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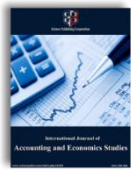

Impact of Financial Literacy on Fintech Adoption: The Role of Digital Literacy and Cybersecurity Awareness in A Two-Stage SEM-ANN Model

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Abstract

This study introduces a novel approach to understanding the impact of financial literacy on Fintech adoption by constructing a comprehensive framework that aligns with the OECD definition of financial literacy, which encompasses three core dimensions: financial attitude, financial knowledge, and financial behavior. The study focuses on households in Rajasthan, India, and explores how these components of financial literacy influence the use of digital financial tools, including peer-to-peer lending, digital payments, investment apps, and broader Fintech solutions. Using a reflective second-order Structural Equation Model (SEM) approach, the research tests the relationships between financial literacy and Fintech adoption, providing a more nuanced understanding of their interconnection. Additionally, the study incorporates digital literacy and cybersecurity awareness as sequential mediators, highlighting their role in bridging financial literacy and Fintech adoption. All path coefficients in the SEM model were found to be statistically significant, and the results were further validated using an Artificial Neural Network (ANN) model to capture non-linearity. This study contributes to the field by developing a robust measurement tool for assessing the impact of financial literacy, digital literacy, and cybersecurity awareness on Fintech adoption, offering valuable insights for policymakers and future research on enhancing digital financial inclusion in emerging markets.

Keywords: *Financial Literacy; Fintech Adoption; Financial Attitude; Financial Behavior; Financial Knowledge; Digital Literacy.*

1. Introduction

As India advances toward its goal of becoming a US$5 trillion economy, financial inclusion stands as a crucial pillar for long-term economic growth and development. The Government of India's vision for a "Viksit Bharat"—a developed and empowered nation—is built on the principles of accessibility, affordability, and innovation. In this journey, Fintech companies play a transformative role by harnessing technology to broaden access to financial services, enhance user experiences, and deliver solutions that are both secure and cost-effective. By utilizing digital public infrastructure for data, identity, and payments, these firms are successfully bridging the financial inclusion gap and empowering millions of citizens across the country (National Centre for Financial Education, 2019; Financial Literacy Report, 2023).

India's Fintech ecosystem is rapidly maturing, propelled by a combination of entrepreneurial dynamism, focused government initiatives, robust regulatory frameworks, innovative technologies, and strong investment inflows. As of 2023, India leads the world with an 87% Fintech adoption rate, significantly higher than the global average of 64%, and surpassing major economies such as the USA, Singapore, the UK, and China (EY, 2022). The country ranks third globally by the number of Fintech startups and holds the top position in digital payment volumes. Over 10,200 Fintech startups were registered by 2024, representing a fivefold increase since 2021 (NASSCOM, 2024). This rapid expansion has ushered the sector into a new phase focused on inclusivity, scalability, and sustainable growth (WEF, 2024).

The evolution of Fintech in India has been marked by a series of technological and regulatory milestones over the last decade. Around 2014, the ecosystem began to take shape with the launch of payments and lending startups supported by initiatives such as the Pradhan Mantri Jan Dhan Yojana (PMJDY) (Government of India, 2023). The introduction of mobile wallets, DigiLocker, and India's first Fintech unicorn, PayTM, helped build consumer confidence in digital financial services. Between 2016 and 2017, demonetization, the JAM trinity (Jan Dhan-Aadhaar-Mobile), the Unified Payments Interface (UPI), issuance of payment bank licenses, Goods and Services Tax (GST), and the Bharat Bill Payment System (BBPS) collectively accelerated digital transaction volumes and integrated the financial ecosystem (Reserve Bank of India, 2024).

Subsequent years witnessed the entry of large consumer tech companies into lending, enhancements to UPI, the emergence of card-based Buy Now Pay Later (BNPL) services, and platforms like OCEN and Sahay that facilitated invoice-based lending (Chiratae Ventures, 2024). Improvements in video KYC and MSME registrations further expanded access. The surge in growth-stage funding in 2021, along with innovations such as the Open Network for Digital Commerce and account aggregators, signaled a maturing investment landscape (WEF, 2024). Most recently, between 2022 and 2024, innovations like UPI 123 Pay, the establishment of RBI's Fintech Department, the Reserve

Bank Innovation Hub, Central Bank Digital Currency (CBDC) pilots, and the SRO Fintech Framework have demonstrated strong regulatory support, fostering the next phase of growth (RBI, 2024; Financial Express, 2023). This includes AI-powered credit underwriting solutions such as Mule Hunter.ai, underscoring the sector's transition to a regulated, innovation-driven ecosystem.

Financially, India's Fintech revenues are projected to increase sharply from about US$20 billion in 2023 to nearly US$180–200 billion by 2030, growing at a compound annual rate of 30%. This robust growth is underpinned by a rapidly expanding middle class that makes up roughly one-third of the population, government schemes like PMJDY and India Stack, and the development of integrated digital public infrastructure spanning identity verification (Aadhaar, CKYC, eKYC), payment systems (UPI, RuPay, AePS), and frameworks enabling secure, paperless transactions (NASSCOM, 2024). India's dominance in digital payment volumes is remarkable, accounting for nearly 48.5% of the global real-time transaction volume (India Fintech Report, 2022). Consumers use digital platforms for a wide array of financial activities, including mobile and FASTag recharges, utility bill payments, booking transportation, cable and DTH payments, credit card settlements, cab bookings, subscription management, mutual fund investments, and travel insurance, illustrating deep and varied engagement with digital financial services (Global Findex Database, 2021).

Within the Fintech sector, digital lending is the fastest-growing segment, operating across more than 1,300 cities with a loan portfolio exceeding INR 7,500 crore. Over 70,000 loans have been disbursed to more than 60,000 small businesses, showcasing strong penetration into MSMEs and informal sectors (NASSCOM, 2024). The share of digital lending in Fintech revenues is expected to more than double from 25% in 2023 to over 53% by 2030 (Accenture, 2023). These platforms employ AI-driven underwriting models that specifically target underserved populations such as women entrepreneurs and gig economy workers (Financial Express, 2023). WealthTech, though currently a smaller segment accounting for 1–2% of revenues, is projected to expand significantly, reaching 18% by 2030. Wealth management platforms serve millions of users, offering integrated services across stocks, bonds, ETFs, and cryptocurrencies, with features including AI-based investment advice, IPO subscriptions, robo-advisory, fractional shares, and systematic investment plans (EY, 2023). Despite this progress, only 18% of Indians were stock investors in 2022, indicating a large untapped market potential (Ministry of Finance, 2023).

