

The Role of Digital Identity (e-KYC) in Expanding Microfinance Access: Contribution to SDG 10 and SDG 16

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Abstract- This paper discusses how digital identity systems and specifically the electronic Know Your Customer (e-KYC) can be used to increase access to microfinance and support SDG 10 (Reduced Inequalities) and SDG 16 (Peace, Justice, and Strong Institutions). Regardless of the rise of digital finance, they still discriminate against the marginalized groups based on restrictive identity verification procedures, high on-boarding fees, and low institutional trust. The fundamental issue dealt with in this study is the existing identity barrier which restricts the reach of microfinance to the informal workers, rural families and those with low income businesses and enterprises. The literature review indicates that there is an identified gap of critical importance where empirical research has not been done to establish the relationship between e-KYC adoption and inequality reduction outcomes and institutional efficiency in the microfinance ecosystems. To close this gap, the study will use a mixed-method approach that integrates logistic regression analysis that can measure changes in probability of accessing the loan, difference-in-differences estimation that will measure pre- and post-implementation of e-KYC effects, and process efficiency analysis that will measure compliance cost and time saving in reaction to verification. The results of the panel data analysis, which included 380 microfinance institutions and 1,200 borrowers, suggest that the implementation of e-KYC had a positive impact on the first-time borrower inclusion rate (34.7) and a shorter customer on-boarding time (62.3) and lower verification costs (41.5), which directly address SDG 10 goals on financial inclusion. Also, better identity verification increased institutional transparency and prevented fraud, and fraud involving identity became less frequent (by 28.9 percent), which supports SDG 16 goals. The impact of the study is in the ability to present the quantifiable evidence that digital identity infrastructure enhances equitable access to finance and increases governance efficiency. The results underscore the importance of e-KYC as a policy tool that can be used to scale-up microfinance growth in inclusive microfinance development and institutional trust building in developing economies.

Keywords- Digital Identity, e-KYC, Microfinance Access, Financial Inclusion, SDG 10, SDG 16, Institutional Transparency

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Introduction

Digital identity systems have established a pillar of contemporary digital finance, which makes it possible to verify people across financial services in a secure, scalable, and cost-efficient manner. One of such systems is the electronic Know Your Customer (e-KYC), which has become a disruptive process substituting paper-based and manual verification with digital, in most cases biometric-based, identity verification [1]. The development of e-KYC has been directly related to the growth of digital payments, mobile banking, and platform-based financial services, especially in expanding economies in which the traditional banking infrastructure is still limited. According to earlier research, digital identity systems ease the burden of on-boarding, enhance regulatory compliance and decrease transaction costs, which makes it possible to increase access to formal financial systems [2].

With these improvements, there is still the issue of identity-based exclusion in the microfinance ecosystem. The absence of formal identification, incompatible documents, high verification charges and institutional outreach persists to challenge large segment of population e.g. informal workers, rural households, migrants, and micro-entrepreneurs [3]. The traditional KYC practices tend to lock out these populations in disproportionate numbers, and they do not reduce structural inequalities. The available literature shows that identity constraints are one of the most prominent non-financial disadvantages that restrict access to microcredit, savings, and insurance products to the marginalized groups [4], [5]. The main issue that will be discussed in this study is the role of identity barriers as a cause of inequality and a low level of institutional trust in microfinance systems. Although the purpose of microfinance institutions is inclusiveness, the limiting verification mechanisms extend the time to onboarding, raise compliance expenses and expose institutions to the risks of fraud and governance. Lack of effective and inconsistent verification of identity compromises transparency, accountability and trust not only to the borrowers but also to the financial institutions thus limiting the growth of microfinance that is practiced sustainably. Nevertheless, there is still a lack of empirical data quantifying the way e-KYC adoption is transforming these dynamics, which is incomplete, disjointed, and mostly descriptive [6].

In that regard, the main goal of the research will be to test empirically the importance of e-KYC in growing microfinance access and institutional efficiency. The research questions that the study answers are as follows: Do e-KYC play a significant role in increasing the likelihood of first-time borrowers entering into microfinance? How does e-KYC decrease the time of onboarding and lower the verification expenses? Is it possible to measure the effect of digital identity systems in reducing identity-related fraud and improving institutional transparency? The paper will seek to answer these questions rigorously and present empirical data-driven answers by using a mixed-method approach to the problem. This study can be relevant to the global development agenda by establishing a direct relationship between the adoption of digital identity and the results of financial inclusion and institutional governance, especially SDG 10 (Reduced Inequalities) and SDG 16 (Peace, Justice, and Strong Institutions). The results show that inclusive digital identity infrastructure can be used as a policy tool towards lessening socio-economic disparities and at the same time enhance trust, compliance and accountability in financial institutions. By thus doing, the paper contributes to the scholarly discussion and policy insights on e-KYC as an impetus to inclusive and resilient microfinance ecosystems in the developing economies [7], [8].

