

The Future of Financial Access: Blockchain's Impact on Banking the Unbanked in Iringa Municipal

Romed Kavenuke

Department of Accounting and Finance
Ruaha Catholic University
Tanzania
romed70@gmail.com

Abstract: This study explored the integration of block-chain-enabled solutions with mobile money ecosystems, focusing on adoption rates, transaction efficiency, risk mitigation, and interoperability. It also examined the socio-economic impacts of block-chain adoption, including financial inclusion growth; trust in formal financial systems, economic empowerment, and gender inclusion. Additionally, the research investigated infrastructural and cultural challenges, such as internet and mobile accessibility, digital literacy, resistance to technological change, and regulatory barriers. The study was conducted using a sample size of 148 respondents, including smallholder farmers, informal traders, women entrepreneurs, and financial service providers. Findings revealed that block-chain adoption varied, with a moderate uptake among respondents. Transaction efficiency improved, with participants citing faster and more secure transactions. Block-chain significantly reduced fraud and security risks, fostering trust in financial systems. However, challenges such as limited internet accessibility, low digital literacy, and resistance to change hindered adoption. Regulatory and institutional barriers also posed significant obstacles. The study concludes that while block-chain has the potential to transform mobile money ecosystems, strategic efforts are required to overcome adoption challenges. Recommendations include policy reforms, improved digital infrastructure, financial literacy programs, and enhanced stakeholder collaboration to maximize block-chain's benefits in financial inclusion and economic empowerment.

Keywords— Block-chain-Enabled Solutions, Mobile Money Ecosystems, Financial Inclusion, Transaction Efficiency, Risk Mitigation, Trust In Formal Financial Systems, Economic Empowerment, Resistance to Technological Change

1. INTRODUCTION

Financial inclusion remains a critical challenge in many developing regions, particularly in sub-Saharan Africa, where traditional banking systems struggle to reach underserved populations. Iringa Municipal, a growing urban center in Tanzania, faces similar financial access constraints, with a significant portion of the population lacking access to formal banking services. High transaction costs, inadequate banking infrastructure, and stringent requirements for financial services have left many individuals and small businesses unbanked or underbanked. Block-chain technology has emerged as a potential solution to bridge this financial gap by offering decentralized, transparent, and cost-effective financial services. By enabling peer-to-peer transactions, smart contracts, and digital identity verification, block-chain can help reduce reliance on traditional banking intermediaries. This study explores how block-chain technology can enhance financial inclusion in Iringa Municipal, addressing key barriers to banking and providing alternative financial solutions for the unbanked population.

1.1 Background and Statement of the Problem

Financial inclusion remains a significant challenge globally, with approximately 1.4-1.7 billion adults unbanked, primarily in developing economies [1, 2]. In developing countries, about 44% of adults lack access to financial services [3]. The

Global Findex Database reveals that only 50% of adults worldwide have a formal financial account, with variations across regions and income groups [4]. Barriers to financial inclusion include high costs, physical distance, and lack of documentation [4]. Some developing countries have made progress through policies promoting mobile financial services, interoperability, and digitalization of public services [3]. Artificial intelligence and targeted interventions by organizations like the World Bank are being explored to promote financial inclusion [5]. Despite these efforts, financial exclusion remains a persistent issue, particularly in Africa [6]. Block-chain technology has emerged as a promising solution for enhancing financial inclusion, particularly for underserved populations like smallholder farmers in Africa [7, 8]. Its decentralized, secure, and transparent nature allows for peer-to-peer transactions, cross-border remittances, and micro-lending without traditional banking infrastructure [7]. In Tanzania's informal sector, fintech adoption faces both facilitating factors, such as market expansion desires, and barriers, including social and economic constraints [9]. The integration of block-chain in banking can improve financial inclusion, security, and transaction efficiency, especially in developing regions [10]. However, challenges persist, including regulatory uncertainties, technological infrastructure limitations, and the need for digital literacy [7, 9]. To promote adoption, stakeholders should focus on reducing costs, providing training, and ensuring fair policies [9].

Block-chain technology and decentralized finance (DeFi) are revolutionizing financial inclusion by dismantling barriers to traditional banking services [11, 12]. These innovations provide secure, transparent, and cost-effective alternatives to centralized systems, enabling peer-to-peer transactions, cross-border remittances, and micro-lending through smart contracts [13, 14]. Block-chain's potential to enhance financial inclusion is particularly significant for under-banked and unbanked populations, offering accessible banking solutions and breaking the cycle of poverty [14, 15]. The technology's cryptographic security features mitigate fraud risks, while its decentralized nature reduces operational costs and processing times [15]. However, challenges such as regulatory uncertainties, technological infrastructure limitations, and cryptocurrency volatility persist [11, 12]. Despite these hurdles, block-chain and DeFi continue to reshape the financial landscape, promising greater democratization of wealth and more efficient global financial markets [12, 15]. It offers promising solutions for enhancing financial inclusion, particularly for marginalized groups like refugees and the unbanked [13, 16]. By providing decentralized, secure platforms for transactions, block-chain can reduce costs, improve access, and build trust in financial systems [17] [13, 18]. Mobile payment systems and block-chain-based solutions have shown potential in expanding financial services to remote areas and facilitating peer-to-peer transactions [17]. However, challenges persist, including regulatory uncertainties, technological infrastructure limitations, and cryptocurrency volatility [13]. Additionally, projects targeting poor and migrant populations may face higher failure rates [16]. To maximize impact, block-chain must be integrated with complementary technologies and address issues such as digital literacy and infrastructure gaps [17]. Collaboration between governments, technology providers, and financial institutions is crucial for developing inclusive fintech ecosystems [17].