Beyond the core sectors of payments, lending, and wealth management, a diverse array of Fintech solutions is gaining ground. These include expense-sharing apps, micro-investment platforms, digital gold purchasing, BNPL services, credit score monitoring tools, insurance marketplaces, neobanking, crowdfunding platforms, emergency loans, and alternative lending products. Together, these innovations broaden access to financial services by providing affordable, convenient, and tailored options to meet diverse consumer needs, further driving financial inclusion (Reserve Bank of India, 2023; Fintech Report India, 2024).

India's InsurTech sectors have outpaced global averages, particularly leading the world. Within the broader Fintech landscape, the insurance sector—InsurTech—has experienced rapid growth in India, outpacing global averages and positioning the country as a leader in digital insurance innovation (India Fintech Report, 2024). InsurTech in India is rapidly evolving from traditional agent-led, paper-based underwriting to AI-driven automation and usage-based insurance models (Indian Insurance Regulatory and Development Authority, 2023). The market is projected to reach US$307 billion by FY30, reflecting strong growth potential (Fintech Insights, 2024). Leading platforms, such as Insurance Marketplace, serve over 16 million customers with more than 42 million policies sold, capturing over 90% of the online insurance marketplace (Digital Insurance India, 2024). Founded in 2008, these platforms offer personalized insurance recommendations across term, health, motor, and business insurance segments, driving greater accessibility and consumer choice (India Fintech Association, 2024).

However, significant challenges remain. Financial literacy is limited, with only 43% of the population demonstrating a basic understanding of financial concepts, which hampers the effective use of digital tools (National Centre for Financial Education [NCFE], 2019). Cybersecurity threats are escalating rapidly, with over 1.2 million cyber fraud complaints recorded in 2024, resulting in losses exceeding INR 177 crore within a fiscal year (Cybersecurity Report, 2024). Additionally, Fintech funding has declined from US$8 billion in 2021 to approximately US$3 billion in 2023, imposing capital constraints on innovation and expansion (Fintech Funding Report, 2023. The way to overcome these challenges is systematic work on increasing the level of financial literacy, creating reliable and trusted platforms, and creating products sensitive to the needs of different customers (Financial Literacy Report, 2023). Educating people to exhibit good financial habits (discipline in saving, budgeting, and intelligent investing) will continue to boost the role of Fintech in the economic growth of India and the achievement of Viksit Bharat 2047.

On this note, this study examines financial literacy as a multidimensional phenomenon that comprises the knowledge of a financial concept, with positive attitudes towards financial behavior and active practice with financial systems as the basis of the successful involvement in digital financial services. Improved financial literacy in these related elements will enable greater trust and readiness to embrace different kinds of Fintech, including peer-to-peer lending, investment platforms, and digital payment systems. Improving these intertwined aspects of financial literacy will allow one to become more confident and willing to implement various Fintech offerings in various fields like peer-to-peer lending, investment platforms, and digital payment systems. The paper delves into the impact of financial literacy on Fintech adoption to provide the audience with vital knowledge that is related to the cognitive and behavioral-based activities that underlie the growing penetration of the world of technology in everyday decisions that involve finances (Financial Literacy Report, 2023; NCFE, 2019). Our results confirm.

This paper is structured as follows: Section 2 will have a detailed review literature; Section 3 will discuss about methodology; Section 4 will present the results and analysis; Section 5 will provide a discussion; Section 6 and Section 7 will provide implications and conclusion, respectively.

2. Literature Review and Hypotheses Development

Recent studies highlight that financial literacy (FL) remains a crucial factor driving Fintech adoption in the era of artificial intelligence (AI) enabled financial services. Individuals with strong FL demonstrate higher confidence and trust in AI-based solutions such as robo-advisory, algorithmic credit underwriting, and automated investment tools (Hidayat-ur-Rehman, 2025; Islam & Khan, 2024). AI-driven platforms like MuleHunter.ai and PaySense have revolutionized credit assessment by using alternative data and predictive algorithms, improving access for underserved consumers (RBI, 2024; WEF, 2024). However, effective participation in such systems requires users to possess not only financial knowledge but also digital and AI literacy to understand data privacy, algorithmic transparency, and bias mitigation (Alt et al., 2024; OECD, 2024). Hence, the integration of financial, digital, and cybersecurity literacy enhances consumer readiness for AI-based Fintech ecosystems, supporting financial inclusion and trust (Lee & Shin, 2018; RBI, 2021).

At the same time, recent research emphasizes the emerging role of ESG-oriented financial literacy in shaping responsible and sustainable Fintech engagement. Digitally literate investors with ESG awareness are more likely to use AI-enabled robo-advisory platforms that recommend socially responsible and green investments (Chakraborty & Nguyen, 2025; OECD, 2024). Behavioural economics explains that

biases like present bias and loss aversion hinder digital credit adoption, requiring educational nudges and literacy interventions (Bhatnagar & Mishra, 2024; López-Fernández & Kim, 2025). ESG-based financial literacy fosters ethical decision-making and promotes long-term sustainability in digital finance (Rathi & Agarwal, 2021; Jain & Yadav, 2023). Moreover, digital and cybersecurity literacy play a crucial role in safeguarding users against misinformation and greenwashing within online financial markets (Kumar et al., 2022; Sarkar et al., 2022). Together, AI-driven financial innovation and ESG-related literacy form the foundation of a transparent, sustainable, and digitally inclusive financial ecosystem

The study examines the interrelationships of financial attitude (FA) and financial Behavior (FB), and financial knowledge (FK), and how the set of factors influences financial literacy (FL) within the context of Fintech adoption (FADO). The interaction between these constructs is important to determine how to develop a detailed model of financial literacy and its impact on Fintech adoption.

