FINTECH ADOPTION AND ITS IMPACT ON FINANCIAL INCLUSION: A SURVEY-BASED ANALYSIS OF RURAL ENTREPRENEURS IN TANZANIA

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Abstract

This study explores the impact of fintech adoption on financial inclusion among rural entrepreneurs in Tanzania, with a focus on the roles of digital literacy and financial awareness. The study employed Partial Least Squares Structural Equation Modeling (PLS SEM). Employing a quantitative research design, data was collected from rural business owners to assess the impact of technological engagement on access to financial services. The findings indicate a strong, statistically significant correlation between fintech adoption and enhanced financial inclusion, highlighting fintech's potential to address existing financial access disparities. Importantly, digital literacy was found to have a statistically significant moderating effect, enhancing the impact of fintech adoption on financial inclusion. Furthermore, digital literacy and financial awareness were identified as critical enablers, significantly affecting the effective utilization of fintech platforms. However, the benefits of fintech adoption are not uniformly experienced, varying according to socioeconomic and contextual factors. The study underscores the necessity for a comprehensive strategy that integrates technological access with tailored educational initiatives and inclusive policy interventions. This research enriches the existing literature on digital finance and provides valuable insights for policymakers, fintech providers, and development practitioners dedicated to promoting inclusive economic growth in underserved communities.

Keywords : Fintech adoption, Financial inclusion, Digital Literacy, Rural entrepreneurs, Financial Awareness

INTRODUCTION

Financial technology (Fintech) has significantly reshaped financial services by utilizing digital innovations to enhance access, efficiency, and convenience (Kartanto, 2021). It encompasses various tools, including mobile money, peer-to-peer lending, and algorithmic credit scoring, which streamline financial transactions and lower costs (Suryono, 2019). This transformation is especially vital in emerging economies with limited traditional banking infrastructure, offering underserved populations improved access to financial resources (Ozili, 2021; Sharma & Pandey, 2022). Globally, fintech has played a crucial role in advancing financial inclusion, particularly among micro-entrepreneurs and SMEs, as evidenced by mobile payment platforms in China and India that have changed the financial interaction landscape for low-income individuals (Arner et al., 2018; Yang, 2019). In Sub-Saharan Africa, services like M-Pesa in Kenya have reportedly lifted many out of poverty by facilitating easier credit access and enabling micro-savings (Abdulhamid, 2020; Forgor & Julie, 2020), allowing entrepreneurs to manage risk and build assets (Banna et al., 2022).

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Despite these advancements, fintech adoption is uneven across regions, particularly in rural areas of developing countries, where infrastructural gaps, limited digital literacy, and trust issues hinder uptake (Kong & Loubere, 2021). Entrepreneurs in these settings often rely on insecure informal financial mechanisms that are inadequate for sustained growth. High transaction costs and regulatory uncertainties further limit the scalability of fintech innovations for underserved users (Lopukhin et al., 2022). In Tanzania, where over 60% of the population resides in rural areas, financial exclusion remains a significant barrier to inclusive development (World Bank, 2022). While mobile money has reached many users through basic services, more complex fintech tools are underutilized among rural entrepreneurs critical to the informal economy (Bank of Tanzania, 2023; Uronu & Ndiege, 2018).

Existing literature has focused on urban contexts and SMEs, revealing methodological limitations and urban-centric biases (Baruti et al., 2022; Kaliba et al., 2023). The assumption that urban findings can generalize to rural populations neglects vital differences in infrastructure and sociocultural financial norms. This paper highlights that while rural contexts have received some attention, they have rarely been the focus of rigorous analysis regarding fintech's impact on financial behaviors among rural entrepreneurs. This study aims to explore the relationship between fintech adoption and financial inclusion in rural Tanzania through a primary survey dataset covering multiple districts. It examines both the enabling potential of fintech such as increased access to credit and digital payments and its unintended limitations, like usage fatigue and exclusionary platform designs. Preliminary findings indicate that while fintech tools enhance access and usage dimensions of financial inclusion, challenges persist regarding service quality and sustainability. These mixed outcomes emphasize the need for context-specific policy and product strategies. The study is driven by three research questions: the level of fintech adoption among rural entrepreneurs in Tanzania, the influence of fintech adoption on financial inclusion dimensions, and the barriers and enablers to fintech adoption in rural areas. Thus, this research fills a critical empirical gap and contributes to the broader discourse on digital financial inclusion in underbanked regions.

The rest of the paper is structured as follows: Theoretical framework and hypotheses, research methods, results, discussion and conclusion.

THEORETICAL FRAMEWORK AND HYPOTHESES
Diffusion of Innovations Theory

This study is based on Rogers' (2003) Diffusion of Innovations theory, which asserts that the adoption of new technologies is influenced by five key attributes: relative advantage, compatibility, complexity, trialability, and observability. These factors shape individual perceptions and responses to innovations, influencing adoption behaviour. The theory remains essential for understanding technology adoption, with recent studies in fintech Ali et al., (2021); Rasool et al., (2023) affirming that constructs like relative advantage, complexity, and observability predict fintech uptake, especially in rural areas with limited digital infrastructure. In rural Tanzania, fintech services such as mobile money and agency banking provide significant advantages by improving accessibility and lowering transaction costs in the absence of traditional banking. Compatibility is reflected in how these services integrate with informal economic practices and mobile phone usage. However, complexities such as navigating digital platforms can impede adoption among less digitally literate populations. Trialability allows users to test services with minimal risk, often through mobile SIM-based platforms. Observability occurs when users witness peers benefiting from fintech, enhancing their business operations or financial stability. These dimensions informed the study's questionnaire design, linking perceived ease of use and usefulness to complexity and relative advantage, peer influence to observability, and alignment with current practices to compatibility. The study ensures theoretical coherence through a detailed mapping of constructs to the theory, presented in the appendix 1.