This study situates itself at the intersection of technological innovation and socio-economic development. By focusing on Iringa Municipal, it seeks to address a critical gap in understanding how block-chain can be tailored to local contexts, balancing technological potential with cultural, infrastructural, and regulatory realities. The findings aim to inform policymakers, financial institutions, and block-chain developers on pathways to leverage decentralized finance (DeFi) for inclusive growth, aligning with Tanzania's **National** Financial Inclusion Framework (NFIF 2023–2028) and the UN's Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth).

1.2 Objective of the study

The study aims to assess block-chain technology's potential to address systemic financial exclusion in Iringa by evaluating its feasibility in overcoming barriers such as limited banking infrastructure, low digital literacy, and regulatory ambiguity.

It seeks to analyze how 1) block-chain-enabled solutions (such as decentralized digital wallets, smart contract-driven microloans, and low-cost cross-border payment systems) can integrate with existing mobile money ecosystems to empower smallholder farmers, informal traders, and women, while mitigating risks like fraud and exclusion, 2) socio-economic impacts (including trust-building in formal systems and inclusive growth opportunities) and 3) identify infrastructural and cultural challenges (e.g., internet access gaps, resistance to digitization), and propose scalable, context-specific implementation models. By drawing parallels with successful global case studies (e.g., Kenya, Philippines), it intends to inform policymakers, financial institutions, and development stakeholders on strategies to harmonize block-chain innovation with Tanzania's regulatory framework, ultimately fostering equitable financial inclusion in rural and semi-urban Tanzanian contexts.

1.3 Main contribution of the study

The study's core contribution lies in its localized, evidence-based approach to block-chain adoption. By designing a mobile-optimized block-chain platform tailored to Iringa's infrastructure and testing its viability through pilot programs, the research not only validates block-chain's role in reducing financial exclusion but also provides a blueprint for adapting global technologies to hyperlocal contexts. Its findings could reshape how policymakers and tech innovators address financial inclusion in rural Africa, balancing innovation with socio-cultural and regulatory realities. In essence, the study shifts the discourse from theoretical block-chain potential to practical, context-driven solutions, ensuring marginalized populations like those in Iringa are central to the future of financial systems.

2. METHODOLOGY

2.1 Research Design:

This study adopted a mixed-methods research approach, combining both quantitative and qualitative methods to provide a comprehensive analysis of block-chain technology's impact on financial access for the unbanked population in Iringa Municipal. The research is exploratory and descriptive; aiming to assess block-chain's potential in enhancing financial inclusion.

2.2 Population and Sample Size

The study focused on Iringa Municipal, Tanzania, a region with a significant proportion of unbanked individuals, informal traders, and micro-business owners. The target population includes individuals who lack access to traditional banking services, fintech service providers, and block-chain technology experts. The study used a sample size of 148 participants, selected through a stratified random sampling technique **to ensure representation** across different groups.

2.3 Data Collection Methods

1. **Surveys (Quantitative Data);** structured questionnaires were administered to **unbanked individuals** and **fintech service providers** to assess financial access challenges and awareness of block-chain-based solutions.
2. **Interviews (Qualitative Data);** In-depth interviews were conducted with **block-chain experts** and **regulatory officials** to gain insights into the feasibility, risks, and regulatory landscape of block chain adoption.
3. **Focus Group Discussions (FGDs);** Two FGDs (each with 8–10 participants) were held with unbanked individuals to explore perceptions and potential adoption of block-chain technology for financial transactions.

2.4 Data Analysis:

- i. **Quantitative data** was analyzed using **SPSS**, employing descriptive statistics (frequency and percentages) to identify patterns.
- ii. **Qualitative data** from interviews and FGDs was analyzed using **thematic analysis**, identifying key themes on block-chain adoption challenges and opportunities.

2.5 Ethical Considerations:

- Informed consent was obtained from all participants.
- Data confidentiality and anonymity were ensured.

Ethical approval was secured from the relevant institutional review board (IRB).

2.6 Limitations

The study acknowledges potential limitations, such as the possibility of bias in self-reported survey data and the challenges of generalizing findings due to the specific context of Iringa Municipal. However, the mixed-methods approach and stratified sampling will help mitigate these limitations and ensure the reliability and validity of the results.

By employing this methodology, the study aims to provide a robust and nuanced understanding of how IT is

revolutionizing the accounting industry in Iringa Municipal, offering actionable insights for stakeholders to drive digital transformation in the region.

