% of the variance (below the 50% threshold). Multivariate outliers were nonexistent at $p < 0.001$, so listwise deletion was unnecessary. Thus, the data were suitable for PLSSEM.

To examine the proposed hypotheses and evaluate the explanatory capacity of the conceptual framework, a three-step analytical procedure was implemented using SmartPLS 4.0.

- **Stage 1 – Data Screening:** The collected survey data were imported into SmartPLS 4.0 and inspected for missing values, extreme outliers ($z > 3$), and basic distributional properties. All variables satisfied acceptable thresholds after list-wise deletion of fewer than 5% of incomplete responses.
- **Stage 2 – Model Estimation:** Both measurement and structural models, including mediation and moderated-mediation pathways, were estimated using a bias-corrected bootstrapping approach with 5,000 resamples. This variance-based technique was selected due to its robustness to non-normal data and suitability for evaluating complex indirect effects (Hair et al., 2019).
- **Stage 3 – Results Visualization:** The finalized structural model was exported from SmartPLS in publication-quality format and presented as Fig. 2, showing standardized path coefficients and R^2 values for all endogenous constructs.

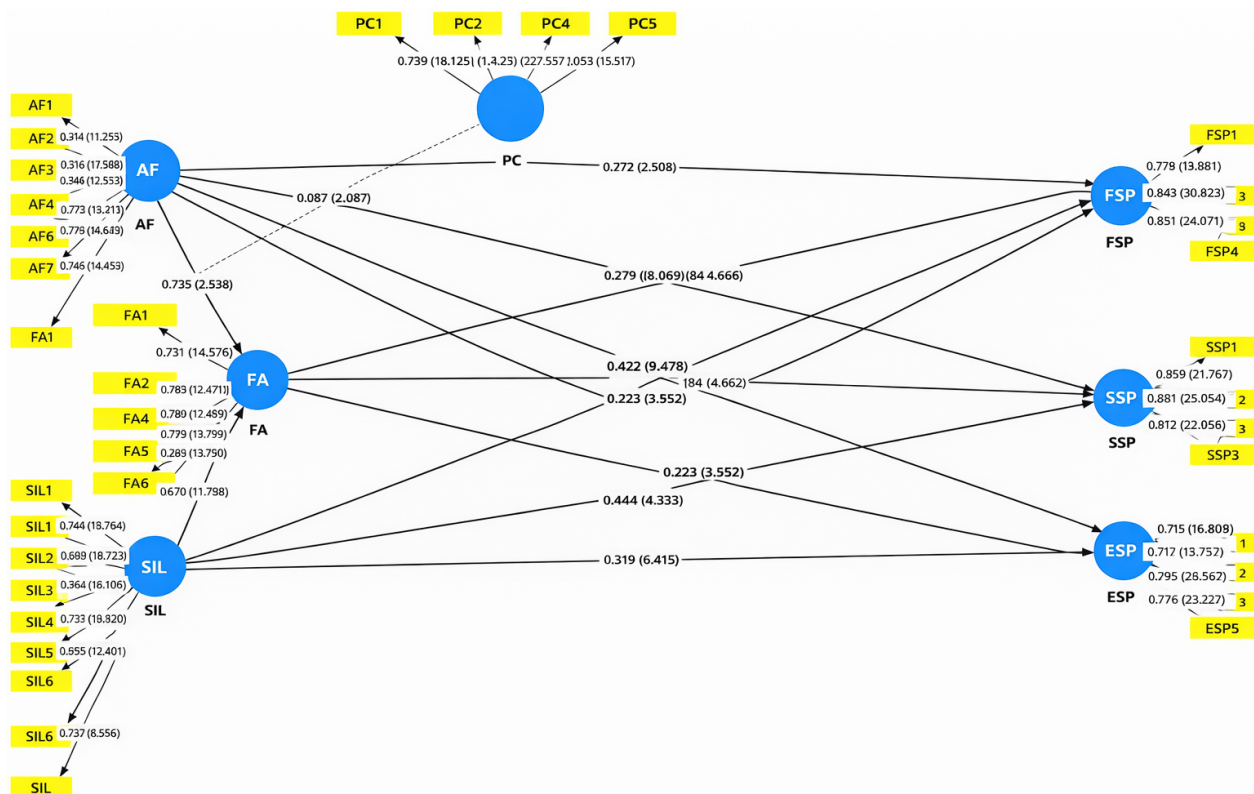


Figure 2. Structural model.