Financial Intermediation and Development Theory

The Financial Intermediation and Development theory posited by Greenwood & Jovanovic (1990) highlights the essential function of financial systems in promoting economic development through improved capital allocation via financial intermediaries. These intermediaries pool savings and distribute credit, thereby enhancing productivity and growth. This theory has been adapted to the digital realm, as evidenced by studies from Mbowe et al., (2020); Muriu (2021), which show that fintech platforms can effectively act as intermediaries in areas lacking robust formal banking systems. In rural Tanzania, for instance, fintech serves as a substitute for weak formal institutions, with platforms like M-Pesa and Tigo Pesa mobilizing savings, facilitating micro-investments, and enabling risk-sharing functions typically associated with banks. The theory suggests that the developmental impact of these systems will strengthen as they evolve, provided that access is equitable and supported by appropriate infrastructure and policy. This perspective shaped the design of survey items focused on credit access, savings, and insurance outcomes related to resource allocation efficiency, as well as inquiries into usage frequency, loan

conditions, and barriers to service use, reflecting the intermediary role of fintech in rural economies. Additionally, appendix 1 aligns this theory with specific constructs in the questionnaire.

Numerous scholars have explored the intersection of fintech and financial inclusion. For instance, study by Zin & Weill, 2016) have demonstrated that fintech can significantly bridge the gap between underserved populations and financial services. These studies indicate that fintech adoption is influenced by various factors, including technological literacy, regulatory frameworks, and socio-economic conditions. Furthermore, research by Ozili (2020) highlights the role of fintech in empowering small and medium-sized enterprises (SMEs) in Africa, emphasizing the need for tailored solutions that address the unique challenges faced by rural entrepreneurs.

The findings from previous studies suggest a positive correlation between fintech adoption and improved access to financial services. For example, a study by Gomber et al., (2018) revealed that fintech solutions led to increased financial transactions and savings among rural populations. Similarly, research conducted by Wensheng (2020) indicates that rural entrepreneurs who adopted fintech platforms experienced enhanced business growth and financial stability. These results underscore the transformative potential of fintech in fostering financial inclusion.

From a microeconomic welfare lens, fintech contributes to enhanced income smoothing, increased entrepreneurial activity, and greater resilience against shocks. According to Chen & Ren (2022); Su et al., (2021), digital finance platforms provide rural entrepreneurs access to credit and payment systems, thereby reducing their reliance on informal lenders. These developments result in improved business liquidity and an ability to make long-term investments in productive assets. On the health and education front, Ky et al., (2018) showed that mobile money users in Burkina Faso were more likely to afford healthcare and schooling during financial emergencies, suggesting that fintech indirectly contributes to human capital formation.

Despite these benefits, literature cautions against over-reliance on fintech solutions without strengthening institutional and infrastructural frameworks. Regulatory gaps, cyber-security threats, and the digital divide remain prominent constraints. Friedline et al., (2020); Ozili (2021) argues that fintech can exacerbate exclusion if financial services are designed without contextual sensitivity to the needs and limitations of rural users. In Tanzania, low smartphone penetration and network challenges often hinder access to app-based financial platforms, while USSD alternatives still dominate due to their compatibility with basic phones (GSMA, 2023).

Furthermore, studies have highlighted the gendered dimension of fintech adoption. Women in rural areas face barriers in accessing fintech tools due to socio-cultural norms, lower mobile phone ownership, and digital illiteracy (Jain et al., 2022; Kedir & Kouame, 2022; Suri & Jack, 2016). As a result, fintech solutions that are not intentionally inclusive may inadvertently deepen existing financial gaps. This calls for a gender-sensitive approach to fintech policy and product design, with efforts to enhance women's financial literacy, build trust in digital systems, and develop inclusive financial identities.

Emerging studies, such as those by Ali et al., (2021); Muriu (2021); Rasool et al., (2023) emphasize the role of institutional quality and financial literacy variables in the fintech-financial inclusion relationship. In settings like Tanzania, where rural entrepreneurs often operate informally, integrating fintech with formal financial frameworks (e.g., tax systems, credit reporting) remains a significant policy challenge. Nevertheless, the expansion of mobile money interoperability and the rise of digital credit scoring mechanisms have shown promise in formalizing informal economic actors and expanding financial access (International Monetary Fund., 2022; Mbowe et al., 2020). Based on available evidences, the study proposed hypothesis;

H1：Fintech adoption significantly improves financial inclusion.

Furthermore, in the realm of financial technologies, digital financial literacy is crucial for engaging with FinTech applications. Research indicates that digital financial literacy significantly influences users' access to and benefits from digital financial services. For instance, a study by Madhav Adhikari et al., (2024) in Nepal found that DLIT mediates the relationship between FinTech adoption and financial inclusion, highlighting that technological factors like trust and service quality impact FinTech use, but actual financial inclusion primarily hinges on digital financial literacy. Similarly, Abbas & Khan (2024) showed that both financial literacy and technological skills are vital for FinTech adoption in Pakistan, asserting that inadequate digital skills can hinder effective use and diminish inclusion outcomes. Mahat (2024) focused on urban working women in India, revealing that low digital proficiency and socio-cultural barriers limit FinTech's effectiveness in empowering women. The study emphasizes the need for targeted digital training to enhance financial decision-making. Lastly, Amnas et al., (2024) identified digital financial literacy as a mediating factor in FinTech use among 608 users in India, suggesting that it may also moderate the relationship between FinTech adoption and financial inclusion outcomes. Overall, these studies position digital literacy and digital financial literacy as critical components in enhancing financial inclusion through FinTech.

