Chapter 2

Beyond Physical Collateral: Leveraging Digital Murabahah and AI-Credit Scoring for Financial Inclusion: Evidence from Ethiopia

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Abstract

Financial inclusion remains a persistent challenge in developing economies, where access to formal credit is often constrained by stringent collateral requirements. This challenge is particularly evident in Ethiopia, where many micro, small, and medium enterprises (MSMEs), women, youth, and rural households remain excluded from financial services despite having viable economic activities and repayment potential. Within Islamic finance, Murabahah was designed as an asset-based and ethical financing mechanism that promotes fairness and economic participation. However, many Islamic financial institutions continue to rely on conventional collateral requirements, limiting access for asset-poor populations. This study investigates how digital Murabahah financing integrated with artificial intelligence (AI)-based credit scoring can reduce dependence on physical collateral and enhance financial inclusion in Ethiopia while maintaining Shariah compliance. Employing a qualitative document analysis approach, the study examines reports from Islamic financial institutions, fintech companies, development organizations, regulatory bodies, and industry publications. The findings indicate that emerging digital Murabahah platforms have introduced collateral-free financing models by utilizing alternative data sources, including mobile money transactions, utility payments, e-commerce activities, and behavioral indicators, to assess creditworthiness. Available evidence suggests that these initiatives have expanded access to financing among women, youth, first-time borrowers, and rural communities while supporting business growth and employment creation. Nevertheless, challenges related to AI transparency, algorithmic fairness, data governance, and Shariah oversight remain significant. The study concludes that AI-enabled digital Murabahah presents a promising pathway for advancing inclusive Islamic finance in Ethiopia, provided that robust regulatory, ethical, and consumer protection frameworks are established.

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1. Introduction

Financial inclusion has emerged as a central pillar of contemporary development policy. Access to formal financial services enables households to smooth consumption, manage risks, and invest in productive activities, while expanding opportunities for micro, small, and medium enterprises (MSMEs) to grow and create employment. Inclusive financial systems contribute to poverty reduction, entrepreneurship, and broader economic development (Beck et al., 2007). Despite these benefits, financial exclusion remains a persistent global challenge. Approximately 1.4 billion adults remain outside the formal financial system, with exclusion concentrated heavily in developing economies and among marginalized populations (Demirgüç-Kunt et al., 2021). One of the most significant barriers to financial inclusion is the traditional requirement for physical collateral (Yaldız et al., 2014). Banking systems rely heavily on collateralized lending models in which borrowers must pledge legally recognized assets such as land, buildings, or vehicles as security against default risk (Fleisig, 2006). Although such mechanisms function effectively in economies with well-developed property registration systems, they create substantial exclusion in developing countries where many individuals operate within informal economic arrangements. In these contexts, economically active populations often possess productive capacity and stable income streams but lack formally documented assets recognized by financial institutions (Jrad, 2023). As a result, millions of entrepreneurs, farmers, women, and youth remain excluded from formal credit markets despite their repayment potential.

Islamic finance emerged as an alternative financial system grounded in ethical principles of justice, risk-sharing, and real economic activity. Built upon the prohibition of Riba (interest), Gharar (excessive uncertainty), and Maysir (speculation), Islamic finance seeks to promote equitable financial relationships tied to tangible assets (Legass et al., 2025). The industry has evolved into a global sector exceeding USD 5 trillion in 2024, encompassing banking, capital markets, and digital financial services (Standard Chartered, 2024). Among its most widely used instruments is Murabahah, a cost-plus sale contract in which a financial institution purchases an asset and resells it to a client at an agreed profit margin. In principle, Murabahah was intended to facilitate trade and productive investment while avoiding exploitative debt-based financing. However, despite its ethical foundations, Islamic finance has frequently replicated the operational structures of conventional banking, particularly regarding collateral requirements (Buhary et al., 2023; Ropiah, 2025). Islamic banks in many jurisdictions continue to require substantial physical collateral for Murabahah financing, effectively excluding the same populations marginalized by conventional systems (Adamu, 2018; Mehmood

et al., 2024). This contradiction has generated an important debate: how can Islamic financial institutions maintain prudent risk management while fulfilling the broader objectives of Shariah (Maqasid al-Shariah), particularly social justice, inclusion, and economic empowerment?

The rapid expansion of financial technology and artificial intelligence has introduced new possibilities for addressing this challenge. Digital finance platforms increasingly utilize alternative data sources—mobile money transactions, utility payments, e-commerce activity, and digital behavior patterns—to evaluate borrower creditworthiness (Razavi & Elbahnasawy, 2025). AI-driven credit scoring systems reduce dependence on traditional collateral by generating behavioral and predictive assessments of repayment capacity. Within Islamic finance, scholars have explored blockchain technologies, smart contracts, and AI-enabled services (Oladapo et al., 2022; Rabbani et al., 2020). Nevertheless, much of this literature remains theoretical and speculative. Existing studies focus primarily on Shariah compliance and technological adoption while giving limited attention to collateral dependency. More importantly, the literature rarely examines whether AI-driven alternative-data scoring can systematically substitute physical collateral in Islamic financing models such as Murabahah. If digital Islamic finance platforms can successfully replace asset-based security with data-driven risk assessment while maintaining Shariah compliance, this would represent a major transformation in inclusive finance.