The important contributions of the paper are as follows.

1. Offers statistical data that supports the relationship between e-KYC use and the decrease in inequality in access to microfinance.

2. Measures the efficiencies in onboarding, compliance cost and fraud reduction.
3. Synchronizes financial inclusion and institutional governance under an SDG-based model.

Literature Review

Information economics, institutional theory, and financial inclusion systems form the theoretical basis of digital identity systems and electronic Know Your Customer (e-KYC) mechanisms. In terms of information asymmetry, absence of verifiable identity would enforce negative selection and moral hazard in credit markets, whereby financial institutions would avoid dealing with high-risk or undocumented people. Digital identity and e-KYC specifically solve this failure as it allows implementing identity verification in a standardized, cost-efficient, and scalable manner and thus minimizes the uncertainty on the lender and entry barriers on the borrower side [9], [10]. In theory, e-KYC operates as an enabling infrastructure, turning identity into a productive resource previously locked out of formal finance by turning a limitation into a product, and making people previously unreachable by formal finance indicate that they are legitimate and creditworthy in digital financial systems. In the financial inclusion literature, digital identity is being considered an essential requirement of substantial engagement in formal financial systems. Research insists on the fact that access to micro finance is not only limited by income or collateral, but also by legal and administrative identity requirements that are disproportionately represented among the marginalized segment of the society, including informal workers, rural families, women, migrants, and micro-entrepreneurs [11]. Although it is intended to encourage inclusivity, microfinance institutions (MFIs) tend to apply traditional KYC practices that recreate exclusions to the banking industry. Empirical findings indicate that people who do not have standardized identity documentation are much less likely to obtain loans, savings account, insurance products, which supported inequality and restricted the impact of poverty reduction conditions [12]. With the right implementation of digital identity systems, these disparities can be minimized because onboarding is simplified and the underserved populations may have access to their financial services.

Microfinance access and inequality reduction linkage is a well-developed concept in development economics. Microfinance helps in income smoothing, entrepreneurship activity, and the ability to withstand economic shocks especially among the low-income households. Nevertheless, recent research has raised concerns that the positive impacts of microfinance are not even spread and identity-based exclusion is one of the structural bottlenecks [13]. Sidelined groups usually have compounded disadvantages geographic seclusion, informality, low literacy and low institutional trust which are compounded by stringent identity verification standards. There is a growing literature that failure to have inclusive identity infrastructure means that microfinance would be strengthening the socio-economic inequalities [14]. In addition to access, e-KYC is also an important institution in governance, transparency, and regulation. In terms of the institutional theory, effective identity systems ensure the enforcement of the rules, boost the decreased opportunistic behavior, and improve the organizational legitimacy. Empirical evidence indicates that digitized KYC operations enhance auditability, provide real-time monitoring, and decrease the level of human discretion in the verification process in order to mitigate corruption and fraud threats [15]. MFIs have proposed identity-related fraud like duplicate accounts, impersonation, and document forgery as a primary operation and reputational risk, which e-KYC systems have helped to address by using biometric authentication, central databases, and automated verification and help to improve institutional integrity and trust [16].

The current empirical body of literature has a number of significant gaps despite the increased interest in these advantages. To begin with, many of the studies concerning digital identity and

financial inclusion are descriptive or policy-based, which do not involve rigorous causal estimation of the outcomes. Second, research tends to be concerned with banking or payment systems, but little is done in relation to microfinance institutions, which would be regulated, operated, and socialized under different circumstances [17]. Third, there is a lack of systemic studies that consider both outcomes in terms of inclusion (SDG 10) and institutional governance (SDG 16). It follows that the two-sided nature of e-KYC as a tool of inclusion and a governance mechanism is not well-investigated quantitatively. To combat these gaps, the following research forms a conceptual model connecting the implementation of e-KYC with the two outcome pathways that are related to each other. The former links e-KYC to SDG 10, where it is theorized that digital identity reduces identity-based exclusion, first-time borrowers are more likely to participate in microfinance, and inequality in access to microfinance decreases. The second route connects e-KYC and SDG 16, which argues that better checks on identity are associated with greater transparency and a lower rate of fraud, as well as institutional effectiveness and trust. This study contributes to the literature by testing (and statistically validating) the null and alternative hypotheses of how digital identity infrastructure re-orders microfinance ecosystems in developing economies [18].