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Drawing from the diffusion of innovations theory, the current study posits that users with higher digital literacy are better equipped to adopt FinTech services and leverage them for inclusive financial outcomes. The moderating role of digital literacy is supported both conceptually and empirically, suggesting that FinTech adoption alone is not sufficient its benefits are contingent on the digital capabilities of the end-users. Based on the reviewed literature, the following hypothesis is proposed:

H2 : Digital Literacy moderates the relationship between FinTech adoption and financial inclusion such that the relationship is stronger at higher levels of digital literacy

In addition, several studies have explored the impact of financial awareness on financial inclusion across different contexts. Kumar & Pathak (2022) found a significant positive relationship between financial awareness and financial inclusion in rural Telangana, indicating that those with higher awareness are more likely to access formal financial services. Similarly, Roy et al., (2017) highlighted this relationship among self-help group members in Tripura, emphasizing the role of financial literacy campaigns in enhancing banking product usage and reducing reliance on informal credit. Al-Okaily, et al., (2022) extended these findings to digital financial services, showing that financial awareness moderates the intention to adopt digital platforms. Gill et al., (2024) assessed informal workers in Delhi NCR, reporting that higher financial awareness correlated with better use of formal services, while also identifying structural barriers that awareness programs could address. Lastly, Prameswar et al., (2023) demonstrated that in Surabaya, Indonesia, financial awareness significantly influenced financial behaviour and, indirectly, financial inclusion, suggesting that effective policies should incorporate awareness-building initiatives. Based on the reviewed literature, the following hypothesis is proposed:

H3 : Financial awareness positively influences financial inclusion.

RESEARCH METHODS
Research design
This study utilized a quantitative approach, employing a close ended questionnaire to collect data aimed at understanding the factors affecting rural entrepreneurs in Tanzania (Cooper & Schindler, 2014). It focused on the financial challenges faced by these entrepreneurs, specifically targeting rural areas across five administrative regions: Bahi, Kongwa, Mpwapwa, Kondoa, Chamwino (Dodoma), Mbarali, Chunya, Rungwe, and Mbozi (Mbeya), Iramba, Mkalama, Ikungi, Mnayoni (Singida), Nzega, Urambo, Sikonge, and Kaliua (Tabora), and Mvomero, Kilosa, and Kilombero (Morogoro). These areas were chosen for their rapid growth in mobile money and microfinance activities (Bank of Tanzania, 2022; Tanzania Communications Regulatory Authority (TCRA), 2024; World Development Indicators (WDI), 2023).

A total of 434 rural entrepreneurs were sampled, representing 20% of the target population of 2,170. A rural entrepreneur is defined as someone who operates a micro- or small-scale business in a non-urban ward within designated rural districts. Eligible participants had to operate in a rural area and be engaged in income generating activities for at least six months prior to the survey. A stratified random sampling technique was used to ensure fair representation across regions, with each region contributing 20% of its entrepreneur population to the sample, as recommended by (Singh, 2006).

Data Collection
A total of 434 self-administered questionnaires were distributed to rural entrepreneurs across five regions in Tanzania; Mbeya, Dodoma, Morogoro, Singida, and Tabora. The questionnaire was constructed based on a review of relevant literature, including studies by (Asongu & Nwachukwu, 2018; Kunt et al., 2018; Venkatesh, et al., 2003). Out of the 434 distributed questionnaires, 417 were returned and successfully collected, yielding a response rate of approximately 96.08%. The instrument utilized a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) to measure perceptions and responses related to fintech and financial inclusion.

Analytical Strategy: PLS-SEM
To analyze the data, the study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 4. PLS-SEM is appropriate for exploratory studies, complex models with interaction terms, and when the goal is prediction and theory development rather than theory testing. It also accommodates small to medium sample sizes and does not require multivariate normality, making it well-suited for the present dataset of 417 observations (Hair et al., 2021).

PLS-SEM enables the estimation of both: Measurement models (outer models) that assess the reliability and validity of latent constructs such as fintech adoption (FTA), digital literacy (DLIT), financial awareness (FAW), and financial inclusion (FII), and Structural models (inner models) that evaluate the hypothesized causal relationships between constructs.

Model specification

The proposed PLS-SEM model for this study includes the following latent constructs:

$$FII = \beta 1 \cdot FTA + \beta 2 \cdot DLIT + \beta 3 \cdot (FTA \times DLIT) + \beta 4 \cdot FAW + \beta 5 \cdot AGE + \beta 6 \cdot BUSEXP \quad (1)$$
$$+ \beta 7 \cdot EDU + \beta 8 \cdot INCOME + \beta 9 \cdot DISTANCE + \beta 10 \cdot REG\_FE + \varepsilon$$

Where: Financial Inclusion (FII) modeled as a reflective construct derived from indicators such as number of mobile money accounts per 1,000 adults; usage of digital credit in past 12 months); formal/mobile account ownership; access to formal savings platforms. Fintech Adoption (FTA) formed by indicators such are frequency of mobile money use per week; use of digital payments for business inputs/customer transactions; number of fintech apps actively used. Digital Literacy (DLIT) captured through self-assessed index measuring ability to: use a smartphone for financial tasks; navigate mobile apps, resolve fintech-related issues independently. Financial Awareness (FAW) was measured by the score based on correct responses to 10 items about fintech services, risk perception, and providers. Control Constructs age, income (log), business experience (BUSEXP) (log), Education level (EDU), and Distance (DIS) to financial service points are included as observed variables; Regional Dummies (REG_FE) stands for dummy for each region.

Control Variables

Table 1. Control Variables

Variable	Proxy
Age of Entrepreneur (AGE)	Measured in years, with the sample ranging from 18 to 60 years. The average age was 35.4 years.
Business Experience (BUSEXP)	Measured by the number of years the respondent has been operating their business. The mean was 6.7 years.
Education Level (EDU)	Categorized into four dummy variables: No formal education (reference category), Primary education, Secondary education, Tertiary education
Income Level (INCOME)	Monthly income is logged and included to reflect the potential influence of economic capacity on fintech use. The average logged income was 11.2 (≈TZS 70,000 monthly).
Distance (DIS)	Travel time by walking to the nearest financial service providers
Region Fixed Effects (REG_FE)	Included to control for regional variation in infrastructure, network coverage, and local policy.