These issues are particularly relevant in Ethiopia, one of the largest and fastest-growing Islamic finance markets in Sub-Saharan Africa. Ethiopia has a substantial Muslim population estimated at one-third of the total, many of whom historically remained excluded from formal banking due to the absence of interest-free financial services (Legass & Durmuş, 2024). The regulatory landscape changed following the National Bank of Ethiopia's authorization of interest-free banking and the licensing of fully fledged Islamic banks. Simultaneously, Ethiopia has accelerated digital transformation through initiatives such as the BRIDGE 2030 digital strategy, telebirr mobile financial services, and the Fayda digital identification system. However, access to formal credit and digital financial services in Ethiopia lags significantly behind its East African neighbors. Reports shows that 70% of micro-firms and 40% of SMEs face credit access difficulties, while only 35% of adults hold formal bank accounts. The digital divide is even starker: less than 5% of Ethiopians use mobile payment systems, compared to 80% in Kenya. Despite these digital advancements, credit provision remains heavily dependent on conventional collateral mechanisms. Islamic financial institutions commonly require collateral valued significantly above the financing amount. This dependence

generates multiple layers of exclusion. Rural households possess land under customary systems but lack formal title deeds. Women entrepreneurs frequently lack assets registered in their own names. Young entrepreneurs rarely hold sufficient physical assets to satisfy bank requirements. Consequently, access to Islamic finance remains concentrated among relatively asset-rich urban populations, undermining the inclusive aspirations of Shariah-compliant finance. The challenge is compounded by inefficient collateral verification processes—manual, bureaucratic, and time-consuming—often delaying Murabahah transactions for weeks or months. This produces a "geography of exclusion" in which access to Shariah-compliant capital remains unevenly distributed across the country. Unlike many established Islamic finance markets constrained by legacy systems, Ethiopia's Islamic finance sector has emerged during a period of rapid digital transformation, creating opportunities for technological leapfrogging toward mobile-based, AI-enabled financing models.

Despite these opportunities, important research gaps remain unresolved. First, existing studies on Ethiopian Islamic finance focus primarily on legal frameworks and operational challenges, with no attention to digitally delivered Murabahah integrated with AI-based credit assessment. Second, while studies identify collateral requirements as a major obstacle, little empirical research examines whether alternative-data AI models can function as viable substitutes for physical collateral in Islamic financing systems. Third, there is a shortage of scholarly engagement with the ethical and regulatory implications of AI-driven Islamic finance, particularly concerning algorithmic fairness, consumer protection, transparency, and Shariah governance. Accordingly, this study investigates how digital Murabahah financing and AI-enabled alternative-data credit scoring can contribute to financial inclusion in Ethiopia by reducing dependence on physical collateral while maintaining Shariah compliance, fairness, and consumer protection. The research question is: How can Ethiopia move beyond physical collateral by integrating digital Murabahah delivery systems and AI-based credit scoring to expand financial inclusion among MSMEs and low-income Muslim populations without undermining Shariah principles and ethical financial governance?

2. The Conceptual Foundation

2.1. Overview of Murabahah

Murabahah is a Sharia-compliant, asset-backed financing contract in which a financial institution purchases a commodity from a third party and resells it to a client at a disclosed cost plus an agreed profit margin. The contract emphasizes transparency, requiring full disclosure of the original purchase price

and markup, while also ensuring that the financier possesses ownership and control of the asset before resale (Djumadi et al., 2025). In theory, Murabahah differs fundamentally from conventional lending because it is tied to a real economic transaction involving tangible assets rather than interest-bearing debt. The financed asset itself is expected to provide security for the transaction, reflecting the Islamic finance principles of fairness, shared responsibility, and avoidance of speculative or exploitative financial practices (Harahap et al., 2023). Despite these principles, the practical application of Murabahah has increasingly evolved into a debt-like financing mechanism, particularly when payments are deferred over time. Since financial institutions face risks of default and information asymmetry, they frequently require additional collateral such as real estate, cash margins, personal guarantees, or liens on other assets (Miqdad et al., 2025). This creates what scholars describe as the "collateral paradox" of Murabahah: although the transaction is already backed by a physical asset, Islamic banks continue to rely on conventional risk-management tools to protect themselves from loss. As a result, Murabahah often functions similarly to conventional credit arrangements, demonstrating a shift from its original trade-based philosophy toward a more risk-averse and debt-oriented institutional model (Gemilang & Hutagalung, 2025).