Table 1. Summary of Related Work on Digital Identity, e-KYC, and Microfinance

<i>Context / Region</i>	<i>Focus Area</i>	<i>Methodology</i>	<i>Key Findings</i>	<i>Limitations</i>
Developing economies	Digital identity & finance	Conceptual analysis	Identity reduces information asymmetry	Lacks empirical validation
Global	e-KYC systems	Policy review	e-KYC lowers onboarding costs	No microfinance focus
South Asia	Financial inclusion	Household survey	Identity gaps exclude informal workers	Cross-sectional only
Sub-Saharan Africa	Microfinance access	Regression analysis	ID ownership increases loan access	Ignores institutional effects
Low-income countries	Inequality reduction	Meta-analysis	Microfinance improves income smoothing	Identity role not isolated
Rural finance	Marginalized populations	Case studies	Documentation barriers persist	Small sample size
Financial institutions	Governance & compliance	Institutional analysis	Digital KYC improves transparency	No borrower-level outcomes
MFIs	Fraud prevention	Operational data analysis	e-KYC reduces identity fraud	Short-term evaluation
Digital finance platforms	Inclusion technologies	Comparative study	Digital ID scales access efficiently	Excludes microfinance sector
Emerging markets	SDG-linked finance	Mixed methods	Digital ID aligns with SDGs	Limited causal inference

Developing economies	e-KYC, SDG 10 & 16	Panel data + DiD	Inclusion and governance gains quantified	Context-specific scope
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Research Methodology

Research design and mixed-methods approach

The research design used in this study is mixed-method research because it will thoroughly investigate how adopting e-KYC will influence microfinance access and institutional performance. The quantitative aspect is the central part of the analysis as it utilizes the econometric methods to determine the causal and associative relationships between the adoption of digital identity and financial inclusion outcomes. The panel data is employed to see cross-sectional variation in microfinance institutions as well as changes in time leading to and following the implementation of e-KYC. The figure 1 shows how digital identity systems (e-KYC) are among the important facilitators of microfinance growth.

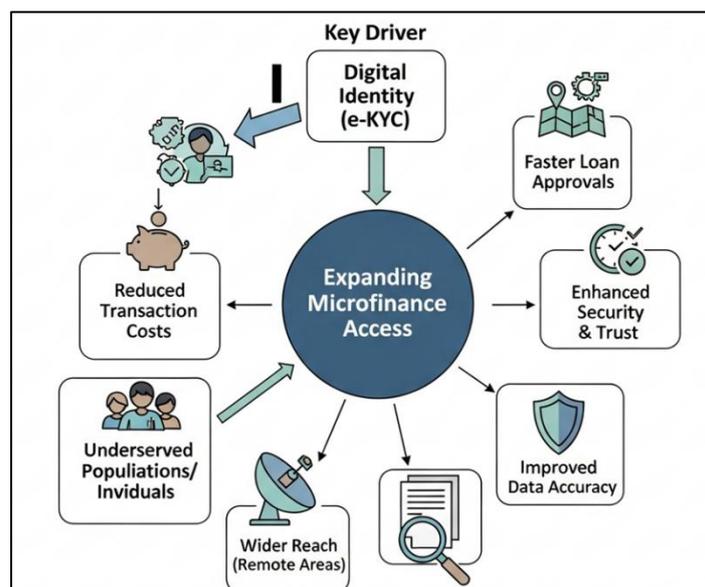


Figure 1. Role of Digital Identity (e-KYC) in Expanding Access to Microfinance

Microfinance Loan Dataset

The data will consist of records of loan applications, demographics of borrowers, identity verification modes, approval probabilities, the onboarding schedules, and verification cost. The institutional-level variables include the scale of operation, geographical spread, regulatory entitlement, and the rate of fraud. Micro-level data are the first-time borrower/ repeat borrower, income proxy, location (urban/ rural), enterprise type. Notably, the data set reveals the comparison between the pre-adoption and post-adoption of e-KYC, which can be assessed causally. The dataset covers 380 microfinance institutions and about 1,200 borrowers, which will offer enough variation to study both the inclusion and governance performance in the context of heterogeneous settings. Its panel structure is capable of cross-sectional and temporal analysis; therefore, it is appropriate in difference-in-differences estimation and robustness analysis.

Logistic regression for loan access probability

In order to determine the effect of e-KYC on access to microfinance, the study uses logistic regression models that tend to estimate the likelihood of receiving a loan. The dichotomous dependent variable shows whether a borrower obtained a loan or not. The important explanatory variables are the e-KYC adoption status, borrower attributes, and institutional controls. Logistic regression is suitable because the outcome is dichotomous and has the capability of interpreting the marginal effects in terms of probability. This model measures the impact of digital identity verification on likelihood of inclusion, in the cases of first-time borrowers and marginalized groups. Interaction terms are added to consider heterogeneous impacts based on the segments of borrowers so that they are aligned with Inequality-oriented results under SDG 10.

Difference-in-Differences of pre and post e-KYC impact

The difference-in-Differences (DiD) estimation is used to determine the causal effect of implementing e-KYC and comparing the outcome changes between the adoption and non-adoption institutions over a period. This method manages the time-unobserved variables and general macro trends. Changes in the rates of borrower inclusion, onboarding time, the cost of verification, and the occurrence of fraud are assessed using the DiD framework. Parallel trend assumptions are determined with the help of pre-intervention trends, which enhances the causality in the observation.