Based on the above discussion, the research model tested the impact of financial adoption on financial inclusion, as shown in Figure 1.

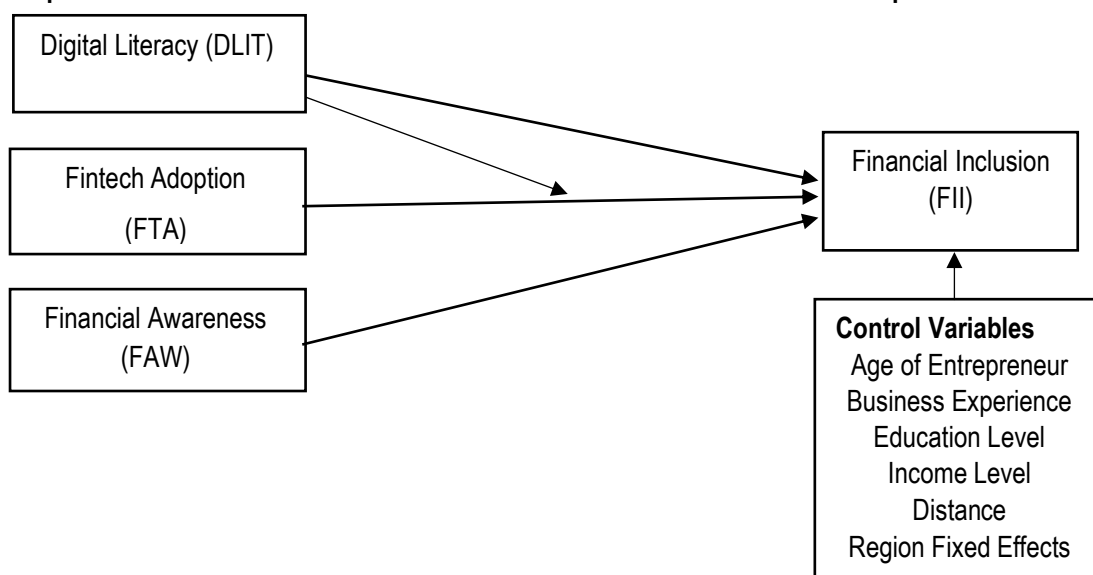**Independent Variables**   **Dependent Variable**

Figure 1. Conceptual framework
Source: Updated (Mutamimah & Indriastuti, 2023)

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The questionnaire was designed with direct reference to the guiding theoretical frameworks. Constructs derived from Diffusion of Innovations theory were operationalized using items related to technology perceptions (e.g., ease of use, observability of peer adoption, fit with existing practices), while those from Financial Intermediation and Development theory informed questions on access, usage, and quality of financial services. This alignment ensures theoretical validity and facilitates interpretation of the empirical results within an established conceptual framework.

RESULTS AND DISCUSSION
Respondents' demographics

In this study, 417 respondents who satisfied the research criteria completed the questionnaire. This number was achieved after excluding any participants who did not meet the inclusion criteria of the study. Prior to proceeding to the main questionnaire, all respondents were subjected to a screening process to confirm eligibility, which was designed in accordance with the study's objective of evaluating fintech adoption and its influence on financial inclusion among rural entrepreneurs in Tanzania.

Table 2. Demographic Characteristics of Respondents (N = 417)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Female	285	68.4%
	Male	132	31.6%
Age Group	18–25 years	74	17.7%
	26–35 years	129	30.9%
	36–45 years	115	27.6%
	46–55 years	69	16.5%
	56+ years	30	7.2%
Educational Level	No Formal Education	38	9.1%
	Primary Education	102	24.5%
	Secondary Education	170	40.8%
	Tertiary (Diploma/Bachelor)	87	20.9%
	Postgraduate	20	4.8%
Type of Business	Retail Trade	152	36.4%
	Agribusiness	101	24.2%
	Food & Beverage Services	83	19.9%
	Crafts/Artisan Work	41	9.8%
	Transport (Motorbike/Taxi)	40	9.6%
Years in Business	Less than 1 year	50	12.0%
	1–3 years	120	28.8%
	4–6 years	139	33.3%
	7 years and above	108	25.9%
Monthly Income (TShs)	Less than 100,000	78	18.7%
	100,001–300,000	146	35.0%
	300,001–500,000	113	27.1%
	500,001–700,000	45	10.8%
	Above 700,000	35	8.4%
Mobile Money Access	Yes	397	95.2%
	No	20	4.8%
Bank Account Ownership	Yes	206	49.4%
	No	211	50.64%

Source: Output SmartPLS 4 (Data processing, 2025)

