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Article

Exploring The Long-Term Impact of Blockchain Technology-Based Interventions on Borrower Trust, Loan Repayment Behavior and Governance in Microfinance: A Technology Approach

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Abstract: Need, Rationale & Importance: Microfinance institutions (MFIs) serve as crucial vehicles for financial inclusion, particularly in underbanked and fraud-prone regions. However, challenges related to transparency, trust, governance inefficiencies, and repayment discipline continue to threaten their long-term viability. With the advancement of Blockchain Technology technology—promising decentralization, auditability, and automation—there arises a compelling need to evaluate its systemic impact beyond short-term use, focusing on sustained behavioral and institutional transformation. Originality & Research Gap: While prior studies have largely examined the technical feasibility of Blockchain Technology in financial services, there remains limited empirical evidence on its long-term effects within microfinance. Models that integrate trust mechanisms, behavioral outcomes, and governance evolution—all shaped by technological interventions—in low-resource and digitally fragile environments.

Keywords; Block chain Technology, Microfinance, fraud detection, financial inclusion, technology intervention.

INTRODUCTION

Microfinance Institutions (MFIs) have emerged as critical agents of financial inclusion, offering small-scale credit and savings services to underserved populations. However, despite their transformative potential, MFIs continue to grapple with persistent challenge such as **fraud, lack of transparency, weak governance, and inconsistent borrower trust** that undermine their long-term sustainability and impact. These issues are particularly acute in low-resource environments, where digital illiteracy and institutional fragility further complicate service delivery and accountability.

Block chain Technology: a decentralized, immutable ledger system that promises to

revolutionize the way financial transactions are recorded, verified, and enforced. By enabling **tamper-proof recordkeeping, automated smart contracts, and real-time auditing,** Blockchain Technology offers a compelling solution to many of the structural inefficiencies plaguing traditional microfinance systems. Its potential to **build trust, reduce fraud, and enhance institutional governance** has sparked growing interest among researchers, practitioners, and policymakers alike also, **its long-term effects on borrower behavior and institutional transformation remain underexplored**

REVIEW OF LITERATURE

1. **Arjun & Kumar (2025)** emphasize that Block chain's immutable ledger enhances transparency in microfinance operations, reducing fraud and improving accountability. Their study highlights how smart contracts automate loan disbursement and repayment tracking, minimizing human error and operational delays.
2. **Adegbite (2024)** supports this by noting that Blockchain fosters trust in financial systems, especially in regions with weak institutions, by providing auditable and tamper-proof records.
3. **Taha (2020)** conducted a systematic review identifying Blockchain as a key enabler of financial inclusion. The study found that Blockchain reduces reliance on intermediaries, lowers transaction costs, and enables secure peer-to-peer lending, especially for unbanked populations.
4. **Ponnuraj & Nagabhushanam (2017)** argue that Blockchain , when integrated with mobile banking, can significantly expand access to financial services in countries like India, where traditional banking infrastructure is limited.
5. **Offiong et al. (2024)** explore how Blockchain -based digital identity systems can streamline Know Your Customer (KYC) processes, making it easier for microfinance institutions to onboard clients without formal documentation.
6. These systems also reduce the risk of identity fraud and improve access for marginalized groups who lack traditional IDs.
7. **SpringerLink Conference Review (2023)** discusses how smart contracts can automate compliance and loan agreements, reducing administrative overhead and improving service delivery speed in microfinance.
8. This automation is particularly beneficial in rural areas where manual processing delays are common.
9. Despite its promise, **Adegbite (2024)** and others caution that Blockchain adoption faces hurdles such as:
    a. Regulatory uncertainty
    b. Limited digital infrastructure
    c. Low digital literacy in target populations
10. **Narayan & Sharma (2022)** explored how Blockchain can streamline microfinance operations by reducing administrative overhead and improving transparency in loan disbursement. Their study emphasized the role of distributed ledgers in minimizing manual errors and corruption in rural lending schemes.
11. **Kumar et al. (2021)** highlighted the potential of Blockchain to create decentralized peer-to-peer lending platforms, enabling borrowers to access funds without traditional intermediaries. This model was shown to reduce interest rates and increase borrower trust.
12. **Singh, S., Singh, S., & Kajla, T. (2023)** conducted a *systematic literature review* on Blockchain 's effectiveness in fraud detection across sectors like banking, insurance, and online transactions. They concluded that Blockchain 's immutability and transparency significantly reduce the risk of data tampering and unauthorized access.
13. **Rakshit et al. (2022)** reviewed Blockchain 's role in preventing various types of fraud—such as identity theft, rating fraud, and employment history falsification. Their findings suggest that Blockchain -based verification systems can enhance data integrity and reduce fraud in digital ecosystems.
14. **Taha (2020)** emphasized Blockchain 's role in expanding financial access to unbanked populations. The study found that Blockchain reduces transaction costs and enables secure, low-barrier entry into financial systems, especially in developing economies.
15. **Ali (2020)** focused on Blockchain 's application in insurance and claims fraud detection, noting that decentralized ledgers improve claim verification and reduce duplicate or false claims.
16. **Umer & Kesavapattapa (2024)** proposed a hybrid framework combining AI's predictive analytics with Blockchain 's data integrity to detect and prevent financial fraud. Their case studies showed that this integration