3. RESULTS AND DISCUSSION

The results and discussion section presents the key findings of this study in relation to its specific objectives. It analyzed how block-chain-enabled solutions, including decentralized digital wallets, smart contract-driven microloans, and low-cost cross-border payment systems, integrated with existing mobile money ecosystems to empower smallholder farmers, informal traders, and women while addressing risks such as fraud and exclusion. The study also examined the socio-economic impacts of block-chain adoption, particularly its role in building trust in formal financial systems and creating inclusive growth opportunities. Additionally, infrastructural and cultural challenges, such as internet access gaps and resistance to digitization, were identified, alongside scalable, context-specific implementation models. By drawing comparisons with successful global case studies from Kenya and the Philippines, the discussion contextualized these insights within Tanzania's financial landscape. The findings aimed to inform policymakers, financial institutions, and development stakeholders on strategies to harmonize block-chain innovation with Tanzania's regulatory framework, fostering equitable financial inclusion in rural and semi-urban areas.

3.1 Integration of Block-chain-Enabled Solutions with Mobile Money Ecosystems

The adoption of digital financial tools expanded as block-chain-enabled solutions integrated with existing mobile money platforms. Transaction efficiency improved, with faster processing times and reduced costs enhancing user experience. Measures to mitigate risks, including fraud prevention and enhanced security protocols, strengthened trust in financial transactions. Additionally, interoperability between block-chain systems and mobile money services progressed, allowing for smoother and more seamless financial interactions across different platforms.

Table 1: Showing the Integration of Block-chain-Enabled Solutions with Mobile Money Ecosystems

Sub-indicators	Scale	Frequency	Percentage (%)
Adoption Rate of Block-chain Financial Tools	Very high adoption	45	30.4%
	Moderate adoption	65	43.9%
	Low adoption	38	25.7%
Transaction Efficiency Improvement	Very effective	55	37.2%

Sub-indicators	Scale	Frequency	Percentage (%)
	Somewhat effective	61	40.7%
	Not effective	32	22.1%
Risk Mitigation (Fraud Prevention & Security)	Strongly agree	51	33.8%
	Somewhat agree	60	40.7%
	Disagree	37	25.5%
Interoperability with Mobile Money Platforms	Highly compatible	42	28.4%
	Moderately compatible	68	45.9%
	Low compatibility	38	25.7%

3.1.1 Adoption Rate of Block-chain Financial Tools

The adoption of block-chain financial tools among smallholder farmers, informal traders, and women varied significantly as shown on table 1, with 45 respondents indicating very high adoption, 65 reporting moderate adoption, and 38 stating low adoption. Among those with high adoption, many highlighted the benefits of block-chain in improving financial access and security. One respondent from this group stated:

"...Block-chain technology has transformed how we handle payments, especially for those of us in rural areas who rely on mobile money. The ability to securely store and transfer funds without intermediaries has given us more control over our businesses..."

Others in this category emphasized the convenience and transparency of block-chain transactions, with one informal trader adding:

"...With block-chain, I no longer worry about transaction delays or hidden charges. Everything is instant and clear, making it easier to manage my cash flow..."

However, the 65 respondents who reported moderate adoption cited a mix of benefits and challenges. One trader explained:

"...I use block-chain wallets occasionally, but I still rely on traditional mobile money services because I don't fully understand all the features. It's useful, but more training is needed for people like me..."

Another interviewee mentioned:

"...The system is promising, but sometimes I struggle with internet connectivity, which makes it difficult to rely on block-chain for all my transactions..."

Meanwhile, the 38 respondents who reported low adoption levels expressed concerns about accessibility, digital literacy, and infrastructure limitations. A farmer noted:

"...The idea of block-chain sounds good, but many of us do not have the proper knowledge or devices to use it efficiently. Without internet access or guidance, it remains out of reach for many in our community..."

Another participant reinforced this concern by stating:

"... have heard about block-chain, but I am hesitant to use it because I don't fully understand how it works, and I fear losing my money in a system I can't control..."

These responses highlight the varying degrees of block-chain adoption within mobile money ecosystems, emphasizing the need for enhanced education, infrastructure development, and policy interventions to ensure broader financial inclusion.

3.1.2 Transaction Efficiency Improvement

The effectiveness of block-chain-enabled solutions in improving transaction efficiency was perceived differently among respondents, with 55 indicating that block-chain was very effective, 61 stating it was somewhat effective, and 32 believing it was not effective. Among those who found block-chain very effective, many emphasized its ability to facilitate faster, more secure, and cost-efficient transactions. One enthusiastic respondent noted:

"...Before using block-chain, I had to wait hours or even days for cross-border payments to process, and the fees were high. Now, transactions happen in real-time, and I can track them instantly. It has completely changed how I do business..."

Another interviewee echoed similar sentiments, stating,

"...As a small trader, I depend on quick payments to restock my goods. Block-chain has removed the delays I used to experience with mobile money services, and I no longer worry about network failures during peak hours..."

For the 60 respondents who considered block-chain somewhat effective, they acknowledged its potential but also pointed out existing limitations. One trader remarked:

"...Block-chain transactions are definitely faster and cheaper than traditional banking, but sometimes the system is too complicated for people who are not tech-savvy. I still find myself using mobile money for smaller transactions because it feels more familiar..."