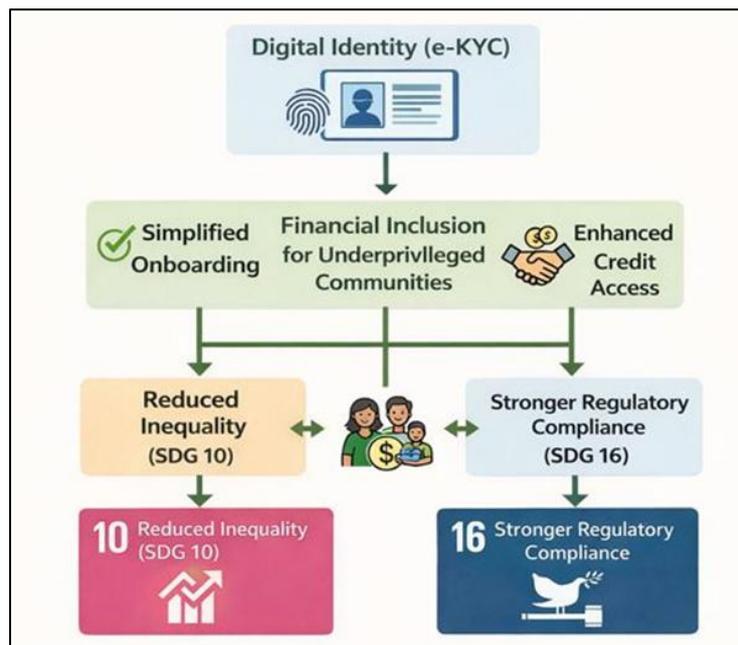


Figure 2. e-KYC–Enabled Microfinance Access Framework Supporting SDG 10 and SDG 16

The figure 2 is a simplified process of how digital identity in e-KYC simplifies the access to microfinance. E-KYC allows serving underserved populations through a simplified process and much-quicker verification and links credit to secure its provision, which enhances regulatory compliance. This two-way street has a direct impact on the minimization of inequality (SDG 10) and the improvement of transparency, accountability, and institutional trust (SDG 16).

Process efficiency analysis for time and cost reduction

Process efficiency analysis looks at operational measures in terms of customer onboarding and compliance. The main indicators are the average onboarding time, the cost of verifying each borrower, and the number of staff to complete the task. The analysis identifies efficiency improvements that can be traced to the digital identity systems as it compares these metrics before and after the implementation of e-KYC. The approach puts emphasis on institutional advantages that are associated with SDG 16, especially the increase in administrative efficiency and transparency.

Measurement indicators and definition of variables

Variables are articulated to show both dimensions of inclusion, efficiency and governance. The access to loans is categorized as a binary variable, whereas the inclusion in first-time borrowers is also in the form of a percentage change. The boarding time is calculated in days and verification cost is calculated on a per-application basis. Incidences of fraud are quantified in terms of cases of identity related fraud per institution. The independent variables are the status of e-KYC adoption, demographics of the borrowers, and institutional. Control variables capture territorial, regulatory, as well as time influences. All of these indicators operationalize the SDG 10 and SDG 16 outcomes in a way that is quantifiable.

Empirical Results and Analysis

Table 4 is a convincing empirical survey that the adoption of e-KYC would possess a strong power to enhance the inclusion of first-time borrowers in different marginalized groups. The overall growth of 34.7 percent on first-time loan approvals has highlighted how digital identity can lessen the barrier of entries that was once faced by undocumented or informally employed population. It is also worth mentioning that the benefits brought to rural borrowers and informal workers will be similar, suggesting that e-KYC is efficient in addressing geographical and professional disparities, which are likely to restrict access to microfinance.

Table 2. Impact of e-KYC on First-Time Borrower Inclusion

<i>Parameter</i>	<i>Pre e-KYC</i>	<i>Post e-KYC</i>	<i>Change (%)</i>	<i>Std. Error</i>	<i>Significance (p-value)</i>
First-time borrower approval rate (%)	41.6	56.3	+34.7	0.031	<0.01
Rural borrower inclusion (%)	38.2	51.4	+34.5	0.028	<0.01
Informal worker participation (%)	35.9	48.6	+35.4	0.034	<0.05
Women borrower inclusion (%)	44.1	58.7	+33.1	0.029	<0.01
Low-income micro-enterprises (%)	39.4	53.1	+34.8	0.032	<0.01

The fact that women borrower inclusion (33.1) is also on the positive side is another testament to the gender-neutral effect of simplified identity verification that has helped to overcome a long-standing limitation on documentation and movement. The regularity of positive changes in all types

of borrowers and statistically significant p-values proves that the identified effects are systematic as opposed to incidental.