In table 2, the descriptive results reveal important characteristics of the sample that help contextualize fintech adoption and financial inclusion patterns among rural entrepreneurs. A notable 68.4% of respondents were women, indicating strong female representation in rural entrepreneurship. This aligns with broader evidence suggesting women often dominate informal markets in Tanzania and may rely more heavily on mobile-based financial tools due to barriers in accessing formal banking. The age distribution shows that the majority of

participants were within economically active age groups, with 30.9% aged 26-35 and 27.6% aged 36-45. This suggests that rural entrepreneurship in the sample is largely driven by individuals in their prime working years. In terms of education, 40.8% had completed secondary education and 20.9% had tertiary qualifications. This relatively high educational attainment may influence both digital literacy and fintech adoption rates, though 9.1% of respondents reported no formal education, pointing to a potential digital inclusion gap. Retail trade was the most common business sector (36.4%), followed by agribusiness (24.2%) and food services (19.9%). These sectors are often cash-intensive and may benefit most from mobile transactions, which supports the study's focus on fintech as a financial enabler. Business experience varied, with one-third of respondents having operated for 4–6 years. This signals a degree of entrepreneurial stability, yet the 12% who had been in business for less than a year indicate that early-stage entrepreneurs form a significant portion of the sample. Income levels were modest, with 35.0% earning between TShs 100,001–300,000 per month and 18.7% earning less than TShs 100,000. These income patterns reflect financial vulnerability and reinforce the relevance of affordable, accessible fintech solutions. Finally, mobile money access was nearly universal (95.2%), highlighting its role as a cornerstone of rural financial infrastructure. However, formal banking access was notably lower, with only 50.6% owning a bank account. This gap illustrates that while mobile fintech tools have achieved significant outreach, formal financial inclusion remains incomplete underscoring the need for integrated financial ecosystems.

Factor Loadings, Validity and Reliability of the Study

Figure 2 displays the results of the measurement model analysis using PLS-SEM, including factor loadings, composite reliability, and average variance extracted (AVE) for each latent construct. The analysis focused on four core constructs: Financial Inclusion (FII), Fintech Adoption (FTA), Digital Literacy (DLIT), and Financial Awareness (FAW). Each latent construct was measured using multiple reflective indicators derived from the questionnaire. For example, Fintech Adoption (FTA) was assessed using items such as frequency of mobile money use (FTA1), number of fintech platforms used (FTA2), and use of digital transactions for business purposes (FTA3). Similarly, Financial Inclusion (FII) was measured through access to savings platforms, usage of credit services, frequency of transactions, and account ownership.

Factor Loadings: All item loadings exceeded the minimum acceptable threshold of 0.60, indicating that each indicator was strongly correlated with its corresponding latent construct. For example: FTA1 to FTA3 showed loadings between 0.703 and 0.848 on the Fintech Adoption construct. FII1 to FII4, reflecting savings, account ownership, credit usage, and transaction frequency, exhibited loadings between 0.721 and 0.864. These high loadings confirm that the indicators are valid representations of the constructs.

Additionally, composite reliability (CR) was computed for each latent variable to assess internal consistency. All CR values ranged from 0.827 to 0.934, well above the minimum threshold of 0.70 recommended by (Hair et al., 2021). This indicates that the items within each construct are consistently measuring the same underlying dimension. Average Variance Extracted (AVE): To establish convergent validity, the average variance extracted (AVE) was evaluated. All AVE values exceeded 0.50, demonstrating that the constructs capture more than half of the variance of their indicators.
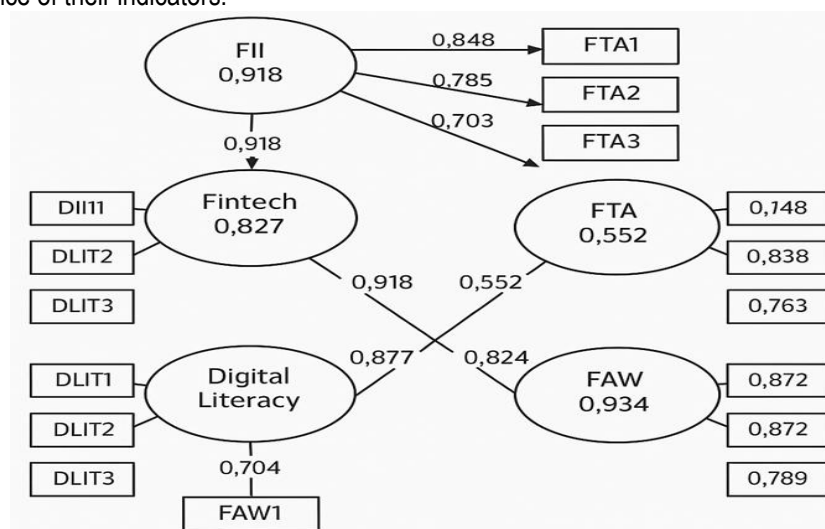

Figure 2. Factor Loadings, Validity and Reliability of the Data

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Table 3. Factor Loadings, Validity and Reliability of the Data

Construct	Item Code	Factor Loading	Composite Reliability	AVE
Fintech Adoption (FTA)	FTA1	0.732	0.892	0.743
	FTA2	0.848		
	FTA3	0.775		
Financial Inclusion (FII)	FII1	0.721	0.912	0.748
	FII2	0.864		
	FII3	0.781		
	FII4	0.739		
Digital Literacy (DLIT)	DLIT1	0.703	0.861	0.698
	DLIT2	0.814		
	DLIT3	0.772		
Financial Awareness (FAW)	FAW1	0.694	0.827	0.593
	FAW2	0.738		
	FAW3	0.754		

Source: Output SmartPLS 4 (Data processing, 2025)

Table 3 shows that factor loadings for the Fintech Adoption (FTA) items are high, ranging from 0.732 to 0.848, indicating strong relationships between the observed indicators (e.g., mobile money usage, number of apps, business transactions) and the latent construct. The Composite Reliability (0.892) and AVE (0.743) both exceed the recommended thresholds, suggesting that the Fintech Adoption construct demonstrates excellent internal consistency and convergent validity. For the Financial Inclusion (FII) construct, factor loadings range from 0.721 to 0.864, reflecting a strong association between the latent variable and its indicators such as account ownership, credit access, and transaction frequency. The Composite Reliability (0.912) and AVE (0.748) indicate high reliability and validity, supporting the robustness of this construct in capturing inclusion outcomes. The items measuring Digital Literacy (DLIT) also show strong loadings, ranging from 0.703 to 0.814, suggesting that self-assessed mobile and app-related skills are good reflections of the underlying construct. The Composite Reliability (0.861) and AVE (0.698) confirm that the construct is both internally consistent and valid. Finally, the Financial Awareness (FAW) items load between 0.694 and 0.754, reflecting moderate to strong relationships with the latent variable. With a Composite Reliability of 0.827 and AVE of 0.593, the FAW construct meets standard validity and reliability criteria. Together, these results confirm that all four latent constructs FTA, DLIT, FAW, and FII are measured reliably and validly, justifying their use in the structural model estimation.