2.1. Financial literacy as a means to achieve fintech adoption

Financial literacy (FL)—comprising numeracy, knowledge, confidence, and critical thinking—is the key driver of Fintech adoption (Lusardi & Mitchell, 2017). It reduces the digital divide and supports digital inclusion (OECD, 2020). Studies show FL positively impacts the use of digital wallets, savings tools, and trust in Fintech across India and low-income countries (Ghosh & Vinod, 2017; Grohmann et al., 2018; Bhushan & Medury, 2014). FL also aids understanding of digital terms, charges, and privacy, ensuring sustained use (Zhou et al., 2021). Hence, FL is a precondition for effective Fintech adoption, enhancing readiness, confidence, and trust (Lee & Shin, 2018; RBI, 2021). The hypothesis is:

H1 Financial literacy is positively related to Fintech adoption.

2.2. Financial literacy as a means to achieve digital literacy

Financial literacy (FL) and Digital literacy (DL) have a bidirectional, reinforcing relationship. While DL—competence in using digital tools—is often considered a prerequisite for Fintech use, FL can also promote DL, especially in developing economies where financial motivation drives digital engagement (Ng, 2012; OECD, 2020). FL provides cognitive and procedural skills to navigate digital financial services safely, leading to incidental digital skills acquisition (Agarwal et al., 2021; Bhushan & Medury, 2014). Financially literate individuals develop problem-solving mindsets, encouraging exploration of digital solutions (Reddy & Rao, 2020). In digitally underserved areas, FL facilitates first-time digital use via government schemes and Fintech outreach (RBI, 2021; NITI Aayog, 2020). Thus, FL acts as a gateway to digital inclusion by fostering necessary digital competencies. The hypothesis is:

H2: Financial literacy is positively related to Digital literacy.

2.3. Digital literacy as a means to achieve fintech adoption

Digital literacy (DL), the ability to use digital technologies effectively, is essential for Fintech adoption (Ng, 2012), shaping ease of use and trust (Davis, 1989; Venkatesh et al., 2003). It mitigates technophobia and fraud concerns (Arner et al., 2015; Gomber et al., 2017) and positively impacts Fintech uptake globally and in India (Goldfarb & Tucker, 2019; Bhushan & Medury, 2014; Zhou et al., 2021). DL is vital in rural/semi-urban areas lacking digital education, with policies highlighting its role in safe use (RBI, 2021; NITI Aayog, 2020). It mediates the link between FL and Fintech use, turning knowledge into practical interaction (Yew et al., 2020; Agarwal et al., 2021). Digitally literate users can critically assess platforms and manage digital financial lives responsibly (Lee & Shin, 2018). The hypotheses are below:

H3: Digital literacy is positively to Fintech adoption.

H4: Digital Literacy Mediates the relationship between Financial Literacy and Fintech Adoption.

2.4. Digital literacy as a means to achieve cybersecurity awareness

Digital literacy (DL) goes beyond technical skills, encompassing critical evaluation, secure communication, and ethical internet use (Jones & Mitchell, 2015; Bawden, 2008). With sophisticated threats like phishing, malware, and identity theft, DL now includes cybersecurity awareness (Martin, 2006; Lankshear & Knobel, 2011). Research shows DL fosters safer internet practices and should be embedded in education policies (West, 2013; Kurtz, 2016). It strengthens privacy awareness in social media, employee training, and IoT/device security (Kowalski et al., 2017; Binns, 2019; Chung et al., 2021; Sarkar et al., 2022). Agencies such as the European Commission (2020) and FTC (2021) stress DL's role in promoting cybersecurity across all demographics, including seniors. Based on the body of literature that proves the correlation between cybersecurity awareness and digital literacy as a positive variable, the hypothesis below is suggested:

H5: Digital Literacy is positively related to Cybersecurity Awareness

2.5. Financial literacy as a means to achieve cybersecurity awareness

Financial literacy (FL), originally tied to economic decision-making (Lusardi & Mitchell, 2011), has expanded to cover digital financial risks like phishing, identity theft, and secure banking (Van Rooij et al., 2011; Atkinson & Messy, 2012). Studies show that financially literate individuals are better at detecting fraud and protecting accounts (Perry & Morris, 2005; Pisa et al., 2018). FL strengthens cybersecurity practices in mobile payments and workplace security, including strong passwords and 2FA (Choi & Lee, 2016). Programs like the U.S. FL initiative and Digital Financial Integration (Education Commission, 2019) integrate FL and cybersecurity education for vulnerable groups. Overall, FL enables safer online finance use, making users more resilient to cyber threats. The hypothesis stated based on this body of literature is the following:

H6: Financial Literacy is positively related to Cybersecurity Awareness.

2.6. Cybersecurity awareness as a means to achieve fintech adoption

Cybersecurity education builds trust in Fintech, making consumers more likely to adopt digital services (Laukkanen, 2016; Mae et al., 2019). Awareness of threats like phishing and data theft encourages protective behaviors such as 2FA, raising confidence in platforms (Zhao et al., 2020; Chung et al., 2017). Studies show cyber-aware users perceive mobile banking, wallets, and P2P lending as safer (Kim et al., 2021; Pereira et al., 2022). Adoption rates are higher in regions with cybersecurity programs, as users feel secure using digital finance

(Akter et al., 2020). Integrating cybersecurity education into onboarding boosts consumer trust and drives Fintech use (Fitzgerald & Kousenidis, 2021). It is on this research base that the following hypothesis is given:
H7: Cybersecurity Awareness is positively related to Fintech Adoption.

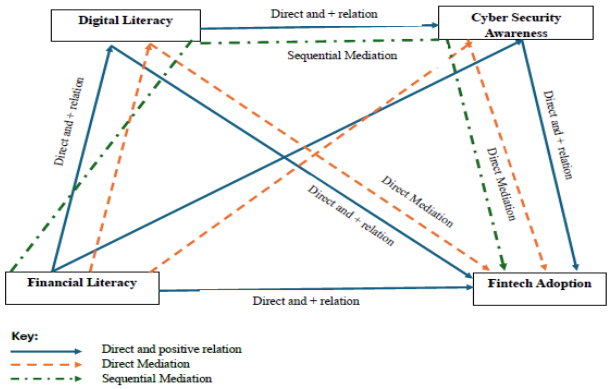

Fig. 1: Conceptual Research Model (SEM-ANN Framework).