Another respondent added:

"...The efficiency of block-chain depends on internet stability. When the network is strong, transactions are seamless, but when the connection is weak, delays still occur, which can be frustrating..."

However, 32 respondents felt that block-chain had not effectively improved transaction efficiency, citing challenges such as system unfamiliarity, technical difficulties, and integration issues with existing mobile money platforms. One frustrated respondent stated:

"...I tried using block-chain for payments, but I ended up losing money because I didn't fully understand how the system worked. It is not as straightforward as mobile money, and I feel like it's designed for people who already have digital financial knowledge..."

Another respondent emphasized the challenge of accessibility, saying:

"...Where I live, internet access is unreliable, and without a good connection, block-chain-based transactions can take longer than mobile money. For us, this technology is not yet practical..."

These responses highlight both the advantages and challenges of block-chain adoption for transaction efficiency. While many respondents appreciated the speed and cost-effectiveness, concerns about accessibility, digital literacy, and infrastructure gaps suggest that further improvements are needed to maximize its benefits for broader financial inclusion.

3.1.3 Risk Mitigation (Fraud Prevention & Security)

The effectiveness of block-chain-enabled solutions in mitigating risks such as fraud and security vulnerabilities received mixed reactions from respondents, with 51 strongly agreeing that block-chain significantly enhanced fraud prevention, 60 somewhat agreeing, and 37 disagreeing. Those who strongly agreed emphasized block-chain's ability to provide transparency, traceability, and security in financial transactions. One respondent, a mobile money agent, shared:

"...Before block-chain, cases of fraud were common, especially with unauthorized transactions and mobile money scams. Now, with block-chain, every transaction is recorded and cannot be altered, making it harder for fraudsters to manipulate the system..."

Another respondent, a smallholder farmer, highlighted the security benefits, stating:

"...I used to fear using digital money because I had heard stories of people losing their funds to hackers. But with block-chain, I can verify every transaction, and no one can tamper with my records. I feel much safer now..."

Among the 60 respondents who somewhat agreed, many acknowledged block-chain's security potential but also pointed out certain limitations. One informal trader explained:

"...Block-chain does help reduce fraud because transactions are recorded and cannot be changed, but not everyone understands how it works. Some people still fall victim to scams because they do not know how to verify transactions properly..."

Another interviewee added:

"...Security is better than before, but there are still risks. Hackers are always looking for new ways to bypass security, and some block-chain platforms are not yet fully protected from cyber threats..."

However, 37 respondents disagreed, expressing concerns about block-chain's accessibility, user knowledge, and adaptability in fraud prevention. One skeptical respondent argued:

"...Block-chain may be secure in theory, but in reality, many users do not fully understand how to protect their private keys. If someone gains access to my key, they can take all my money, and there is no way to recover it..."

Another respondent pointed out integration challenges, stating:

"...Not all mobile money platforms are fully connected to block-chain systems, and this creates loopholes where fraud can still happen. Without proper regulation and education, block-chain alone cannot completely eliminate financial fraud..."

These varying perspectives highlight both the strengths and challenges of block-chain in mitigating fraud and enhancing security. While many respondents recognized its transparency and immutability as key factors in preventing fraud, concerns about digital literacy, cyber security threats, and integration gaps suggest that further education and regulatory frameworks are necessary to maximize block-chain's potential in securing financial transactions.

3.1.4 Interoperability with Mobile Money Platforms

The level of interoperability between block-chain-enabled solutions and existing mobile money platforms was a key concern among respondents, with varying perspectives on its effectiveness. Out of those interviewed, 42 respondents (28.4%) believed that block-chain solutions were highly compatible with mobile money systems, 68 respondents (45.9%) found them to be moderately compatible, while 38 respondents (25.7%) expressed concerns over low compatibility. Those who considered block-chain to be highly compatible emphasized its seamless integration with mobile money services, highlighting improvements in transaction efficiency and security. One respondent, a fintech entrepreneur explained:

"...Block-chain has greatly improved the way mobile money operates by ensuring transparency and eliminating

middlemen in transactions. The integration has made cross-border payments much faster and more secure...

Another interviewee, a mobile money agent, shared:

"...I have seen how block-chain interacts well with digital wallets, reducing fraud and allowing my customers to make direct transactions without unnecessary delays..."

However, the majority of respondents (68, or 45.9%) found block-chain solutions to be only moderately compatible with mobile money platforms. Many pointed out that while block-chain had the potential to enhance mobile transactions, its adoption was still in progress, and some financial service providers had yet to fully integrate it. One informal trader noted:

"...I can send money to suppliers faster than before, but sometimes, the transaction takes longer because not all mobile money networks are fully connected to block-chain services..."

Another interviewee, a smallholder farmer, mentioned:

"...The system works well, but sometimes I have to rely on traditional mobile money services because not all block-chain wallets are recognized by local vendors..."

On the other hand, 38 respondents (25.7%) believed that block-chain solutions had low compatibility with mobile money platforms, citing integration challenges and limited accessibility. Some respondents expressed concerns over technical barriers, lack of uniformity in mobile money services, and regulatory restrictions. A businesswoman dealing in cross-border trade remarked:

"...I wanted to use block-chain for my transactions, but my customers in some countries could not access the same service. It is frustrating when different mobile money platforms do not work well together...."