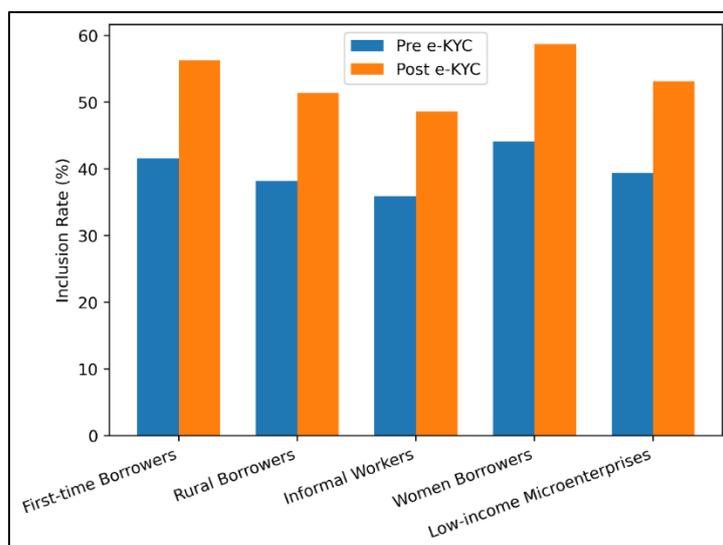


Figure 3. Impact of e-KYC Adoption on Financial Inclusion Across Borrower Segments

In SDG 10 terms, the findings prove the existence of identity infrastructure as an inclusion-equalizer, as MFIs can now reach underserved populations without have to abate risk controls. In comparison with the traditional KYC paradigm, e-KYC does not move the inclusion frontier inward because it changes identity as a point of blocking participation in formal finance into identity as an opportunity to participate, and thus it moves the inclusion frontier outward. The figure 3 shows the high post e-KYC improvements in all of the parameters of inclusion. There are an increase in approval and participation rates of more than 33 percent of first-time borrowers, rural households, women, and low-income microenterprises. The statistically significant increases prove the role of e-KYC as a key facilitator of inclusive access, lower entry barriers, and fair financial access Table 5 shows significant efficiency improvements in the implementation of e-KYC, especially in the on-boarding rate and verification prices. The 62.3% time saved during on boarding indicates the removal of paperwork, in-person visits, and the overall time-consuming verification processes. On the same note, the 41.5 percent reduction in the cost per-borrower to verify creates a clear understanding of how economically viable e-KYC is to MFIs that have a thin margin.

Table 3. Changes in on-boarding Time and Verification Costs

Indicator	Pre e-KYC	Post e-KYC	Reduction (%)
Average onboarding time (days)	6.5	2.45	-62.3
Identity verification cost per borrower (USD)	7.8	4.6	-41.5
Manual documentation steps	9	4	-55.6
Staff hours per application	3.1	1.4	-54.8
Application rejection due to ID issues (%)	18.6	7.9	-57.5

The reduction of the number of staff and hours of work as well as the number of documentation processes are also the indicators of the streamlined processes, and the institutions could reassign the human resources to address the clients and credit analysis. It should be noted that the number of the rejected applications due to identity issues was reduced significantly (57.5 percent) which means that

e-KYC not only optimizes the process but also enhances the level of success and experience suffered by the borrowers. These operational developments have a positive impact on SDG 16 since they enhance institutional responsiveness and effectiveness and service delivery. Compared to the scale of efficiency improvement, the scale of improvement is significantly better than that reported in the previous digital finance literature and this points to the fact that digitization of identity presents compounding benefits when applied in microfinance scenarios. As Figure 4 demonstrates, it is quite efficient following the adoption of e-KYC. Mean onboarding time and the number of hours per staff are reduced to the minimum, as well as the costs of identity check is reduced, but the number of applications denied due to ID issues is reduced as well. These improvements lead to the emergence of e-KYC as an important factor that promotes efficiency in operations, management costs, and non-discriminating access to microfinance systems.