After establishing the quality of the data and the robustness of the measurement instruments, we proceed to present the empirical results. The upcoming section begins with the assessment of the measurement model—including reliability, validity, and model fit—before examining the structural model to evaluate the eight proposed hypotheses.

4. Result

Both the measurement and structural models were estimated using SmartPLS 4.0. PLS-SEM was selected over CB-SEM due to its advantages: (i) minimal assumptions regarding data distribution, (ii) transparent handling of formative-indicator deletion, and (iii) provision of out-of-sample predictive assessments (PLSpredict), which supports both theory testing and prediction objectives. Consistent with best practices for large datasets, a two-stage evaluation was conducted: first, examining the measurement model for reliability and validity, and second, evaluating the structural model to test hypotheses while highlighting explanatory and predictive capabilities (Chin, 2009).

4.1. Measurement model

Table 4 presents the reliability and convergent validity results. Internal consistency reliability was examined using Cronbach's alpha ($\alpha > 0.70$) and composite reliability (CR > 0.70) thresholds, following Hair et al. (2012). As shown in Table 4, Cronbach's alpha values range from 0.847 to 0.925, exceeding the recommended 0.70 threshold. Similarly, composite reliability values also fall between 0.847 and 0.925, satisfying the established criteria (Hair et al., 2016).

Convergent validity was evaluated using the Average Variance Extracted (AVE > 0.50), with values ranging from 0.525 to 0.681, indicating adequate convergent validity across constructs.

Discriminant validity (DV) was assessed using two approaches. First, the heterotrait-monotrait (HTMT) ratio proposed by Henseler et al. (2015) was applied. As shown in Table 5, all HTMT values are below the 0.85 threshold, confirming acceptable discriminant validity. Second, following Fornell (1981), the square root of AVE for each construct exceeded its inter-construct correlations (Table 6), further supporting discriminant validity.

Having satisfied all reliability and validity criteria, the analysis proceeded to the structural model. Model-fit indices (Table 7) also support moving forward to hypothesis testing.

4.2. Structural model

Following the confirmation of measurement model reliability and validity, multicollinearity diagnostics were performed. Table 7 shows that the highest variance inflation factor (VIF) is 1.850, indicating no concerns of multicollinearity (Ozturk & Ullah, 2022). Effect sizes (f^2) were calculated to evaluate the magnitude of relationships among latent constructs. According to Chin (1998), f^2 values of 0.02, 0.15, and 0.35 denote small, medium, and large effects, respectively. Table 7 indicates effect sizes of 0.193 (ESP), 0.376 (SSP), 0.286 (FSP), and 0.229 (FTA), all exceeding the 0.02 threshold, reflecting meaningful effects.

The coefficient of determination (R^2) for endogenous constructs was also examined: ESP ($R^2 = 0.610$), SSP ($R^2 = 0.691$), FSP ($R^2 = 0.594$), and FTA ($R^2 = 0.616$). Following Chin (1998), R^2 values above 0.60 represent strong explanatory power, values around 0.30 are moderate, and values below 0.19 are weak. These results indicate strong explanatory power for ESP, SSP, and FTA, while FSP demonstrates acceptable predictive capability. Additional fit indices, SRMR = 0.055 (< 0.08) and NFI = 0.80, further confirm the adequacy of the model.

Hypotheses were tested using PLS-SEM with 5000 bias-corrected bootstrapped subsamples, providing stable confidence intervals for indirect effects (Chin, 2009; Henseler et al., 2015). A priori power analysis (Cohen, 2013) indicates that the sample size ($n = 350$) offers >0.80 power to detect small-to-medium effects at $\alpha = 0.05$.

The results reveal that access to finance (AF) positively and significantly affects ESP ($\beta = 0.114$, $t = 2.801$, $p < 0.05$), SSP ($\beta = 0.131$, $t = 2.748$, $p < 0.05$), and FSP ($\beta = 0.142$, $t = 3.507$, $p < 0.05$), supporting H1a–H1c. Sustainable innovative leadership (SIL) similarly exerts significant positive effects on ESP ($\beta = 0.103$, $t = 2.294$, $p < 0.05$), SSP ($\beta = 0.118$, $t = 2.608$, $p < 0.05$), and FSP ($\beta = 0.128$, $t = 2.663$, $p < 0.05$), supporting H2a–H2c.