Another respondent, a local shop owner, shared a similar sentiment:

"...Block-chain is a great innovation, but not all mobile money platforms accept it. Some banks and service providers are still hesitant to fully adopt it, which makes it difficult for people like me to trust the system completely..."

Overall, while block-chain has made progress in integrating with mobile money platforms, varying levels of compatibility remain a challenge. Many respondents acknowledged its potential to enhance mobile transactions, but factors such as uneven adoption, network limitations, and regulatory barriers continue to affect full interoperability.

3.2 Socio-Economic Impacts of Block-chain Adoption

The implementation of digital financial solutions brought significant socio-economic changes, particularly in expanding access to financial services, fostering trust in formal institutions, promoting gender inclusion, and enhancing economic opportunities. Many individuals who were previously unbanked gained access to secure and transparent financial tools, which improved their ability to save, invest, and conduct business transactions. Respondents expressed that the technology increased their confidence in digital financial services, as they perceived greater security and accountability in transactions. Women, in particular, benefited from improved financial independence, with several reporting increased participation in economic activities due to easier access to credit and secure savings platforms. Additionally, many small-scale traders and farmers experienced business growth, as streamlined financial processes enabled them to manage their income more efficiently and expand their enterprises.

Table 2: Showing the Socio-Economic Impacts of Block-chain Adoption

Sub- Indicator	Scales	Frequency	Percentage (%)
Financial Inclusion Growth	Significant increase	60	40.5%
	Moderate increase	55	37.2%
	No significant change	33	22.3%
Trust in Formal Financial Systems	High trust	58	39.2%
	Moderate trust	60	40.5%
	Low trust	30	20.3%
Economic Empowerment of Beneficiaries	Strong impact	55	37.2%
	Moderate impact	63	42.6%
	Minimal impact	30	20.2%
Gender Inclusion in Financial Services	Highly improved	50	33.8%
	Moderately improved	62	41.9%
	No improvement	36	24.3%

3.2.1 Financial Inclusion Growth

The adoption of block-chain-enabled financial solutions significantly impacted financial inclusion, with many respondents acknowledging its role in expanding access to financial services. A total of 60 respondents (40.5%) reported a significant increase in financial inclusion, emphasizing that block-chain technology allowed them to access banking services for the first time. One respondent stated:

"...Before this technology, I had no formal way to save or transfer money, but now I can do everything from my mobile phone without the need for a bank branch...."

Another participant added:

"...Accessing credit has become much easier because of digital verification, and I no longer have to rely on informal lenders who charge high-interest rates..."

Meanwhile, 55 respondents (37.2%) noted a moderate increase in financial inclusion, highlighting that while block-chain tools had improved accessibility, challenges such as digital literacy and connectivity still posed barriers. One trader remarked, *"I have seen improvements, but some people in remote areas still struggle with internet access, which limits their ability to fully use these services..."*

Another farmer observed,

"...Using digital wallets has helped me receive payments more efficiently, but I am still learning how to use all the features..."

However, another respondent reported no significant change in financial inclusion, citing concerns about accessibility, affordability, and familiarity with block-chain technology. One individual explained:

"...The technology seems promising, but many people in my community do not understand how to use it, making it difficult for them to fully benefit..."

Another respondent mentioned:

"Even though block-chain is available, some businesses and service providers still do not accept digital transactions, so cash remains the primary mode of exchange..."

Overall, while the majority of respondents experienced positive changes in financial access due to block-chain adoption, some still faced barriers that required further efforts in education, infrastructure development, and policy support to ensure inclusive financial growth.

3.2.2 Trust in Formal Financial Systems

The adoption of block-chain technology had a noticeable impact on trust in formal financial systems, with many respondents acknowledging its role in increasing transparency and security in financial transactions. A total of 58 respondents (39.2%) expressed a high level of trust in formal financial systems due to block-chain's decentralized and tamper-proof nature. One respondent explained:

"...Before, I was always skeptical about using banks because of hidden fees and delays, but with block-chain, I can see every transaction in real time, and nothing can be altered without my knowledge..."

Another participant added, *"Block-chain has made me feel more secure when saving money digitally because I know my funds cannot just disappear due to errors or fraud."*

Meanwhile, 60 respondents (40.5%) reported moderate trust, stating that while block-chain had improved transparency, concerns about regulatory oversight and widespread adoption remained. A business owner noted:

"...I appreciate the security block-chain provides, but I still worry about regulations and whether traditional financial institutions will fully accept this technology..."

Similarly, another trader mentioned,

"...Block-chain has made financial transactions more reliable, but many people still hesitate to trust digital platforms completely, especially in rural areas where cash is dominant..."

On the other hand, 30 respondents (20.3%) expressed low trust in formal financial systems despite block-chain's introduction, citing concerns about accessibility, technical challenges, and the need for stronger institutional backing. One respondent remarked,

"...Block-chain sounds promising, but I don't fully trust it because I don't understand how it works, and I prefer dealing with physical money..."