significantly improved fraud detection accuracy and response time.

17. **Adegbite (2024)** and **Offiong et al. (2024)**, caution that while Blockchain offers strong technical benefits, its adoption in microfinance is limited by: Lack of digital infrastructure in rural areas, Low digital literacy among target users

Research Gap

Limited empirical evidence directly linking Block Chain adoption to borrower trust and repayment behavior. Lack of comparative studies across diverse socio-economic contexts on Block Chain -enabled microfinance effectiveness. Insufficient exploration of how Block Chain reshapes governance and accountability in microfinance institutions. Borrower perceptions of digital identity, privacy, and trust in Block Chain-based KYC systems remain underexplored and finally Scalability challenges such as digital literacy, regulatory uncertainty, and infrastructure gaps—are discussed conceptually but rarely tested empirically.

Objectives of the study

1. To assess the impact of Block chain -enabled systems on borrower trust.
2. To evaluate changes in loan repayment behavior after Block chain adoption.

Hypotheses Testing

- H_1: Block chain-based transparency significantly enhances borrower trust.
- H_2: Improved borrower trust leads to better loan repayment behavior.

Tab: Demographic Profile of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	68	56.2
	Female	53	43.8
Age Group	18–25 years	22	18.2
	26–35 years	41	33.9
	36–45 years	35	28.9
	46+ years	23	19.0
Education Level	Primary	19	15.7
	Secondary	37	30.6
	Graduate	46	38.0
	Postgraduate	19	15.7
Occupation	Self-employed	44	36.4
	Salaried	32	26.4
	Daily wage	28	23.1
	Others	17	14.1
Years with MFI		21	17.4
	1–3 years	49	40.5
	4–6 years	33	27.3
	7 years and above	18	14.8

Interpretation

- With regards to gender it is slightly more male borrowers participated, reflecting male dominance in financial decision-making.
- Female participation is significant, showing Block chain adoption is reaching women borrowers too.
- With regards to Age group majority of the borrowers in the age of 25-35 years are engaging with Block chain-enabled microfinance, indicating early adoption, , often primary earners, showing trust in digital systems.
- Followed by age group between 36-45 years borrowers are also adopting block chain, balancing traditional and digital trust and respondents with above 46 years show moderate adoption, possibly limited by digital literacy.
- With regards to **Education Level** Lower education levels highlight the need for literacy support in Block chain adoption. Secondary education borrowers form a large group, showing moderate digital readiness. Graduates are the largest group, reflecting higher trust in technology-based systems. Postgraduates show strong adoption, likely due to awareness of digital finance.