AF also significantly predicts FinTech adoption (FTA) ($\beta = 0.306$, $t = 5.060$, $p < 0.05$), confirming H3, while SIL positively influences FTA ($\beta = 0.277$, $t = 3.469$, $p < 0.05$), confirming H4. FTA, in turn, has significant positive effects on ESP ($\beta = 0.373$, $t = 3.314$, $p < 0.05$), SSP ($\beta = 0.427$, $t = 3.565$, $p < 0.05$), and FSP ($\beta = 0.464$, $t = 4.692$, $p < 0.05$), supporting H5a–H5c. These findings align with EMT, highlighting FinTech's role in driving sustainable performance through operational efficiency, eco-innovation, and enhanced financial outcomes.

Mediation analyses (Table 9) confirm that FTA partially mediates the relationship between AF and sustainability outcomes: ESP ($\beta = 0.114$, $t = 2.801$, $p < 0.05$), SSP ($\beta = 0.131$, $t = 2.748$, $p < 0.05$), and FSP ($\beta = 0.142$, $t = 3.507$, $p < 0.05$), supporting H6a–H6c. FTA also partially mediates the effect of SIL on sustainable performance: ESP ($\beta = 0.103$, $t = 2.294$, $p < 0.05$), SSP ($\beta = 0.118$, $t = 2.608$, $p < 0.05$), and FSP ($\beta = 0.128$, $t = 2.663$, $p < 0.05$), supporting H7a–H7c.

Finally, moderated mediation results (Table 10) indicate that financial competence (FC) strengthens the indirect effect of AF on FTA and subsequent sustainable performance. Specifically, $FC \times AF \rightarrow FTA \rightarrow ESP$ ($\beta = 0.033$, $t = 1.975$, $p < 0.05$), $FC \times AF$

→ FTA → SSP ($\beta = 0.037$, $t = 1.888$, $p < 0.05$, marginal), and $FC \times AF \rightarrow FTA \rightarrow FSP$ ($\beta = 0.040$, $t = 2.088$, $p < 0.05$). These results suggest that higher FC enhances SMEs' ability to leverage financial access and FinTech adoption, ultimately improving sustainability outcomes.

Overall, the structural model demonstrates robust predictive and explanatory power, validating the conceptual framework. Fig. 2 presents the finalized structural model with standardized path coefficients and R^2 values.

5. Discussion

While previous research has examined sustainable performance, few studies investigate the combined effects of access to finance (AF) and sustainable innovative leadership (SIL) on sustainable outcomes through the mediating role of FinTech adoption (FTA). This study provides empirical evidence that AF and SIL, both directly and indirectly via FTA, enhance environmental (ESP), social (SSP), and financial sustainability performance (FSP) among Pakistani SMEs. Furthermore, financial competencies (FC) moderate the mediation pathway between AF and FTA. These findings support the integrated application of Ecological Modernization Theory (EMT) and Resource-Based View (RBV), highlighting the interplay of internal intangible resources and external digital tools in achieving sustainable firm outcomes.

The results align with meta-analytic evidence suggesting that internal dynamic capabilities, when combined with digital enablers, accelerate the sustainability transition (Oduro, 2024). By simultaneously examining AF, SIL, FTA, and FC, this study extends prior research by mapping sequential relationships rather than simple correlations. Given the competitive and financial constraints faced by SMEs, economic priorities often overshadow environmental and social goals (Malesios et al., 2021). Additionally, psychological barriers, such as ethical concerns regarding job displacement or data privacy, may hinder FinTech adoption even with strong financial and leadership support. This study highlights that SMEs with both financial accessibility and SIL are better equipped to address multi-dimensional sustainability challenges.

The Pakistani cultural context further shapes these dynamics. Hofstede's dimensions of power distance and collectivism (2010) indicate that hierarchical leadership may facilitate top-down FinTech adoption but could constrain employee-driven innovation. Meanwhile, collectivist norms can encourage adoption if innovations benefit the community, yet resistance may arise if perceived as disruptive.

The study confirms that financial accessibility is a core determinant of sustainable outcomes (H1a–H1c). Consistent with Zhang and Wei (2021), SMEs with stronger financial resources invest more in eco-friendly technologies, human capital, and operational efficiencies. This study shows an even stronger effect in Pakistan ($\beta = 0.373$), suggesting that local financing conditions amplify environmental benefits. AF also positively influences social performance through stakeholder engagement programs funded by accessible capital (Appiah-Kubi et al., 2024; Chowdhury et al., 2022; Dudley, 2021).