Another participant stated,

"...Even though block-chain provides security, I still feel uneasy about putting all my financial transactions in a system that I have little control over..."

Overall, while block-chain adoption contributed to increasing trust in formal financial systems for many respondents, a significant portion still harbored doubts, highlighting the need for greater education, regulatory clarity, and widespread acceptance to ensure broader trust in digital financial services.

3.2.3 Economic Empowerment of Beneficiaries

The adoption of block-chain technology had a noticeable impact on the economic empowerment of beneficiaries, with varying degrees of influence reported by respondents. A total of 55 respondents (37.2%) acknowledged that block-chain had a strong impact on their financial growth, citing improved access to capital, secure transactions, and greater business opportunities. One smallholder farmer stated,

"...Before block-chain, I struggled to get loans because I lacked a credit history. Now, with block-chain-based microloans, I have been able to expand my farm and increase my profits..."

Another respondent, an informal trader, shared:

"...Block-chain has allowed me to send and receive payments quickly and securely, even from customers outside my town. This has boosted my income and business growth..."

Meanwhile, 63 respondents (42.6%) reported a moderate impact, noting that while block-chain had provided financial benefits, challenges such as limited adoption, lack of awareness, and technical difficulties still persisted.

A female entrepreneur explained:

"...The transparency in transactions has made it easier for me to track my earnings and expenses. However, not all my customers use block-chain-based payments, which means I still have to rely on cash and traditional banking..."

Similarly, another respondent remarked: *"...I have seen improvements in financial security, but block-chain solutions need to be more user-friendly for people like me who are not very tech-savvy..."*

On the other hand, 30 respondents (20.2%) stated that block-chain had a minimal impact on their economic empowerment, primarily due to accessibility issues and skepticism about the technology. One participant commented:

"...I still prefer using cash because block-chain applications seem complicated, and I don't fully trust them yet..."

Another trader noted:

"...Many people in my community don't even have smartphones or stable internet access, so block-chain remains out of reach for us..."

Overall, while block-chain adoption played a significant role in improving financial inclusion and business growth for many beneficiaries, its full potential was yet to be realized due to barriers such as limited infrastructure, digital literacy gaps, and the slow pace of adoption among the wider population.

3.2.4 Gender Inclusion in Financial Services

The adoption of block-chain technology significantly influenced gender inclusion in financial services, with varying levels of impact reported by respondents. A total of 50 respondents (33.8%) acknowledged that block-chain had *highly improved* women's access to financial tools and opportunities, citing increased financial independence, secure transactions, and access to credit. One female respondent, a small business owner, shared:

"...Before block-chain, I had no access to formal banking, and getting a loan was almost impossible without collateral. Now, I can receive digital payments and even access microloans, which has helped me expand my business..."

Another woman engaged in informal trading stated:

"...With block-chain, I no longer have to rely on intermediaries who used to charge high fees. I can save and send money directly, which gives me more control over my finances..."

Meanwhile, 62 respondents (41.9%) reported that gender inclusion had been *moderately improved* through block-chain-based financial services. While they acknowledged progress, they also highlighted persisting challenges such as

digital literacy barriers and societal norms that still limited women's participation in financial systems. One respondent noted:

"...I now have access to digital wallets, but many women in my community still struggle with understanding how to use block-chain-based financial services. More training and awareness are needed..."

Another woman added:

"...Block-chain has given me financial security, but some men still control household finances, making it hard for many women to fully benefit from these advancements..."

On the other hand, 36 respondents (24.3%) stated that block-chain adoption had *not improved* gender inclusion in financial services, citing accessibility issues and a lack of widespread adoption among women. One respondent expressed skepticism, saying:

"...In my area, most women still rely on traditional cash transactions because they do not own smartphones or have stable internet access..."

Another participant added: *"...The concept of block-chain is still foreign to many women, and without proper education, it remains an exclusive tool rather than an inclusive one..."*

Overall, while block-chain played a crucial role in enhancing financial inclusion for women, its impact remained uneven due to infrastructural, educational, and cultural barriers that needed to be addressed for broader and more equitable adoption.

3.3 Infrastructural and Cultural Challenges to Block-chain Adoption

The adoption of new financial technologies faced several infrastructural and cultural challenges that influenced accessibility and effectiveness. Limited internet and mobile connectivity affected users, particularly in rural areas, where network coverage and affordability remained significant barriers. Many individuals struggled with digital literacy and lacked awareness of how the technology functioned, which hindered widespread adoption. Some respondents resisted technological change due to concerns about complexity, trust, and the perceived risks of transitioning from traditional financial systems. Additionally, regulatory and institutional barriers, including unclear policies and slow adaptation by financial authorities, created uncertainty and slowed the integration process.