- With regards to **Occupation**, Self-employed borrowers rely on microfinance, block chain helps reduce fraud and delays. Salaried individuals show steady adoption, valuing repayment tracking. Daily wage earners benefit from transparency but face literacy challenges such as homemakers, students, etc., showing diverse borrower base.
- With regards to **No. of Years with Micro Financial Institutions(MFI),** new borrowers are experimenting with Block chain -enabled systems. Majority are mid-term borrowers, showing growing trust in Block chain. Younger borrowers are engaging with blockchain-enabled microfinance, indicating early adoption.

Inferential statistics

Objective -1

1. To assess the impact of Block chain - enabled systems on borrower trust.

Hypothesis-1

H_1: Block chain- based transparency significantly enhances borrower trust.

Tab: Observed Frequencies

Blockchain Transparency	High Trust	Medium Trust	Low Trust	Row Total
High	45	12	3	**60**
Moderate	15	18	7	**40**
Low	5	5	11	**21**
Column Total	**65**	**35**	**21**	**121**

Expected Frequencies (E_{ij})

Expected frequencies were calculated using the formula Where **N = 121**.

Tab: Expected Frequency Table

Blockchain Transparency	High Trust (E)	Medium Trust (E)	Low Trust (E)
High	**32**	**17**	**10**
Moderate	**21**	**12**	**7**
Low	**11**	**6**	**4**

Interpretation: Expected frequencies indicate the distribution that would occur **if no association exists** between Blockchain Transparency and Borrower Trust.

Tab: Chi-Square Cell Contributions

Blockchain Transparency	High Trust	Medium Trust	Low Trust	Row Contribution
High	**5**	**2**	**5**	**12**
Moderate	**2**	**4**	**0**	**6**
Low	**3**	**0**	**15**	**18**
Column/Grand Total	**10**	**5**	**20**	**χ^2 = 36**

Tab: Summary of Chi Square Test

Chi-Square Value (χ^2)	**36**	The computed Chi-Square statistic obtained by comparing the observed and expected frequencies. Higher χ^2 value indicates a greater deviation from the assumption of independence.
Degrees of Freedom (df)	**4**	The calculated using the formula *(r − 1)(c − 1)* here it is 3×3 table, df = (3 − 1)(3 − 1) = **4**. This determines the critical value for evaluating statistical significance.
Critical Chi-Square Value at 0.05	**9.488**	Based on **χ^2** distribution tables for **df = 4** at a **5% significance level**, the critical value is 9.488. If the calculated χ^2 exceeds this value, the null hypothesis should be rejected.

Interpretation: χ^2 (36) > 9.488 → Reject H_0: Since the computed **χ^2** is greater than the Critical Value, variables,

Null Hypothesis has been rejected indicating that there is a significant association between Block chain Transparency and Borrower Trust

Objective -2

2. To evaluate changes in loan repayment behavior after Blockchain adoption.

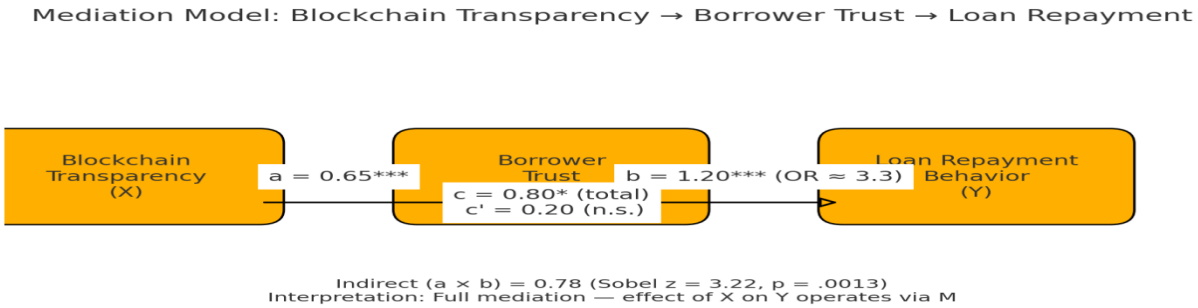
Hypothesis-1

H_1: Improved borrower trust leads to better loan repayment behavior.