SIL demonstrates significant positive effects on ESP, SSP, and FSP (H2a–H2c), even in Pakistan's volatile policy environment, emphasizing the resilience of sustainable leadership in driving performance (Suriyankietkaew et al., 2022). These findings reinforce RBV principles by confirming that intangible resources, such as leadership and FC, are critical for converting financial access into sustainable outcomes (Kumlu, 2014; Zahra, 2021).

The study also finds that AF and SIL significantly facilitate FinTech adoption (H3 and H4), as slack financial resources reduce perceived risks and enable technological experimentation (Kersten et al., 2017; Sun & Zhang, 2023). FTA, in turn, positively impacts

ESP, SSP, and FSP (H5a–H5c), confirming its mediating role in translating financial access and leadership into tangible sustainability outcomes, consistent with EMT (H6a–H6c; H7a–H7c). FTA allows SMEs to mitigate waste, emissions, and energy consumption while enhancing operational efficiency and social responsibility (Allahham et al., 2024; Xie et al., 2023; Yan et al., 2022).

Moreover, the moderated mediation analysis demonstrates that FC strengthens the relationship between AF and FTA, thereby amplifying sustainable performance (H8). Financial competencies including knowledge, expertise, and behavior—enable managers to maximize the impact of financial resources across environmental, social, and financial domains (Dewi et al., 2020). This pattern aligns with Teece's (2007) resource orchestration logic within an EMT framework, suggesting that targeted FC training programs can convert every unit of external finance into multi-dimensional sustainability gains. Policymakers should therefore complement financial support with competency development initiatives to optimize SME sustainability outcomes (Hossain et al., 2023).

In sum, this study demonstrates that sustainable innovative leadership, financial access, FinTech adoption, and financial competence collectively form a robust mechanism to enhance SME sustainability in emerging economies. The findings offer actionable insights for managers, policymakers, and researchers aiming to strengthen SME performance across environmental, social, and financial dimensions.

6. Conclusion

This study investigates how access to finance (AF) and sustainable innovative leadership (SIL) serve as key drivers for FinTech adoption and sustainable performance in SMEs. It bridges several gaps in the literature and contributes to theory in multiple ways.

First, while prior research has examined AF from perspectives such as innovation-driven growth (Santos et al., 2024), green finance, and environmental performance (Citil, 2024; Fan et al., 2024), studies linking AF to triple-bottom-line sustainability outcomes remain scarce. Similarly, the role of SIL in facilitating FinTech adoption and improving firm performance particularly in emerging economies has received limited attention.

Second, the study emphasizes managerial financial competencies (FC) as strategic tools for overcoming financial accessibility challenges. FC not only facilitates access to finance but also plays a proactive role in enabling FinTech adoption. When combined with SIL, these internal resources mitigate adoption risks, address return uncertainty, and enhance implementation feasibility. From an industrial-organizational psychology perspective, this research reconceptualizes SIL as a leadership schema rooted in future-oriented cognition, ethical reasoning, and pro-innovation affect, extending classical transformational and ethical leadership frameworks. FC is reframed as a cluster of individual differences financial self-efficacy, analytic decision-making style, and risk tolerance that influence technology adoption under resource constraints. Integrating these constructs into an EMT-RBV framework offers a novel psychological model explaining how leader cognition and employee capabilities jointly drive FinTech adoption and, consequently, sustainable performance in emerging-market SMEs.

Third, the study employs Ecological Modernization Theory (EMT) to underscore the role of advanced technologies, like FinTech, in mitigating environmental impacts while simultaneously enhancing social and financial outcomes (ESP, SSP, and FSP) (Yu et al., 2023). Resource-Based View (RBV) principles further demonstrate that intangible assets, such as SIL and FC, create competitive advantages by overcoming financial constraints and improving firm performance. The findings reveal how AF and SIL promote FinTech adoption in Pakistani manufacturing SMEs, providing contextual insight into emerging markets.

This research is among the first to integrate EMT and RBV to explain FinTech adoption as a mediator between internal capabilities (SIL and FC) and sustainable performance. Empirical validation within Pakistan's SME manufacturing sector in an underexplored context adds contextual novelty to the literature. Furthermore, the study extends Teece's (2007) resource orchestration logic, illustrating how digitally mediated financial transactions complement rare managerial capabilities. These insights contribute to leadership and technology-adoption theory in resource-constrained settings, offering unique implications for industrial-organizational psychology.

Finally, by addressing environmental, social, and financial sustainability collectively, this study advances sustainability theory through a holistic lens, unpacking the complex dynamics of SME performance in emerging markets. Overall, it offers significant contributions to both theoretical development and managerial practice.