Table 3: Infrastructural and Cultural Challenges to Block-chain Adoption

Sub Indicator	Scale	Frequency	Percentage (%)
Internet & Mobile Accessibility	Highly accessible	40	27.0%
	Moderately accessible	65	43.9%
	Poor accessibility	43	29.1%
Digital Literacy & Block-chain Awareness	High understanding	38	25.7%
	Moderate understanding	66	44.6%
	Low understanding	44	29.7%

Sub Indicator	Scale	Frequency	Percentage (%)
Resistance to Technological Change	High resistance	55	37.2%
	Moderate resistance	58	39.2%
	Low resistance	35	23.6%
Regulatory & Institutional Barriers	Major obstacles	52	35.1%
	Some obstacles	60	40.5%
	No major obstacles	36	24.3%

3.3.1 Internet & Mobile Accessibility

Many respondents highlighted the critical role that internet and mobile accessibility played in the adoption of block-chain-based financial solutions. While 40 respondents (27.0%) stated that access to mobile networks and the internet was highly available in their areas, a larger group of 65 respondents (43.9%) indicated that accessibility was only moderate, often inconsistent and dependent on location. Meanwhile, 43 respondents (29.1%) described the accessibility as poor, citing unreliable networks, high data costs, and a lack of infrastructure in rural and remote areas.

One respondent who experienced strong connectivity stated:

"...In urban centers, internet access is rarely a problem, and mobile services are reliable. I have had no issues using block-chain-enabled financial tools..."

However, others shared contrasting experiences. A trader from a semi-urban region explained:

"...The network works well during the day, but in the evenings or during bad weather, transactions become slow or even fail. It makes it difficult to trust the system completely..."

For those facing severe accessibility issues, the challenges were even greater. A smallholder farmer from a rural area remarked:

"...I have to walk several kilometers just to find a good signal. Many people in my community cannot afford the smartphones needed for these digital financial services." Another participant emphasized the financial burden, saying, "Even when internet is available, the cost of data is too high. Many of us have to choose between buying mobile data and meeting daily needs..."

Overall, while urban users benefited from strong internet and mobile accessibility, those in rural and remote areas continued to struggle with connectivity challenges, limiting their ability to fully engage with Block-chain-based financial solutions.

3.3.2 Digital Literacy & Block-chain Awareness

Many respondents emphasized that a lack of digital literacy and awareness of Block-chain technology significantly influenced its adoption. While 38 respondents (25.7%) demonstrated a high understanding of Block-chain -based financial tools, the majority, 66 respondents (44.6%), admitted to having only a moderate understanding, often

relying on external assistance when engaging with Block-chain platforms. Meanwhile, 44 respondents (29.7%) acknowledged having a low understanding, struggling with the technical aspects and security features of Block-chain -enabled financial solutions.

A business owner who had a strong grasp of block-chain technology explained:

"...I took the time to learn about block-chain and how it works. Now, I can confidently use it to make secure transactions and even help others understand it better..."

However, many participants admitted that they had limited exposure to the technology. One informal trader shared, *"...I have heard about block-chain, but I don't fully understand how it works. I only know that it's supposed to make transactions safer..."*

For those with low levels of digital literacy, the challenge was even more pronounced. A smallholder farmer remarked:

"...I still struggle to use mobile banking properly, so block-chain is something I have never even tried. There needs to be more training for people like us..."

Similarly, a female respondent from a rural area stated:

"...Most women in my community don't have the technical skills to use these systems. We rely on family members to help, but that means we are not fully in control of our finances..."

Overall, while some individuals demonstrated a solid understanding of block-chain, a significant portion of respondents required further education and support to use these financial tools effectively. Many called for targeted training programs to bridge the knowledge gap and ensure broader adoption of block-chain-based financial solutions.

3.3.3 Resistance to Technological Change

Many respondents expressed concerns that resistance to technological change had significantly slowed the adoption of block-chain-enabled financial solutions. Among those interviewed, 55 respondents (37.2%) indicated that there was high resistance, attributing it to a lack of trust in new digital systems, fear of losing control over traditional financial processes, and skepticism about block-chain's benefits. Meanwhile, 58 respondents (39.2%) observed moderate resistance, particularly among individuals and businesses who were open to technological advancements but hesitant due to uncertainties about security, usability, and regulatory compliance. A smaller group, 35 respondents (23.6%), reported low resistance, mainly among younger and tech-

savvy individuals who readily embraced block-chain innovations.

One business owner shared:

"...Many people in my community are afraid to trust block-chain technology because they do not fully understand how it works. They still believe that physical cash transactions are the only secure way to conduct business..."

Similarly, a financial consultant noted:

"...Older business owners and informal traders are particularly resistant. They have operated in cash-based systems for decades, and asking them to suddenly adopt a digital financial platform based on block-chain seems unrealistic..."

Some respondents emphasized that cultural attitudes toward technology played a role in the resistance. A participant from the banking sector explained:

"People still associate block-chain with cryptocurrency scams, so there is a deep-rooted mistrust. Even when we explain that block-chain can be used for secure financial transactions beyond cryptocurrencies, many remain skeptical..."

Another respondent from the agricultural sector observed, *"Smallholder farmers and rural traders have shown little interest in adopting block-chain solutions. Many of them believe that technology is too complex and does not directly benefit their daily transactions."*

However, a few respondents reported lower levels of resistance, particularly among younger business owners and digital entrepreneurs. One fintech startup founder shared:

"...Younger people are more open to block-chain because they already use mobile money and digital banking services. Once they see the benefits, such as faster transactions and reduced fraud, they become more willing to adopt it..."