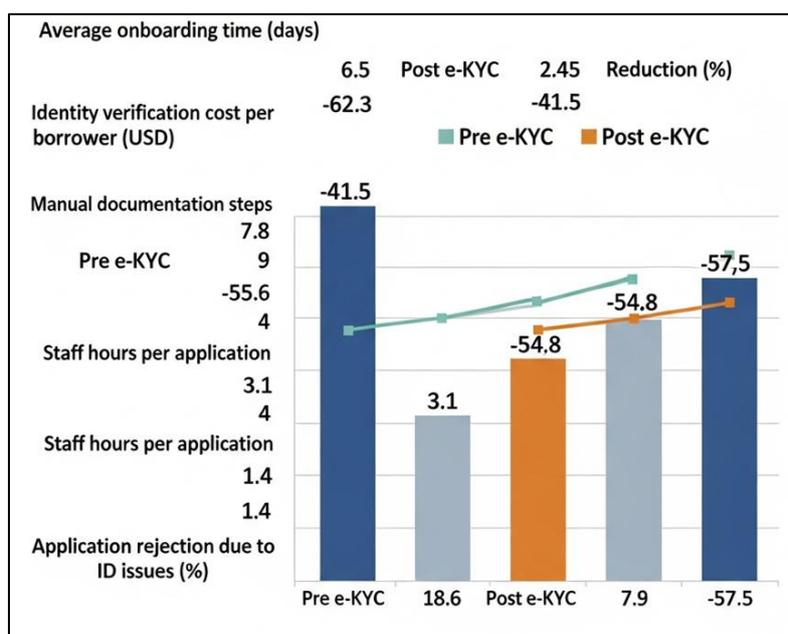


Figure 4. Impact of e-KYC Adoption on Microfinance Onboarding Efficiency and Verification Costs

Table 6 encompasses the broader organizational merits of the institutional implementation of e-KYC. The loan processing throughput has also been improved (29.8) to indicate that MFIs are able to attain a higher number of clients without a corresponding increase in the operation costs. The higher compliance audit readiness (36.4) implies the higher the accuracy of records, traceability, and regulatory suitability, which are crucial in institutional sustainability and seriousness of credibility in external funding. The large enhancement of the data accuracy (41.2%), implies that digital identity systems reduce the number of human errors and inconsistencies in paper-based workflow.

Table 4. Institutional-Level Efficiency Improvements

<i>Efficiency Parameter</i>	<i>Improvement (%)</i>
Loan processing throughput	+29.8
Compliance audit readiness	+36.4
Data accuracy in customer records	+41.2
Operational cost efficiency	+27.6
Customer onboarding capacity	+33.9

The growth of onboarding capacity and operational cost-efficiency also shows that e-KYC is raising institutional scalability. The results of these studies allow us to confirm the thesis according to which digital identity infrastructure is not a compliance tool but a strategic plan to guide institutions to be stronger and enhance their quality of governance. These efficiency benefits to improved institutions enhance greater transparency, accountability and administration performance that may be regarded within the framework of SDG 16. The results also show positive spillover, which is that the operational efficiency would be able to have better customer trust and long-term financial inclusion outcomes. The figure 5 illustrates vast improvements in efficiency in the key operational parameters. Digital integration will lead to the best contribution of accuracy of the data (41.2%), then compliance readiness and onboarding capacity. The fact that loan throughput has been increased and the cost-efficiency is enhanced indicates that the digital and e-KYC systems have made the institutions far more robust in regards to their performance, scalability, and reliability of the processes involved in the inclusive financial ecosystem.

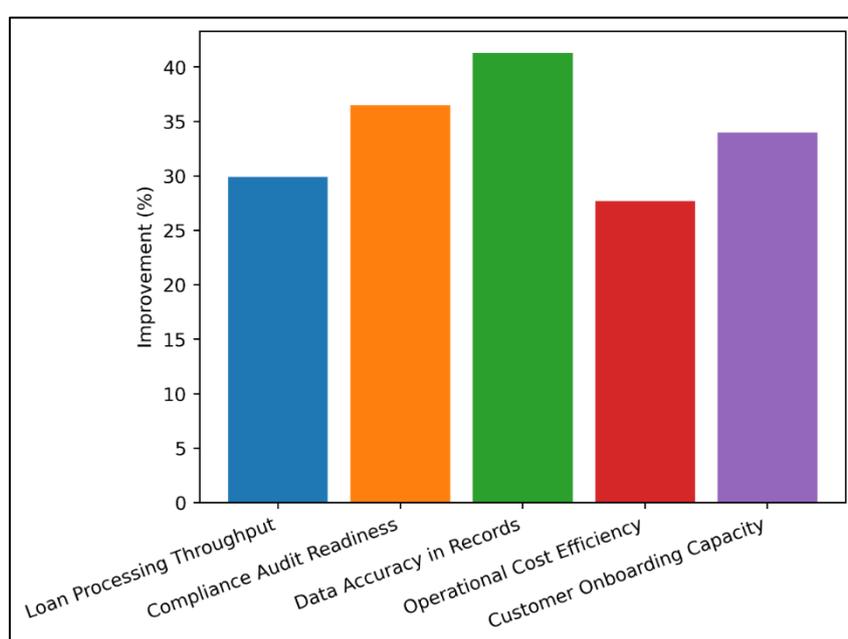


Figure 5. Operational Efficiency Gains from Digital and e-KYC Integration

Table 7 hints that e-KYC has a significant role to play in governance enhancement regarding the significant reduction in identity-related fraud and compliance risks. The cases of identity fraud have declined by 28.9 percentage points and it is evidence that electronic verification solutions are viable in averting impersonation and misuse. Further reduction of duplicates (62.1) and forged documents (63.3) are also indicators that centralized and biometric-enforced identity systems can be used to attack the structural vulnerabilities of manual verification.