3. Research Methodology

The study employed a non-probability judgmental sampling method focusing on Fintech users in Rajasthan, a state that has seen rapid digital growth with INR 246 Cr+ UPI transactions in 2024, 57% internet penetration, and 85.5% smartphone ownership among households (The Economic Times). Rajasthan's rise in P2P lending was significant, with LenDenClub reporting a 100% investor increase in 2022, and Jaipur emerging as a major hub. This aligns with India's broader trend where Tier 2 and Tier 3 cities drive Fintech adoption, with 60% of Groww's users coming from such regions (EY). Millennials and Gen Z were chosen as the focus groups since they represent the largest user base, with 59% of lenders and 87% of borrowers in P2P platforms under 40 years (Money Control). Questionnaires were distributed across seven major divisions of Rajasthan—Jaipur, Jodhpur, Ajmer, Bharatpur, Bikaner, Kota, and Udaipur—representing over half of the state's population. A total of 600 valid responses were collected, exceeding both the GPower minimum of 111 (effect size 0.3, alpha 0.05, power 0.95) and the "50 times rule" threshold of 350 for ANN models with 7 parameters (GPower; Alwosheel, van Cranenburgh, & Chorus, 2018), ensuring reliability and validity.
A quantitative approach was adopted to assess perceptions of constructs such as financial literacy, financial behavior, financial attitude, and Fintech adoption, with questionnaires designed from established literature and empirical insights. The development process involved expert consultation, pre-testing, and refinement via repeated administration to improve clarity and context sensitivity. Financial literacy was conceptualized as multidimensional, comprising awareness, knowledge, skills, attitude, and behavior (OECD, 2013). Its three dimensions—financial knowledge, financial behavior, and financial attitude—were measured, with financial knowledge covering concepts like interest, inflation, budgeting, and risk diversification (Lusardi & Mitchell, 2014; Chen & Volpe, 1998). Empirical studies have shown links between financial literacy and positive outcomes in savings, credit use, and investments (Huston, 2010; Lusardi & Tufano, 2015). This structured methodology enabled a context-specific, reliable framework to analyze Fintech adoption in Rajasthan's digitally growing ecosystem.

4. Results and Analysis

This section details the outcomes of the Measurement and Structural Model assessment using PLS-SEM. The measurement model ensures the validity and reliability of constructs, whereas the structural model evaluates the significance of hypothesized relationships.

4.1. Measurement model assessment: reliability of lower-order constructs

Construct quality was measured through factor loadings, reliability, and validity. Factor Loadings and Reliability of Constructs presented in Table 1 validate construct reliability and internal consistency for all variables. There was no negative loading of 0.50 or greater in all factors, which helped to verify item relevance (Hair et al., 2016). Cronbach's Alpha and Composite Reliability (CR) were used in testing reliability (which is performance consistency) (Mark, 1996). The Alpha values were 0.835, 0.962, and the CR values were 0.890, 0.968, above the 0.70 mark (Hair et al., 2011). These results verify good construct reliability in all measures.4.2 Convergent and discriminant validity of lower-order constructs.
Validity was tested through PLS-SEM, confirming convergent validity as all AVE values exceeded 0.50 (Fornell & Larcker, 1981). Discriminant validity was established since constructs were conceptually distinct with no high intercorrelations (Bagozzi et al., 1991). Following Fornell & Larcker's (1981) criterion, the square root of AVE for each construct was greater than its correlations with others. Table 2 displays the Fornell–Larcker Criterion Matrix, which compares the square root of AVE values with inter-construct correlations to establish discriminant validity. The results confirm that each construct is conceptually distinct from the others. HTMT analysis further supported discriminant validity, with ratios below the thresholds—≤0.85 (Kline, 2011) and ≤0.90 (Teo et al., 2008). Table 3 provides the Heterotrait–Monotrait (HTMT) Ratio Matrix, offering further confirmation of discriminant validity, with all HTMT values remaining below the accepted 0.90 threshold. Results confirmed all HTMT ratios were within acceptable limits, ensuring strong validity.

Table 1: Factor Loadings and Reliability of constructs

Construct	Item & Statement	Outer Loading	Cronbach's Alpha	Composite Reliability (rho_a)	AVE
CA (Cybersecurity Awareness)	1. I know how to keep my digital accounts and passwords secure.	0.811	0.853	0.853	0.694
	5. I understand basic digital terms like encryption and data privacy.	0.844			
	7. I feel secure entering personal information on digital platforms.	0.848			
	8. I understand and use multi-factor authentication for extra security.	0.827			
DL (Digital Literacy)	1. I can easily navigate websites and mobile apps.	0.825	0.835	0.836	0.669
	2. I troubleshoot common tech issues (e.g., login problems) on my own.	0.821			
	6. I confidently make payments and manage finances online.	0.807			
	7. I regularly learn new digital skills and stay updated with technology.	0.819			
DP (Digital Payments)	2. I use digital payment platforms to make donations to charities/religious organizations.	0.912	0.953	.953	.841
	3. I use digital payment platforms to pay for electricity, gas, and water utility bills.	0.867		–	–
	4. I use digital payment platforms to book tickets for my travel plans.	0.871			
	6. I use digital payment platforms to make credit card payments conveniently.	0.841			
	10. I use digital payment platforms to buy and manage insurance.	0.918			
FA (Financial Attitude)	1. I have a positive attitude toward managing my finances effectively.	0.836	0.897	0.898	0.708
	2. It is necessary to use reliable tools and information to make informed spending decisions.	0.853			
	5. Budgeting and tracking expenses are essential.	0.833			
	7. Regular review of financial goals is important.	0.845			
	10. I believe maintaining disciplined saving habits is key to financial security.	0.84			
FB (Financial Behavior)	2. I save a portion of my income each month.	0.835	0.902	0.904	0.719
	3. I review my budget before big purchases.	0.839			
	4. I track my spending to stay within budget.	0.862			
	7. I use reminders to manage expenses.	0.863			
	10. I compare financial products to make decisions.	0.839			
FK (Financial Knowledge)	1. I understand the risks involved with financial transactions.	0.861	0.904	0.905	0.723
	2. I manage finances proactively and use reliable services.	0.833			
	5. I assess the security features of financial services.	0.856			
	8. I can calculate investment returns.	0.848			
	10. I know how to set up savings/investment plans.	0.852			
FS (Fintech Services Usage)	1. I use expense-sharing apps to split household costs.	0.904	0.962	0.962	0.814
	2. I use micro-investment apps to save with round-ups.	0.898			
	3. I buy digital gold online using apps.	0.906			
	4. I use BNPL for splitting purchases into installments.	0.905			
	5. I use credit score apps to monitor my credit.	0.902			
	6. I use insurance apps for health/motor policies.	0.905			
	8. I contribute to crowdfunding for social causes.	0.895			
IA (Investment App Usage)	1. I manage all assets via investment apps.	0.915	0.940	0.940	0.846
	2. I get personalized investment insights using AI.	0.925			
	5. I use robo-advisory features in investment apps.	0.923			
	10. I set up SIPs and invest using apps.	0.917			
P2P (Peer-to-Peer Lending)	1. I connect with lenders/borrowers via P2P apps.	0.877	0.903	0.903	0.774
	3. I lend via P2P apps to earn higher returns.	0.879			
	4. I match with ideal borrowers/lenders via P2P apps.	0.874			
	10. I track my P2P investments in real-time.	0.888			