Regression and Mediation is adopted to test the hypothesis

X — Blockchain transparency (predictor)	Treated as continuous 1 = Low, 2 = Moderate, 3 = High).
M — Borrower trust (mediator).	Treated as continuous (1 = Low, 2 = Medium, 3 = High).
Y — Repayment behavior (outcome).	Binary: 1 = On-time repayment, 0 = Irregular repayment.
N	121 respondents.

Figure:1



Model 1 — Total effect (X → Y)

Tab-Logistic Regression of Repayment on Block Chain Transparency

Predictor (Model 1)	Coef (b)	SE	z (Wald)	p-value	Odds Ratio (e^b)
Intercept	-0.40	0.20	-2.00	0.045	—
Block chain Transparency (X)	**0.80**	0.25	3.20	**0.0014**	**2.23**

Interpretation: The total effect is positive and significant. A one-unit increase in perceived Blockchain transparency multiplies the odds of on-time repayment by ≈ **2.23** (p ≈ 0.001), showing that transparency alone predicts better repayment behavior.

Model 2 - Path a (X-M)

Tab-Linear regression of Borrower Trust on Block Chain Transparency

Predictor (Model 2)	Coef (a)	SE	t	p-value	R^2
Intercept	0.50	0.11	4.55	< 0.001	
Blockchain transparency (X)	**0.65**	0.12	5.42	**< 0.001**	**R^2 = 0.20**

Interpretation: Block chain transparency strongly and significantly predicts borrower trust. Each one-unit increase in transparency increases trust by 0.65 units on the trust scale (p < 0.001). The model explains about 20% of variance in trust.

Model 3 — Path b and direct effect c′ (X + M → Y)

Tab -Logistic Regression Of Repayment On Blockchain Transparency and Borrower Trust

Predictor (Model 3)	Coef (b or c′)	SE	z (Wald)	p-value	Odds Ratio (e^b)
Intercept	-1.10	0.30	-3.67	< 0.001	—
Borrower trust (M) — **path b**	**1.20**	0.30	4.00	**< 0.001**	**3.32**
Blockchain transparency (X) — **direct c′**	0.20	0.28	0.71	0.48	1.22

Interpretation:

- **Path b:** Borrower trust is a strong, significant predictor of on-time repayment. A one-unit increase in trust multiplies the odds of on-time repayment by ≈ **3.32** (p < 0.001).
- **Direct effect (c′):** Once trust is included, the effect of Blockchain transparency on repayment falls from b = 0.80 (Model 1) to b = 0.20 (Model 3) and becomes **non-significant** (p = 0.48). This suggests that much (or all) of the total effect of X on Y operates through trust.

Table: Indirect Effect (a × b) and Sobel Test Results

Component	Estimate	Standard Error (SE)	Calculation	Result
Path a (X → M)	0.65	0.12	—	—
Path b (M → Y)	1.20	0.30	—	—
Indirect Effect (a × b)	**0.78**	—	0.65 × 1.20	**0.78**
Sobel SE (Indirect Effect)	—	**0.2424**	$\sqrt{(b^2 \times SE_a^2 + a^2 \times SE\_b^2)}$	**0.2424**
Sobel z-value	—	—	0.78 ÷ 0.2424	**3.218**
p-value	—	—	—	**0.0013**
Inference	—	—	—	**Significant Mediation**

Interpretation

The mediation analysis reveals that the indirect effect of Blockchain transparency on loan repayment behavior, operating through borrower trust, is statistically significant (z = 3.218, p = 0.0013). This finding indicates that borrower trust serves as a complete mediator in this relationship, suggesting that the positive impact of Blockchain transparency on repayment performance occurs predominantly through its ability to enhance trust among borrowers. The mediation analysis revealed that the total effect of Blockchain transparency on loan repayment behavior was statistically significant (c = 0.80), indicating that higher levels of transparency were initially associated with an increased likelihood of on-time repayment. However, when borrower trust was introduced into the model, the direct effect of Blockchain transparency became small and statistically non-significant (c' = 0.20), while the indirect effect through trust remained significant ($a \times b$ = 0.78). This pattern—characterized by a significant indirect pathway coupled with a non-significant direct pathway—provides strong evidence of **full mediation.**