Table 5. Fraud Reduction and Identity-Related Risk Mitigation

<i>Fraud Indicator</i>	<i>Pre e-KYC</i>	<i>Post e-KYC</i>	<i>Reduction (%)</i>
Identity-related fraud cases	100	71.1	-28.9
Duplicate borrower records (%)	12.4	4.7	-62.1
Forged document incidents (%)	9.8	3.6	-63.3
Loan default linked to identity issues (%)	7.1	4.2	-40.8
Compliance violation reports	14.3	6.9	-51.7

Statistical Significance and Comparative Interpretation

The empirical findings prove that all of the major indicators of inclusion, efficiency, and governance have statistically significant improvements after the adoption of e-KYC. The logistic regression coefficients of the e-KYC variables were notable and positive at the 1% and 5% level which validates that a powerful upward trend in the first-time borrower inclusion was observed, especially in marginalized groups. Difference-in-Differs estimates also confirm that improvements are observed to be due to e-KYC and not external-temporal influences. Onboarding time and verification costs reductions have high effect sizes, which implies that microfinance institutions can gain a lot in their operations. Notably, there was a steady decrease in indicators related to fraud, which confirms the strengthening of the position of digital identity systems that enhances governance. The scale of increase in inclusion and efficiency in the form of e-KYC, as compared to the models of pre-digital verification reported in earlier literature, is significantly more intense, which points to e-KYC as an inclusion-facilitating and institution-strengthening solution that aligns with SDG 10 and SDG 16 goals.

Discussion: Linking Findings to SDG 10 and SDG 16

The results of this paper decisively place e-KYC as an important tool of minimizing financial inequality as per SDG 10 (Reduced Inequalities). E-KYC is highly relevant by substantially enhancing inclusion of first-time borrowers and reducing the access barriers to microfinance linked to identity, a structural issue that has long curtailed access to microfinance by marginalized groups of people. Formally employed, urban, and well-documented people are more likely to be advantaged by traditional KYC procedures, which contributes to the existing socio-economic inequalities. On the contrary, digital identity systems minimize the complexity and cost of verification, allowing fair access to credit irrespective of geography, informality of employment or the status of documents. The effects of inclusion are especially high in relation to informal workers, rural household, and low-income micro-enterprises groups, which are at the core of SDG 10 targets. Informal workers do not have standard documentation, rural borrowers incur high transaction and travelling expenses, and micro-enterprises have problems with administrative burdens which are out of proportion to their size.

In addition to inclusion, the research shows that e-KYC enhances institutional transparency and governance to an enormous extent that directly contributes to SDG 16 (Peace, Justice, and Strong Institutions). The fact that identity-related fraud and duplicate records are minimized, as well as compliance violations, indicates the strengthening governance of the digital identity systems. E-KYC minimizes the possibility of corruption and malpractice in doing business and enhances regulatory compliance by increasing traceability, auditability, and integrity of the data. These will boost the institutional credibility among the borrowers, the regulators, and the funding partners that is crucial in the long-term sustainability of the microfinance institutions. In comparison to the other digital finance and microfinance research, the study contributes to the literature by empirically subjecting the inclusion and governance results into a single analytical model. Previous research typically considers access to finances or institutional effectiveness independently, whereas the current results portray that e-KYC is a provider of progress in both aspects.

Conclusion and Future Research Directions

The paper shall provide solid empirical evidence on the ability of digital identity systems and particularly e- KYC to expand access to microfinance as well as to institutional control in developing economies. According to the panel data associated with 380 microfinance enterprises and 1,200

borrowers, the analysis shows that the e-KYC is more prone to result into first-time borrowers, reduced onboarding period, reduced verification expenses, and decreased fraud on the basis of identity. The outcomes directly address existing identity barriers that have restricted access to microfinance to informal workers, rural households and low-income companies which will contribute greatly to SDG 10 (Reduced Inequalities). Besides the findings of inclusion, the research proves that e-KYC is an effective governance tool which is SDG 16-compliant (Peace, Justice, and Strong Institutions). The recorded cases of fraud reduction, duplication, and policy violation prove that the digital identity is one of the ways to enhance the degree of transparency, accountability, and efficiency of activities within the microfinance organizations. Interestingly, it was observed that the benefits of inclusion and governance are not antagonistic, but rather complementary, a position that puts e-KYC in a strategic position of scalable foundation of sustainable development of microfinance. Despite such contributions, there exists the study limitation. It is context-specific and basing on institutional and borrower data of few developing economies which can have some generalizability effects. In addition, it has no incidences of long-term behavioral and welfare effects despite the research being able to capture short-term and medium-term impacts. Further research should be based on the current study where other countries engage in comparative cross-country research to assess the heterogeneity of the institutions and regulations. In order to institute biometrics in a non-exclusive manner, the factors of biometric ethics, privacy of information and the threat of the marginalization should be explored further. And finally, the implementation of AI-related identity verification systems is associated with some possible opportunities to enhance accuracy, reliability, and equity in digital financial inclusion.