Note: Items removed because of factor loading <0.7 after measurement model analysis.

Table 2: Fornell-Larcker Criterion Matrix

	P2P	DP	FA	FB	FK	CA	DL	FS	IA
P2P	0.880								
DP	0.672	0.917							
FA	0.460	0.566	0.841						
FB	0.469	0.555	0.500	0.848					
FK	0.485	0.570	0.473	0.460	0.850				
CA	0.486	0.527	0.257	0.295	0.231	0.833			
DL	0.514	0.590	0.406	0.393	0.355	0.539	0.818		
FS	0.658	0.763	0.513	0.563	0.550	0.512	0.603	0.902	
IA	0.665	0.760	0.532	0.563	0.522	0.515	0.581	0.726	0.920

Note: FB=Financial Behavior, FA=Financial Attitude, FK=Financial Knowledge, P2P=Peer to Peer lending, IA=Investment Apps, FS=Fintech solutions, DP =Digital payment platforms.

Table 3: Heterotrait-Monotrait Ratio (HTMT) - Matrix

Constructs	P2P	DP	FA	FB	FK	CA	DL	FS	IA
P2P									
DP	0.724								
FA	0.510	0.611							
FB	0.518	0.597	0.554						
FK	0.536	0.613	0.524	0.509					
CA	0.554	0.585	0.293	0.336	0.263				
DL	0.591	0.661	0.467	0.453	0.408	0.638			
FS	0.706	0.797	0.551	0.603	0.589	0.566	0.672		
IA	0.722	0.803	0.578	0.610	0.565	0.576	0.655	0.764	

4.2. Validating the higher-order construct

These higher-order notions are validated as part of the measurement model evaluation. Each of the constructs was evaluated for reliability and convergent validity. Furthermore, the higher-order constructs were tested for discriminant validity with other lower-order constructs in the study as recommended by Sarstedt et al (2019). The reliability and validity of the higher-order constructs were established (see Tables 4 and 5). The reliability and convergent validity of all other conceptions were established because the reliability value is >.70 and the AVE is greater than.50, respectively. In along to assessing reliability and validity, the discriminant validity of higher-order components with lower-order constructs is also assessed. The results of Fornell and Larcker (1981) criterion show that the square root of AVE of the construct is higher than its correlation with all other constructs. Whereas HTMT is also lower than 90.

Table 4: Higher Order Reliability

Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
FADO	0.906	0.910	0.934	0.781
FL	0.733	0.734	0.849	0.652

Note: FADO Fintech Adoption, FL Financial Literacy.

Table 5: Higher Order Construct Validity

Constructs	Items	Loadings	Sample Mean (M)	Standard Deviation (STDEV)	T-Statistics (|O/STDEV|)	VIF
FL	FA	0.815	0.814	0.016	50.306	1.481
	FB	0.816	0.816	0.015	55.234	1.458
	FK	0.791	0.791	0.018	43.508	1.481
FADO	FS	0.894	0.893	0.009	101.651	2.856
	IA	0.894	0.894	0.009	102.62	2.862
	P2P	0.837	0.837	0.014	60.623	2.132
	DP	0.909	0.908	0.007	127.694	3.205

4.3. Structural model evaluation

The evaluation of hypothesized links in PLS-SEM involved testing path coefficients, coefficient of determination, and t-values to assess relationships between variables (Wah et al., 2012; Sarstedt et al., 2019; Peng et al., 2012). Financial literacy (FL) and Fintech adoption (FADO) were treated as higher-order components, and collinearity was checked through VIF, with all values below 3, ruling out common method bias (Hair et al., 2016; Kock et al., 2015). Path coefficients (β) were assessed using Smart-PLS (Ringle et al., 2015) with bootstrapping of 5000 subsamples under percentile bootstrap and one-tailed testing (Hair et al., 2011). Confidence intervals and the p-value of 1.96 significance value were used to evaluate hypotheses (Aguirre-Urreta et al., 2018; Qing et al., 2020). The obtained results confirmed that all hypotheses developed were highly supported, and Figure 2 and Table 6 offer substantial statistical results and the structural model.

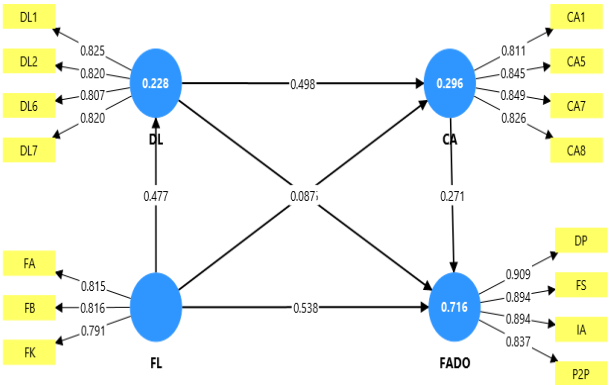

Fig. 2: Structural Equation Model Output.