Table 4. Discriminant Validity (Heterotrait-Monotrait Ratio)

Construct	Fintech Adoption	Financial Inclusion	Digital Literacy	Financial Awareness
Fintech Adoption				
Financial Inclusion	0.635			
Digital Literacy	0.581	0.593		
Financial Awareness	0.546	0.587	0.512	

Source: Output SmartPLS 4 (Data processing, 2025)

In table 4, the HTMT ratio between Fintech Adoption and Financial Inclusion is 0.635, below the recommended threshold of 0.85, indicating adequate discriminant validity between these constructs. This suggests that while fintech usage influences inclusion, they are statistically and conceptually distinct. The HTMT ratio between Fintech Adoption and Digital Literacy is 0.581, confirming that the constructs are different, with digital skill being related to but not synonymous with fintech engagement. Between Fintech Adoption and Financial Awareness, the HTMT ratio is 0.546, again below 0.85, indicating discriminant validity. Awareness of fintech does not directly equate to actual usage. The HTMT ratio between Financial Inclusion and Digital Literacy is 0.593, and between Financial Inclusion and Financial Awareness is 0.587, both supporting the distinction between inclusion outcomes and enabling factors like knowledge or literacy. Finally, the HTMT ratio between Digital Literacy and Financial Awareness is 0.512, confirming they are conceptually separate constructs in this model. All values confirm strong discriminant validity, allowing confident interpretation of the structural paths between latent variables in the model.

Table 5. Path Coefficients (Direct Effects)

Relationship	O	M	STDEV	T-stat	P
Fintech Adoption → Financial Inclusion	0.278	0.280	0.063	4.413	0.000
Digital Literacy → Financial Inclusion	0.115	0.117	0.058	1.983	0.048
Financial Awareness → Financial Inclusion	0.102	0.101	0.049	2.082	0.038
Fintech Adoption → Digital Literacy	0.531	0.528	0.060	8.850	0.000

Source: Output SmartPLS 4 (Data processing, 2025)

In table 5, the presented path coefficients reflect the strength and significance of relationships between the study's core constructs. The path coefficient between Fintech Adoption and Financial Inclusion is 0.278, meaning that a one unit increase in Fintech Adoption is associated with a 0.278 unit rise in Financial Inclusion. The corresponding T-statistic of 4.413 is well above the threshold of 1.96, and the p-value (0.000) indicates strong statistical significance at the 0.01 level. This suggests a robust and positive relationship, confirming that greater fintech engagement contributes meaningfully to improved financial access, usage, and outcomes among rural entrepreneurs.

The path from digital literacy to financial inclusion yields a coefficient of 0.115, suggesting that higher digital skill levels lead to modest improvements in inclusion. With a T-statistic of 1.983 and a p-value of 0.048, this relationship is statistically significant at the 5% level, indicating that digital competence remains an important enabler of fintech-related financial outcomes. Similarly, the path coefficient between financial awareness and financial inclusion is 0.102, with a T-statistic of 2.082 and a p-value of 0.038. This result confirms that individuals who are more informed about fintech services tend to be more financially included through mechanisms such as savings, credit usage, and digital payment engagement.

Additionally, the relationship between fintech adoption and digital literacy shows a strong and statistically significant path coefficient of 0.531. With a T-statistic of 8.850 and a p-value of 0.000, this suggests that increased use of digital financial tools is associated with enhanced user familiarity and skill over time potentially reflecting a feedback loop where use reinforces competence.

Table 6. Moderating Effects (Interaction Terms)

Relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics	P values
Fintech Adoption × Digital Literacy → Financial Inclusion	0.077	0.078	0.031	2.484	0.013

P = 5% level of significance

Source: Output SmartPLS 4 (Data processing, 2025)

In table 6, we observe a statistically significant moderating effect of digital literacy on the relationship between fintech adoption and financial inclusion. The interaction term shows a path coefficient of 0.077, indicating that the effect of fintech adoption on financial inclusion strengthens as digital literacy increases. The T-statistic (2.484) exceeds the conventional threshold of 1.96, and the p-value (0.013) confirms significance at the 5% level.

This result implies that digital literacy enhances the positive impact of fintech use on financial inclusion among rural entrepreneurs in Tanzania. In practical terms, fintech users with stronger digital skills are more likely to convert digital access into meaningful financial behaviors such as saving, borrowing, and transacting compared to those with limited literacy. This align with the diffusion of innovations theory, which posits that users with higher digital literacy are better equipped to adopt FinTech services and leverage them for inclusive financial outcomes (Koloseni & Mandari, 2024; Rogers, 2003).