The findings of this study provide actionable insights for SME managers, policymakers, and supporting institutions in emerging economies, particularly in Pakistan.

Strengthening internal capabilities: SME managers should focus on enhancing financial competencies (FC) and sustainable innovative leadership (SIL). These internal capabilities enable more effective adoption and utilization of FinTech tools, improving access to finance and boosting performance across environmental, social, and financial domains. Investment in human capital development—including financial literacy programs, digital upskilling, and leadership training—should be embedded as a strategic priority within the firm.

Strategic adoption of FinTech: FinTech should be viewed not just as a technological upgrade, but as a strategic transformation aligned with broader sustainability objectives (Dharmayanti et al., 2023). Integrating FinTech into operational processes enhances energy efficiency, reduces environmental footprints, and fosters eco-innovation. Such practices attract environmentally conscious investors and improve financial relationships.

Fostering cross-functional and inter-organizational collaboration: Strong leadership should promote interdepartmental coordination across finance, HR, and marketing to build a digital and sustainable organizational culture. This holistic approach strengthens innovation capacity and aligns strategic goals with long-term growth. Beyond internal coordination, SMEs are encouraged to form external partnerships with supply-chain actors, technology vendors, universities, and even competitors. Collaborative alliances help pool technical expertise, share costs and risks associated with new digital tools, and accelerate the adoption of green practices. This cooperative learning amplifies the performance benefits derived from robust leadership and financial competencies.

Policy support and incentives: Policymakers should establish an enabling environment for SMEs through low-interest credit schemes, tax incentives for green investments, expansion of digital infrastructure, and FinTech awareness campaigns. National policies should integrate digitalization efforts with sustainability-oriented economic objectives to maximize impact.

Institutional coordination: Strengthened collaboration among SMEDA, financial institutions, and government agencies is essential to overcome structural financing barriers and address environmental challenges. Such coordinated support can enhance SME competitiveness while contributing meaningfully to national Sustainable Development Goals (SDGs).

This study has several limitations that present valuable opportunities for future research.

Contextual scope: The sample is limited to Pakistani SMEs, which constrains the external validity of the findings. Comparative studies involving SMEs in other emerging economies could provide richer contextual insights and enhance generalizability.

Research design: The cross-sectional design limits the ability to infer causality. Future research using panel data or longitudinal approaches could capture the dynamic effects of FinTech adoption on sustainable performance over time.

Financial channels: This study primarily focused on bank financing. Future studies should explore alternative funding mechanisms, including equity financing, crowdfunding, and green-capital channels, to better understand the broader financial landscape for SMEs.

Common method bias: Although ex-ante remedies were applied and tests conducted (Section 3.4), single-respondent data may still inflate associations and overstate path coefficients. Future research could adopt multi-source or time-lagged designs to minimize this concern.

Measurement of sustainability: Sustainability performance was self-reported, which may introduce social desirability bias. Triangulating responses with audited financial accounts, energy-use logs, or third-party sustainability reports would enhance measurement accuracy.

Potential reverse causality: High-performing firms may naturally attract innovative leaders and easier access to finance, rather than the reverse. Longitudinal tracking would help clarify the directionality of these relationships.

Policy and institutional factors: The moderating role of government support was not examined. Future studies should investigate how policy interventions condition the relationship between FinTech adoption and sustainable performance, particularly in emerging-market contexts.

Future research could explore several promising avenues to extend the insights of this study. First, comparative cross-country analyses applying the EMT-RBV framework would help determine whether the observed relationships between access to finance, sustainable innovative leadership, FinTech adoption, and sustainable performance hold in different emerging- and developed-market contexts.

Second, longitudinal studies could capture the cumulative and dynamic effects of FinTech adoption on environmental, social, and financial performance, providing a clearer understanding of temporal causality and sustainability trajectories.

Third, the role of policy instruments such as ESG-linked credit lines, green bonds, or digital-infrastructure subsidies merits investigation to evaluate how institutional support moderates or strengthens the pathways from FinTech adoption to sustainable outcomes.

Finally, researchers should examine psychological and behavioral barriers in the adoption process. Specifically, the impact of ethical anxiety including concerns about job displacement, data privacy, or algorithmic bias on the leadership → FinTech adoption pathway warrants further attention. Future studies could explore how targeted leadership strategies or organizational practices can mitigate these psychological barriers, enhancing both FinTech uptake and sustainability performance.

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