The results from the Structural Equation Model (SEM) highlight significant relationships between financial literacy, digital literacy, cyber-security awareness, and Fintech adoption. The direct relationship among these variables was well verified, and the statistical significance of this relationship came out strongly in all hypotheses. H1 tests the relationship between financial literacy and Fintech adoption. The analysis showed that financial literacy significantly influences Fintech adoption, as evidenced by the direct effect coefficient of 0.538, with a T-statistic of 23.863 and a P-value of 0.000. This result confirms that individuals with higher financial literacy are more likely to adopt Fintech services. In H2, the relationship between financial literacy and digital literacy was assessed, with a direct effect coefficient of 0.477, a T-statistic of 14.468, and a P-value of 0.000. These results support the notion that individuals with a better understanding of

financial concepts are more likely to develop strong digital literacy, which is a necessary skill for interacting with Fintech platforms. H3 examined the relationship between digital literacy and Fintech adoption, where the direct effect coefficient was 0.246, with a T-statistic of 8.559 and a P-value of 0.000. This indicates that digital literacy has a significant positive effect on Fintech adoption, highlighting the importance of digital skills in the adoption process. H4 explored the role of digital literacy between financial literacy and Fintech adoption, confirming that digital literacy indeed strengthens the relationship between financial literacy and Fintech adoption, as the results showed a significant relationship between these variables.H5 tested whether digital literacy influences cybersecurity awareness. The analysis revealed a strong effect, with a coefficient of 0.498, a T-statistic of 14.434, and a P-value of 0.000, indicating that greater digital literacy enhances an individual's understanding of cybersecurity risks, which is crucial for building trust in digital financial services. H6 assessed the direct relationship between financial literacy and cybersecurity awareness, finding a positive relationship with a coefficient of 0.087, T-statistic of 2.222, and p-value of 0.026. This result suggests that financial literacy contributes to a better understanding of cybersecurity issues. Finally, H7 evaluated the relationship between cybersecurity awareness and Fintech adoption, with a direct effect coefficient of 0.271, T-statistic of 9.821, and p-value of 0.000. This confirms that higher levels of cybersecurity awareness are positively associated with the adoption of Fintech services. Table 6 shows the Regression Results of Direct, Indirect, and Total Effects, detailing path coefficients, T-values, and significance levels for all tested hypotheses. Each relationship among variables was found to be statistically significant.

Table 6: Regression Results Include Direct, Special, Indirect, and Total Effects

Direct effect		Beta value	T -test values	P values	Decision at 5% Level of Significance
H 7	CA -> FADO	0.271	9.821	0	Supported
H 5	DL -> CA	0.498	14.434	0	Supported
H 3	DL -> FADO	0.246	8.559	0	Supported
H 6	FL -> CA	0.087	2.222	0.026	Supported
H 2	FL -> DL	0.477	14.468	0	Supported
H 1	FL -> FADO	0.538	23.863	0	Supported
Specific Indirect effect					
H 4	FL -> DL -> CA -> FADO	0.064	7.48	0	Supported
Total effect					
	CA -> FADO	0.271	9.821	0	Supported
	DL -> CA	0.498	14.434	0	Supported
	DL -> FADO	0.381	14.227	0	Supported
	FL -> CA	0.324	8.5	0	Supported
	FL -> DL	0.477	14.468	0	Supported
	FL -> FADO	0.743	40.529	0	Supported

Further, following Preacher and Hayes' (2004) guidelines, bootstrapping was used to evaluate the indirect effects. Our hypothesis (H4) is that Digital Literacy (DL) and Cybersecurity Awareness (CA) mediate the relationship between Financial Literacy (FL) and Fintech Adoption (FADO). Results show statistically significant mediation, with the indirect effects of DL and CA both being significant ($\beta = 0.117$, $t = 7.474$, P-value = 0.000 for FL → DL → FADO). This confirms that both digital literacy and cybersecurity awareness enhance Fintech adoption. Similarly, hypothesis H4 supports that Digital Literacy mediates the relationship between Financial Literacy and Fintech Adoption. The results showed that DL → FADO was significant ($\beta = 0.246$, $t = 8.559$, P-value = 0.000), further emphasizing the role of digital literacy in Fintech adoption. The sequential mediation hypothesis (FL → DL → CA → FADO) also produced a significant result ($\beta = 0.064$, $t = 7.480$, $p = 0.000$), validating the combined effect of both DL and CA in enhancing Fintech adoption. These findings are consistent with partial mediation because both direct and indirect effects are significant., confirming that Digital Literacy and Cybersecurity Awareness together mediate the relationship between Financial Literacy and Fintech Adoption.

4.4. Explanatory power of the model

The R^2 value represents the explanatory power of the model in predicting the variance of the endogenous constructs (Ringle et al., 2015). In this study, R^2 values were calculated using the PLS algorithm in Smart PLS, with all results surpassing the threshold of 0.10 (Falk and Miller, 1992). According to Cohen's (1988) classification, R^2 values for Fintech Adoption (FADO), Digital Literacy (DL), and Cybersecurity Awareness (CA) were 0.716,0.228, and 0.296, respectively. These indicate substantial explanatory power for FADO, moderate for DL, and weak for CA. The R^2 values suggest that the model effectively explains the variance in Fintech Adoption while providing a moderate explanation for Digital Literacy and Cybersecurity Awareness. The blindfolding procedure was carried out to determine the predictive relevance. The model has a Q2 value of 0.551 (FADO), 0.101 (CA), and 0.224 (DL), which are larger than zero. Table 7 presents Quality Indicators of the Structural Model, including R^2, adjusted R^2, Q^2 prediction, RMSE, and MAE, which collectively demonstrate the model's strong explanatory and predictive power.

Table 7: Quality Indicators of the Structural Model

	R-square	R-square adjusted	Q square prediction	RMSE	MAE
CA	0.296	0.294	0.101	0.951	0.802
DL	0.228	0.226	0.224	0.884	0.736
FADO	0.716	0.715	0.551	0.672	0.545

4.5. ANN analysis

To capture the non-linear relationships between independent variables and outcome variables (see Table 8), based on the PLS analysis, we performed further analysis with Artificial Neural Networks (ANN) to rank the normalized importance of the significant predictors. A two-staged SEM-PLS ANN technique would complement each other because SEM-PLS is appropriate for hypothesis testing linear relationships, but cannot capture nonlinearity.