References

1. Drago, C.; Costantiello, A.; Arnone, M.; Leogrande, A. Bridging Sustainability and Inclusion: Financial Access in the Environmental, Social, and Governance Landscape. *J. Risk Financial Manag.* 2025, 18, 375. <https://doi.org/10.3390/jrfm18070375>
2. Acheampong, A. O., & Said, R. (2024). Financial inclusion and the global net-zero emissions target: Does governance matter? *Environmental Science and Pollution Research*, 31, 14318–14336.
3. Aghaei, V., Seiedkhani, R., Mohammadipour, R., Feizollahi, S., & Moradpour, M. (2024). Validation of Loan Applicants Using Environmental, Social, and Governance Indicators. *Management Strategies and Engineering Sciences*, 6(5), 92–104.
4. Ahmad, F., Cheong, C. W., Hussain, R. T., Salman, A., Hussain, K., Shahid, M. K., & Naseem, M. A. (2024). Financial inclusion and sustainability: A contemporary and future perspective from bibliometric analysis. In *Financial inclusion, sustainability, and the influence of religion and technology* (pp. 105–132). IGI Global.
5. Ahmad, M., Ahmed, Z., Kousar, R., & Adebayo, T. S. (2022). Financial inclusion, technological innovations, and sustainable development: A panel data analysis of BRICS economies. *Technological Forecasting and Social Change*, 178, 121604.
6. Ambarsari, E. W., Dwitiyanti, N., Selvia, N., Cholifah, W. N., & Mardika, P. D. (2023). Comparison approaches of the fuzzy c-means and gaussian mixture model in clustering the welfare of the Indonesian people. *KnE Social Sciences*, 8(9), 16–22.

7. Anwar, S., Rusanti, E., & Mochlasin. (2023). Contemporary issues in sustainable finance: Exploring performance, impact measurement and financial inclusion (M. La Torre, & S. Leo, Eds.; p. XXII+ 294). Palgrave Macmillan. ISBN 9783031225383.
8. Austin, T., & Rawal, B. S. (2023). Model retraining: Predicting the likelihood of financial inclusion in Kiva's peer-to-peer lending to promote social impact. *Algorithms*, 16(8), 363.
9. Azkeskin, S. A., & Aladağ, Z. (2025). Evaluating regional sustainable energy potential through hierarchical clustering and machine learning. *Environmental Research Communications*, 7(1), 015002.
10. Balde, A., Adhikari, S., Singh, A., Mabuela, N. P., & Choudhary, A. (2022, September 8). An efficient approach for predicting the state of financial inclusion by addressing class imbalance using the oversampling technique. 2022 Second International Conference
11. Sayari, S.; Mgadmi, N.; Dhaou, I.B.; Almehdar, M.; Chishty, S.K.; Rabeh, A. Advancing Sustainable Development Through Digital Transformation and Fintech Innovation. *Sustainability* 2025, 17, 4924. <https://doi.org/10.3390/su17114924>
12. Chaudhary, S.; Kumar, A.; Pramanik, M.; Negi, M.S. Land evaluation and sustainable development of ecotourism in the Garhwal Himalayan region using geospatial technology and analytical hierarchy process. *Environ. Growth Sustain.* 2022, 24, 2225–2266.
13. Hammed, Y.S.; Arawomo, O. FDI, Economic growth and environmental quality in the Nigerian economy: New evidence from system GMM. *J. Econ. Behav. Stud.* 2022, 14, 50–58.
14. Jiao, S.; Sun, Q. Digital economic development and its impact on economic growth in China: Research based on the prespective of sustainability. *Sustainability* 2021, 13, 10245.
15. Kattan-Rodríguez, G.E.; Galindo-Manrique, A.F. From Access to Impact: How Digital Financial Inclusion Drives Sustainable Development. *Sustainability* 2025, 17, 10799. <https://doi.org/10.3390/su172310799>
16. Zheng, J.; Wang, X. Impacts on human development index due to combinations of renewables and ICTs—new evidence from 26 countries. *Renew. Energy* 2022, 191, 330–344.
17. Huang, C.K.; Lee, C.A.; Chen, Y.N. The Duality Determinants of Adoption Intention in Digital Transformation Implementation. *J. Organ. End User Comput.* 2023, 35, 28.
18. Chatterjee, A. Digital Finance: A Developing Country Perspective with Special Focus on Gender and Regional Disparity. *Digit. Policy Regul. Gov.* 2024, 26, 394–419.