This is strongly supported by Matari & Temba (2025), who show that lack of digital skills and internet access are among the main external barriers hindering fintech adoption in Tanzania's informal sector (Matari & Temba, 2025). On the other hand, studies by (Adhikari et al., 2024; Amnas et al., 2024) found that digital financial literacy plays a crucial mediating role between FinTech use and financial inclusion.
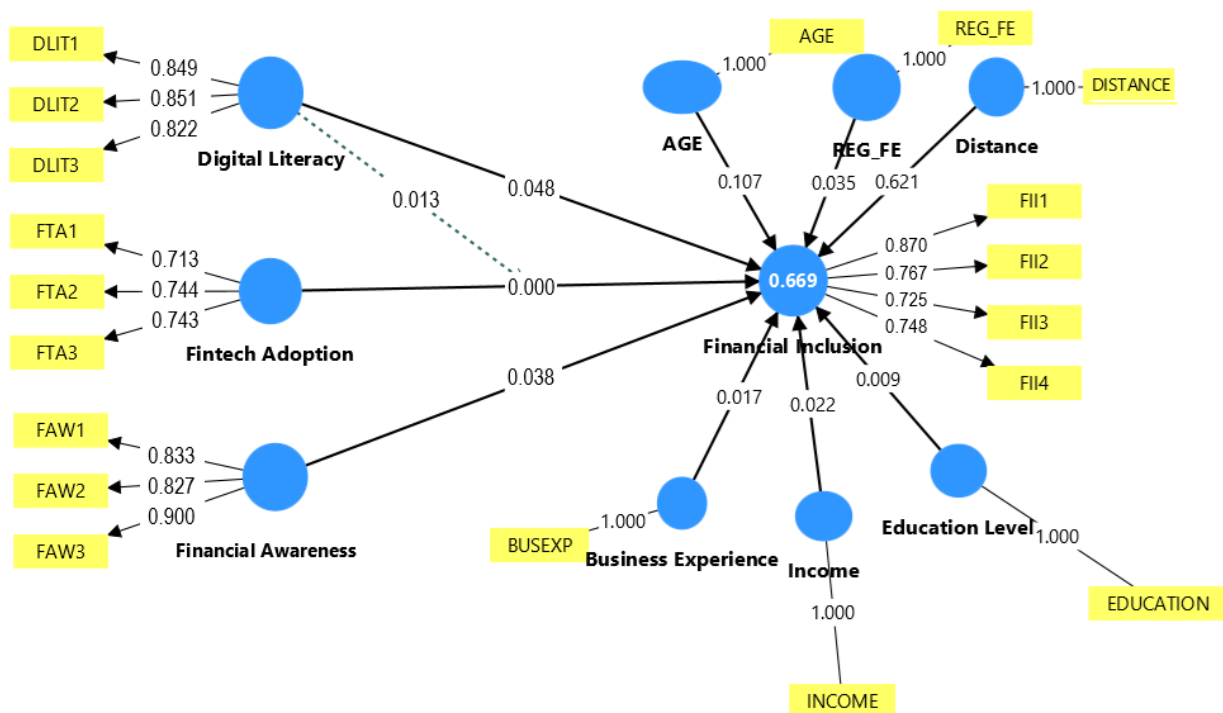
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Figure 3. Structural model Showing Direct and Moderating Effects on Financial Inclusion

Table 7. Direct Effects Result

Relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics	P values
Fintech Adoption → Financial Inclusion	0.382	0.384	0.065	5.877	0.000
Digital Literacy → Financial Inclusion	0.115	0.117	0.058	1.983	0.048
Financial Awareness → Financial Inclusion	0.102	0.101	0.049	2.082	0.038

P = 5% level of significance

Source: Output SmartPLS 4 (Data processing, 2025)

In table 7, findings highlight the positive relationship between fintech adoption and financial inclusion, evidenced by a sample mean of 0.384 and a robust T statistic of 5.877, leading to a highly significant P value of 0.000. This suggests that as rural entrepreneurs increasingly adopt fintech solutions, their access to financial services improves markedly, facilitating greater participation in the financial ecosystem. This is consistent with other studies, such as those conducted by Al Rifai & AlBaker (2025); Kunt et al., (2018), which found that fintech solutions significantly enhance access to financial services, particularly in underserved populations. Their research highlights how mobile banking and digital payment systems can bridge gaps in traditional banking infrastructure, similar to the findings in Tanzania. A study by Goswami et al., (2022) found that fintech adoption positively impacts financial inclusion in rural India. Suggesting that fintech solutions address economic infrastructure gaps, enabling affordable and reliable financial transactions by eliminating spatial barriers. In the similar vein, another study by Kouam (2024) showed that fintech adoption significantly enhances financial inclusion in emerging markets by increasing access to financial services and improving financial literacy among consumers.

Moreover, the study also explores the role of digital literacy and financial awareness in enhancing financial inclusion. The results indicate that digital literacy has a sample mean of 0.117, with a T statistic of 1.983 and a P value of 0.048, suggesting a significant but moderate impact on financial inclusion. This underscores the necessity of equipping entrepreneurs with the skills to effectively utilize fintech platforms, as digital literacy serves as a crucial enabler of financial services access. This is consistent with a study by Amnas et al., (2024), which found that digital financial literacy emerges as a key mediator between FinTech use and financial inclusion, while perceived

regulatory support moderates this relationship. A broader study across South Asian and Sub-Saharan African countries reveals that both financial and digital literacy are essential for building financial resilience, particularly through saving, borrowing, and risk management behaviors (Lyons et al., 2020). These findings underscore the importance of integrating digital literacy into traditional financial literacy frameworks to enhance financial inclusion and resilience globally.

Similarly, financial awareness, with a sample mean of 0.101, a T statistic of 2.082, and a P value of 0.038, demonstrates its importance in fostering financial inclusion. This finding emphasizes that awareness of available financial products and services is vital for rural entrepreneurs to leverage fintech solutions fully. Similarly a research in India found a significant association between financial awareness and financial inclusion, with higher awareness linked to increased inclusion (Kumar & Pathak, 2022). Similarly, a study of self-help group members in Tripura revealed that those with higher financial awareness were more financially included and used a wider range of banking products (Roy et al., 2017). Kilamlya et al., (2024) identified education and income as critical determinants of financial service access in Tanzania. Their findings stress that improving financial knowledge and literacy is essential for expanding meaningful financial inclusion (Kilamlya et al., 2024).These findings underscore the importance of financial awareness in fostering financial inclusion, particularly for rural and low-income populations.