While Artificial Neural Networks (ANN) can detect non-linear relationships, it is not appropriate for hypothesis testing because of their "black box" operation (Hew, Leong, Ooi, & Chong, 2016; Tan, Ooi, Leong, & Lin, 2014). Similar to Liebana-Cabanillas, Marinković, and Kalinić (2017), we used significant SEM-PLS path analysis factors as input neurons for the ANN model (Fig. 3). Non-normal data distribution and the presence of non-linear correlations between exogenous and endogenous variables are two grounds for using an ANN. In addition, the ANN is resistant to noise, outliers, and short sample sizes. It can also support non-compensatory models, in which a decrease

in one component does not need an increase in another. A neural network module from IBM called SPSS was used to implement the ANN analysis.. The ANN algorithm can capture linear and nonlinear relationships and does not need a normal distribution (Teo, Tan, Ooi, Hew, & Yew, 2015). The algorithm can learn through the training process to predict the outcomes of the analysis using a feed-forward-backward-propagation (FFBP) algorithm, where inputs are fed in a forward path and the estimated errors will move in a backward direction (Taneja & Arora, 2019). Multilayer perceptions and sigmoid activation functions were used for the input and hidden layers (Sharma & Sharma, 2019). Through several rounds of the learning process, the errors can be minimized, and the accuracy of the prediction can be further improved (EL Idrissi, Idri, & Bakkoury, 2019). Similar to Leong et al. (2018b), we allocated 90 % of the samples for the training procedure, and the remaining samples were used for the testing procedure. To evade the possibility of overfitting, we engaged a ten-fold cross-validation procedure and obtained the root mean square of errors (RMSE) (Ooi & Tan, 2016). Table 9 portraits that the average RMSE values of training and testing procedures are relatively small at 0.291 and 0.307, respectively. The standard deviation of RMSE across the different datasets is low (0.0117 for training and 0.0374 for testing), indicating that the model's performance is relatively consistent across different sets. Therefore, we confirm that there is an excellent model fit. Using a similar approach as Hew and Kadir (2016), we computed the R2 of the ANN model, and the result reveals that the ANN model predicts FINTECH Adoption with an accuracy of 68.4 %. To measure the strengths of the predictive power of each of the input neurons, we conducted sensitivity analysis (See Table 10) to obtain the normalized importance of these neurons by dividing their relative importance by the maximum importance and presenting it in the form of a percentage (Karaca, Moonis, Zhang, & Gezgez, 2019). The result shows that Financial Literacy is the most important predictor (53.46%), followed by Cyber awareness, which has a normalized importance of 25.84 %. This is followed by Digital Literacy (20.69 %).

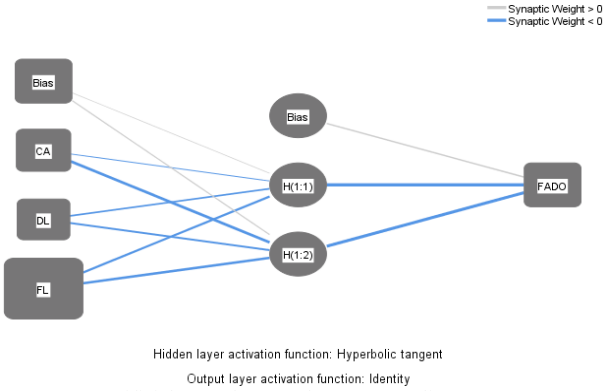

Fig. 3: Artificial Neural Network (ANN) Predictor Importance.

Table 8: Importance of Independent Variable

	IMPORTANCE	NORMALIZED IMPORTANCE
CA	0.24	44.50%
DL	0.219	40.50%
FL	0.541	100.00%

Note: CA=Cybersecurity awareness, FL=financial Literacy, DL=Digital literacy.

Table 9: RMSE Values

S. No.	Training N	SSE	RMSE	Testing N	SSE	RMSE
1	534	22.667	0.299	66	2.084	0.235
2	574	24.947	0.306	26	0.951	0.300
3	522	21.888	0.300	78	3.887	0.331
4	520	23.026	0.302	80	2.557	0.311
5	426	16.956	0.271	174	7.768	0.352
6	468	19.207	0.290	132	5.236	0.285
7	467	19.035	0.289	133	5.498	0.294
8	439	18.347	0.288	161	7.285	0.346
9	443	17.737	0.276	157	7.020	0.343
10	477	19.676	0.292	123	4.801	0.277
Mean	-	20.349	0.291	-	4.709	0.307
Standard Deviation	-	2.226	0.0117	-	2.085	0.0374

Note: SSE stands for Sum Squared Error, RMSE for Root Mean Squared Error, and N for sample size.

Table 10: Sensitivity Analysis

	CA	FL	DL
ANN-1	0.277	0.494	0.229
ANN-2	0.295	0.539	0.166
ANN-3	0.25	0.531	0.219
ANN-4	0.255	0.54	0.205
ANN-5	0.251	0.538	0.211
ANN-6	0.258	0.537	0.205
ANN-7	0.26	0.547	0.193
ANN-8	0.265	0.538	0.197
ANN-9	0.241	0.52	0.239
ANN-10	0.232	0.562	0.205
Average Importance	0.2584	0.5346	0.2069
Normalized importance (%).	48.44	100	38.79

Note: CA=Cybersecurity awareness, FL=financial Literacy, DL=Digital literacy.

5. Discussion

This finding is supported by the outcomes of this study, which contended that financial literacy (FL), digital literacy (DL) and cybersecurity awareness (CA) are all paramount factors influential in encouraging Fintech adoption (FADO) in Rajasthan, as previous researchers noted that digital literacy and knowledge on cybersecurity awareness bear significant consequences on consumer trust (Peters, 2011; Glass and Newig, 2019; Williams and Lertwachara, 2019; Kumar et al., 2022). The sequential mediation analysis revealed direct and indirect influence of FL on FADO, where the mediators are strong with DL and CA. This observation supports the theoretical suggestion that financial knowledge alone is not enough to adopt unless it is accompanied by digital skills and knowledge on the risks online (Choi, 2017; Chen and Cheng, 2020). Specifically, a powerful mediating impact of DL shows that financial knowledge reflects into participation in Fintech only in case people have the digital skills to communicate with apps, and CA assures participation maintenance with the help of trust and safety. In such a way, the study contributes to the rising literatures, which emphasize the high dimensionality of Fintech preparedness, in which the cognitive, technical, and security levels should converge to guarantee substantive digital financial incorporation.