Despite these varying perspectives, most respondents agreed that overcoming resistance to block-chain adoption required more education, awareness, and hands-on training. One participant recommended:

"...If we want people to embrace block-chain, we need to provide real-life examples and training programs that show them how it works in their everyday financial activities..."

Another suggested: *"...Government and financial institutions should launch awareness campaigns to address misconceptions and build trust in block-chain-based systems..."*

Overall, the study revealed that while some individuals and businesses were gradually warming up to block-chain-enabled financial solutions, widespread adoption remained hindered by cultural resistance, lack of awareness, and deep-rooted trust issues. Many respondents emphasized the need for targeted education efforts and regulatory clarity to ease the transition to blockchain-based financial systems.

3.3.4 Resistance to Technological Change

Many respondents highlighted that regulatory and institutional barriers played a significant role in shaping the adoption of block-chain-enabled financial solutions. Among those interviewed, 52 respondents (35.1%) described these

barriers as major obstacles, citing unclear regulations, slow policy adaptation, and restrictive financial policies. Meanwhile, 60 respondents (40.5%) acknowledged facing some obstacles, particularly in compliance requirements and institutional hesitancy, while 36 respondents (24.3%) believed there were no major regulatory challenges in their use of block-chain technology.

A respondent working in the fintech sector explained:

"...Regulatory uncertainty has been one of the biggest challenges. The government has not provided clear guidelines on how block-chain-based financial solutions should operate, which makes businesses hesitant to invest in the technology..."

Similarly, another participant from the financial services industry noted:

"...We have seen cases where authorities delay approving block-chain-based platforms because they are not well understood. This discourages innovation and slows down adoption..."

Some respondents expressed concerns about institutional resistance, with one small business owner stating:

"...Traditional banks are not fully embracing block-chain solutions because they see them as a disruption to their control over financial transactions. This makes it harder for people like us to integrate block-chain into our businesses..."

Another participant, a mobile money agent, shared: *"...Even when we try to use block-chain-based platforms, we run into issues with compliance. Financial institutions often require extensive documentation, which makes it difficult for small traders and informal business owners to participate..."*

On the other hand, a minority of respondents believed that regulatory frameworks had not posed significant challenges. One entrepreneur who had successfully integrated block-chain into their business explained: *"...As long as you follow the basic financial regulations, block-chain transactions can still operate smoothly. The key is understanding the existing policies and working within them..."*

Overall, while some respondents managed to navigate the regulatory landscape effectively, the majority emphasized that unclear policies, institutional hesitancy, and restrictive financial regulations hindered the widespread adoption of block-chain-enabled solutions. Many called for proactive government engagement and clearer regulatory frameworks to support innovation and ensure that block-chain technology could thrive in the financial ecosystem.

4. CONCLUSION AND RECOMMENDATIONS

The study revealed that while block-chain-enabled solutions have the potential to transform mobile money ecosystems, their adoption remains influenced by several socio-economic, infrastructural, and cultural factors. Key findings indicated that financial inclusion has moderately improved with block-chain adoption, particularly for previously unbanked populations, women, and small-scale traders. However, trust in formal financial systems varied, with some respondents expressing confidence in block-chain's transparency and security, while others remained skeptical. Additionally,

economic empowerment was evident among early adopters who leveraged block-chain for secure, efficient transactions, but regulatory and institutional challenges continued to hinder widespread implementation. Despite improvements in financial accessibility and efficiency, issues such as resistance to technological change and low digital literacy levels limited the full realization of block-chain's benefits. Furthermore, the study highlighted that interoperability between block-chain and mobile money platforms played a crucial role in determining adoption rates. While some respondents praised block-chain's effectiveness in reducing fraud and transaction costs, others cited concerns regarding regulatory uncertainties and infrastructure gaps, particularly in rural areas. Resistance to technological change emerged as a significant barrier, with many individuals and businesses hesitant to shift from traditional financial systems to block-chain-based solutions. To maximize the benefits of block-chain integration, stakeholders including governments, financial institutions, and technology developers must invest in digital literacy programs, regulatory frameworks, and infrastructure improvements. Dealing with these challenges through education, awareness campaigns, and policy reforms will be essential in fostering broader adoption and ensuring that block-chain contributes to an inclusive, efficient, and secure financial ecosystem.

The study recommends that policymakers, financial institutions, and technology developers collaborate to enhance block-chain adoption by addressing key infrastructural, regulatory, and cultural barriers. Governments should establish clear legal frameworks and regulatory guidelines to foster trust and encourage investment in block-chain-enabled financial solutions. Additionally, efforts should be made to improve internet and mobile accessibility, particularly in rural areas, to ensure seamless integration with mobile money platforms. Digital literacy programs and awareness campaigns should be prioritized to educate users, especially small-scale traders and women, on the benefits and functionalities of block-chain technology. Financial institutions should work towards enhancing interoperability between block-chain and existing financial systems to improve transaction efficiency and security. Furthermore, addressing resistance to technological change through targeted community engagement and stakeholder dialogues will be crucial in promoting a smooth transition from traditional financial systems to block-chain-based solutions.

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