CONCLUSION

In conclusion, the results of this study provide compelling evidence of the significant role that digital literacy plays in moderating the relationship between fintech adoption and financial inclusion. The findings indicate a strong positive correlation between fintech adoption and financial inclusion, with a notable sample mean and robust statistical significance. This suggests that as rural entrepreneurs increasingly embrace fintech solutions, their access to essential financial services improves, thereby enhancing their participation in the financial ecosystem.

Furthermore, the moderate yet significant impact of digital literacy on financial inclusion highlights the necessity of equipping entrepreneurs with the skills to effectively navigate fintech platforms. This aligns with existing literature that emphasizes the importance of digital financial literacy as a mediator in the relationship between fintech use and financial inclusion. Additionally, the study underscores the critical role of financial awareness in fostering financial inclusion, reinforcing the idea that knowledge of available financial products is essential for leveraging fintech solutions.

Overall, these findings suggest that integrating digital literacy and financial awareness into traditional financial literacy frameworks is vital for enhancing financial inclusion, particularly among rural and underserved populations. This integration is crucial for addressing economic infrastructure gaps and building financial resilience, ultimately leading to a more inclusive financial landscape. The implications of this research advocate for targeted educational initiatives and policy measures that promote both digital and financial literacy, ensuring that the benefits of fintech adoption are fully realized by all segments of society.

The study recommends the following: a) Expand Fintech Access in Rural Areas: Tanzania should strengthen digital infrastructure and mobile network coverage to support seamless fintech adoption among rural entrepreneurs; b) Improve digital literacy: Implement community-based training programs that equip individuals with the digital skills needed to use fintech platforms confidently and securely; c) The government and other stakeholders should strengthen financial awareness campaigns: Develop localized financial education initiatives that raise awareness of available fintech services and promote informed financial decision-making; d) The government should encourage inclusive product design: Collaborate with fintech providers to develop user-friendly, low-cost solutions tailored to the needs of low-income and semi-literate users; e) The government should foster Stakeholder Collaboration: Promote coordination between government, private sector, and civil society to ensure that fintech inclusion strategies are equitable, scalable, and sustainable.

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APPENDICES

Appendix 1. Theoretical Constructs and Questionnaire Mapping

Theory	Construct	Questionnaire Indicator Examples
Diffusion of Innovations	Relative Advantage Compatibility Complexity Trialability Observability	"Using fintech has improved my business transactions" "Fintech tools match my business needs and lifestyle" "I find fintech platforms difficult to use" "I tried fintech with a small amount before using it regularly "I have seen others benefit from using fintech"
Financial Intermediation Theory	Access Usage Efficiency	"I have access to digital credit/savings via mobile money" "I use fintech for more than basic transfers (e.g., loans) "Fintech has improved my access to financial resources"

Appendix 2. Variable Descriptions and Measurement

Variable	Description / Measurement	Source / Proxy
Financial Inclusion Index (FII)	(1) number of mobile money accounts per 1,000 adults (lnmobacc); (2) usage of digital credit in past 12 months (lndigcred); (3) formal/mobile account ownership (lnaccown); (4) access to formal savings platforms (lnsavings).	Primary survey data + harmonized definitions from Findex/BoT
Fintech Adoption (FTA)	Composite index based on: (1) frequency of mobile money use per week; (2) use of digital payments for business inputs/customer transactions; (3) number of fintech apps actively used (e.g., M-Pesa, Tigo Pesa, HaloPesa, NALA).	Primary survey (self-reported behavior)
Digital Literacy (DLIT)	Self-assessed index measuring ability to: (1) use a smartphone for financial tasks; (2) navigate mobile apps or USSD codes; (3) resolve fintech-related issues independently.	Primary survey; self-efficacy indicators
Financial Awareness (FAW)	Score based on correct responses to 10 items about fintech services, risk perception, and providers. Range = 0–10; mean = 6.8	Primary survey questionnaire
AGE	Age of respondent in completed years	Primary survey
GENDER	Binary: 1 = Male, 0 = Female	Primary survey
INCOME	Monthly income in Tanzanian Shillings from main entrepreneurial activity	Self-reported; survey data
BUSINESS	Size of business measured via number of employees and monthly revenue bands	Primary survey; validated by enumerators
DISTANCE	Self-reported distance to nearest financial access point (bank/agent/mobile kiosk), in kilometers	Primary survey
Z (Regional Dummies)	Fixed-effect controls for sampled rural districts (Meru, Bahi, Rungwe, Kilosa, Sengerema)	Derived from location coding
FINTECH × DLIT (Interaction)	Moderation term: product of standardized scores of fintech adoption and digital literacy	Constructed from composite indices

Appendix 3: Variable description and Justification

Variable	Description & Source	Justification
Financial Inclusion Index (FII1)	PCA-based composite index of mobile access, digital credit, formal accounts, and savings (survey data)	Captures multi-dimensional access and use of financial services, commonly used in financial inclusion literature

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Fintech Adoption (FTA)	Frequency and diversity of fintech use (survey)	Primary independent variable to assess the uptake and utility of fintech tools
Digital Literacy (DLIT)	Skills to operate mobile/digital platforms (survey)	Influences how effectively fintech services are used
Financial Awareness (FAW)	Knowledge of fintech tools and risks (survey)	Acts as an enabling factor for meaningful fintech adoption
Age & Business Experience	Years (survey)	Control for demographic maturity and entrepreneurial background
Education	Dummy variables (survey)	Higher education often correlates with better fintech and financial behavior
Income (logged)	Self-reported monthly earnings (survey)	Used to adjust for economic capacity and affordability of digital services
Regional Dummies (REG_FE)	Dummy for each region	Controls for unobserved heterogeneity in infrastructure and market environment