For Rajasthan, where internet penetration stands at 57% and smartphone adoption at 85.5% of households (The Economic Times, 2024), these findings carry strong policy implications. While Fintech platforms like Groww and Zerodha are gaining popularity among urban Gen Y and Gen Z, rural and semi-urban users remain constrained by digital divides and security concerns (Agarwal & Bansal, 2020; Jain & Yadav, 2023). The study highlights that enhancing FL can indirectly foster DL and CA, suggesting an integrated literacy strategy that builds capacity across all three domains. This approach aligns with initiatives such as Internet Saathi, which improved digital access for rural women, yet it demonstrates that program effectiveness could be further enhanced by incorporating financial education and cybersecurity training (Bridgespan Group, n.d.; Sharma et al., 2022). Policymakers therefore need to design interventions that not only bridge the digital divide but also instill consumer confidence by reducing fears of fraud and misuse, thereby encouraging more equitable Fintech participation across demographics.

The results can also be related to opportunities in Fintech business models like peer-to-peer (P2P) lending and crowdfunding, which have encountered a swift growth in Rajasthan through support offered by platforms like RangDe, Ketto, and Milaap to promote microfinance and social enterprises (Bansal and Singh, 2019). These platforms are successful with the active involvement of the consumers; they need to be digitally literate to make certain transactions, financially literate to determine the risks of borrowing and investing, and cyber-conscious so they can later avoid being defrauded. Fintech adoption faces a risk of being somewhat confined to a technologically aware elite without the concomitant development of these three literacies, which will take away some of the locative power of Fintech in practice. As promoted by the authors, trust-building is a central concept of Fintech adoption, where onboarding must incorporate cybersecurity education on the side of the government and adopters (Rathi and Agarwal, 2021). Consequently, the implication of this study is as follows: improving the adoption of Fintech in Rajasthan and other areas will be possible when there is a comprehensive literacy framework, which connects all three aspects of financial, digital, and security engagement and allows consumers to, in addition to adopting it, enjoy staying in the digital financial space.

6. Conclusion

The present study aimed to test the connection between financial literacy, digital literacy, cybersecurity awareness, and Fintech adoption in Rajasthan, to determine the most important dimensions that shape consumer Behavior in digital financial services. Data analysis was conducted with the help of a quantitative design and PLS-SEM (Wah et al., 2012; Hair et al., 2016) using the factor loadings, Cronbach's Alpha, and Composite Reliability as the reliability measures, and path coefficients testing via bootstrapping with 5000 resamples (Ringle et al., 2015). The outcomes affirmed good construct reliability and validity, and all factor loadings are greater than the suggested threshold of 0.5, and the values of VIF are far below 3, which excludes the potential of multicollinearity or common method bias (Kock et al., 2015). The findings established that financial literacy significantly influences Fintech adoption, both directly and indirectly (Rehman, 2025), with digital literacy and cybersecurity awareness acting as strong mediators(Islam and Khan, 2024). This suggests that financial knowledge alone is insufficient unless it is supported by the digital skills to operate Fintech platforms and the awareness to mitigate online risks (Choi, 2017; Kumar et al., 2022). The results also confirm that higher-order constructs of FL and FADO, modeled as multidimensional, were significant in shaping adoption behaviors, aligning with prior research emphasizing the role of trust, competence, and confidence in digital finance ecosystems (Rathi & Agarwal, 2021).

This study, while offering meaningful insights into the relationship between financial literacy, digital literacy, cybersecurity awareness, and Fintech adoption, is not without limitations. The research was geographically confined to Rajasthan, which may restrict the generalizability of results across India's diverse socio-economic and cultural contexts. Differences in technological infrastructure, financial access, and educational backgrounds across other states may influence adoption patterns. Furthermore, the cross-sectional design limits the ability to capture behavioral changes over time, and reliance on self-reported data introduces the potential for response bias, as participants may overstate their financial competence or technology usage (Hair et al., 2016). Future research can mitigate such bias by incorporating triangulation methods—for instance, combining quantitative surveys with qualitative interviews or focus group discussions to validate findings and gain richer behavioral insights.

The research was confined to Rajasthan, which restricts generalizability across India's diverse socio-economic and cultural contexts. Extending the model to other Indian states, such as Uttar Pradesh, Madhya Pradesh, and Bihar, where similar digital inclusion challenges persist, could enhance the external validity of the findings. Moreover, the conceptual framework can be adapted to emerging markets like Indonesia, Vietnam, and Kenya, which face comparable issues of financial illiteracy and uneven digital infrastructure (OECD, 2024; WEF, 2024). Future studies should consider longitudinal designs to capture evolving user behavior and the long-term impact of financial and digital literacy interventions. Incorporating behavioral economics perspectives, such as trust formation, risk aversion, and decision heuristics, could further deepen understanding of user engagement with AI-driven financial platforms. Collectively, these directions will strengthen the empirical foundation of digital financial inclusion research and guide policymakers in building a more equitable and secure Fintech ecosystem. By extending this line of inquiry, scholars and policymakers can contribute to building a robust digital financial ecosystem that enhances inclusion, security, and consumer empowerment.

Declarations

Ethics approval and consent to participate

This research study was conducted following ethical guidelines and principles for academic research. Ethical approval was obtained from the Institutional Review Board (IRB) of Lovely Professional University. All participants provided informed consent to participate in the study, and their privacy and confidentiality have been maintained throughout the research process.

Consent for Publication

All authors have reviewed and approved the final version of the manuscript. Consent for publication has been obtained from all participants where applicable, and there are no objections to publishing this work.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request. The data will be shared in accordance with university guidelines and ethical considerations protecting participant confidentiality.

Declaration of Interest

The authors declare that there are no conflicts of interest associated with this publication.

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Authors' Contributions

Pradeep Singh conceptualized the research, designed the methodology, collected and analyzed the data, and drafted the manuscript. Dr. Rupinder Katoch guided the research design, statistical analysis, and critically reviewed the manuscript. Both authors contributed to the interpretation of results and approved the final version for submission.

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