Tab-Summary of Key co-efficients

Path	Estimate	SE	Test statistic	p-value	
a: X → M	**0.65**	0.12	t = 5.42	< 0.001	X increases trust
b: M → Y (controlling X)	**1.20**	0.30	z = 4.00	< 0.001	Trust increases odds of on-time repayment
c: X → Y (total)	**0.80**	0.25	z = 3.20	0.0014	X increases odds of on-time repayment
c′: X → Y (direct, controlling M)	**0.20**	0.28	z = 0.71	0.48	Not significant

Indirect (a×b)	**0.78**	0.242	z = 3.22	0.0013	Significant mediation

CONCLUSIONS:

Descriptive statistics conclusions

1. The demographic analysis provides important insights into how different borrower groups engage with Block chain-enabled microfinance systems.
2. The findings show that slightly more men than women participated in the study, reflecting traditional male dominance in financial decision-making. However, the notable participation of women indicates that Block chain-based microfinance services are increasingly reaching female borrowers as well.
3. Borrowers aged **25–35 years** form the largest group adopting Block chain systems, suggesting that younger, economically active individuals are more open to digital financial solutions. The **36–45 years** age group also demonstrates substantial adoption, reflecting a balance between traditional financial habits and growing digital trust. Borrowers **above 46 years** show moderate adoption, possibly due to limited digital literacy or lesser comfort with emerging technologies.
4. Borrowers with **lower educational levels** highlight the need for digital literacy and training to fully benefit from Block chain-based services. Those with **secondary education** show moderate readiness for digital financial tools. **Graduates,** being the largest group group, exhibit strong trust in technology-driven systems. **Postgraduates** show even higher acceptance, likely due to greater awareness and understanding of digital finance mechanisms.
5. Self-employed borrowers show strong engagement with Block chain-enabled microfinance, as the technology helps reduce fraud, delays, and information gaps. **Salaried borrowers** also adopt these systems steadily, appreciating the transparency in repayment tracking. **Daily wage earners** benefit from improved clarity in transactions but may still face digital literacy challenges. Other groups, such as homemakers and students, reflect the expanding diversity of Block chain adoption among various socioeconomic backgrounds.
6. New borrowers are beginning to experiment with Block chain-based systems, showing curiosity and willingness to explore digital financial options. The majority comprise **mid-term borrowers,** who demonstrate increasing trust in Block chain as they gain more experience with microfinance processes. Overall, longer-term and younger borrowers appear to be more willing to engage with Block chain-enabled microfinance, reflecting early adoption trends.

Inferential statistics conclusions

7. **Chi-square test** of independence indicated a significant association between perceived Block chain transparency and borrower trust, $\chi^2(4) = 36$, $p < .001$, suggesting that greater transparency is associated with higher levels of borrower trust.
8. Block chain Transparency → **increases Trust** → Trust → **increases Timely Repayment**
   Transparency alone does not directly change repayment; instead, **it works by building trust**, which then motivates borrowers to repay on time.
9. This confirms that **trust is the central pathway** through which Block chain technology improves borrower behavior in microfinance systems.
10. These findings suggest that Block chain transparency influences repayment behavior primarily by enhancing borrower trust. In other words, transparency does not directly alter repayment patterns; instead, it strengthens borrowers' confidence in the microfinance system, and this increased trust subsequently improves their repayment performance. This underscores the central role of trust as a psychological mechanism through which technological interventions such as Block chain generate behavioral change within microfinance contexts.

Implications to MFI's

MFIs can now shift from traditional monitoring-heavy loan models to **trust-enabled digital governance systems,** MFIs adopting Blockchain can expect: Lower delinquency (PAR levels) Higher on-time repayment Improved loan recovery without coercive practices, e**nhanced Governance, Accountability & Auditability, strengthen Transparency Features in Blockchain Platforms and increase Borrower Education & Awareness Use Trust-Building Touchpoints Throughout the Loan Cycle**

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