The implications of this collateral paradox are significant for financial inclusion and the broader objectives of Islamic finance. Heavy collateral requirements disproportionately affect micro, small, and medium enterprises (MSMEs) as well as low-income individuals who lack formally documented assets, even if they are economically productive. Consequently, Islamic finance institutions may unintentionally exclude the very populations they are ethically intended to support. This undermines key objectives of Maqasid al-Shariah, particularly social justice, equitable wealth distribution, and the preservation of economic welfare. Instead of serving as an inclusive alternative to conventional finance, the institutionalization of strict collateral practices risks creating a dual system in which only asset-rich clients can access Sharia-compliant financing. At the same time, vulnerable and asset-poor groups remain financially marginalized.

2.2. AI Credit Scoring and Alternative Data:

Conventional credit scoring relies on formal financial histories—bank accounts, documented income, and registered assets. In developing economies, where most economic activity occurs in informal markets and fewer adults hold formal bank accounts, these models fail to capture the repayment capacity of millions of productive yet unbanked individuals. This is a measurement problem, not a risk problem: excluded populations are creditworthy but

invisible to traditional channels (Razavi & Elbahnasawy, 2025; Rehman et al., 2025).

AI-driven scoring addresses this by leveraging alternative data, including mobile money transactions, utility payments, e-commerce activity, digital savings, and smartphone metadata. Machine learning algorithms process these data points to generate predictive risk scores without requiring physical collateral. Empirical evidence confirms its potential (Nwaimo et al., 2024; Razavi & Elbahnasawy, 2025). However, significant risks remain. Algorithmic bias can reproduce existing discrimination. Data privacy concerns arise from collecting sensitive personal information without adequate oversight (Oware & Amfo, 2025; Shukla & Gupta, 2025). The "black box" problem—unexplainable algorithmic decisions—raises fundamental questions for Islamic finance, where transparency is a Shariah requirement. If a credit score cannot be explained, its use may constitute *gharar* (excessive uncertainty). For Islamic finance, AI scoring offers a pathway to resolve the collateral paradox. By substituting physical asset pledges with data-driven assessment, Islamic banks could extend Murabahah financing to asset-poor Muslims. Yet scholars question: Does algorithmic assessment introduce *gharar*? Are alternative data sources *halal*? Can automated decisions satisfy Murabahah's transparency requirements?. These questions remain unanswered.

2.3. Digital Islamic Finance

Islamic fintech, the application of digital technologies to deliver Shariah-compliant financial services, has emerged as one of the fastest-growing segments of the global Islamic economy. Driven by increasing Muslim demand for digital inclusion and the proliferation of mobile-enabled platforms, the Islamic fintech market has attracted substantial investment, with particularly active ecosystems in Malaysia, Indonesia, the United Arab Emirates, and the United Kingdom (Kılıç, 2023; Nurkholidah et al., 2024; Unal & Aysan, 2022). Unlike conventional fintech, Islamic fintech must satisfy additional layers of compliance: prohibition of interest (riba), avoidance of uncertainty (gharar), asset-backing requirements, and Shariah governance oversight. These requirements create both constraints and opportunities. The constraint is that many conventional fintech models are impermissible (Alsaghir, 2023; Putri et al., 2026). The opportunity is that Shariah-compliant alternatives may appeal to the approximately 1.4 billion Muslims globally who actively seek ethical finance.

Blockchain technology has generated particular excitement within Islamic fintech circles. Smart contracts, self-executing agreements with terms directly

written into code, can automate the sequential steps of a Murabahah transaction: asset verification, bank purchase, possession transfer, installment collection, and default handling (Unal & Aysan, 2022). Automation promises to reduce transaction costs, eliminate paperwork delays, enhance transparency, and create an immutable audit trail for Shariah compliance. Maouchi (2024) proposed a "decentralized Murabahah" model in which blockchain records each transaction stage, enabling real-time verification of asset ownership and possession, potentially resolving the compliance disputes that plague paper-based Murabahah, particularly regarding whether the bank actually possessed the asset before resale. However, the gap between technological possibility and practical application remains vast. Rahman et al., (2025) Note that most blockchain-based Murabahah proposals remain theoretical, with few live deployments beyond pilot stages.

2.4. Financial Inclusion in Ethiopia

Financial inclusion in Ethiopia has expanded considerably over the past decade, driven by financial sector reforms and digitalization initiatives. According to Global Findex (2025), formal account ownership increased from 34.8% in 2017 to approximately 48.8% in 2024. The National Bank of Ethiopia (NBE), through its National Financial Inclusion Strategy (NFIS-II), aims to raise account ownership to 70% by promoting digital finance and expanding banking infrastructure. Despite this progress, inclusion remains uneven. Digital payment adoption stands at only 16%–21% of adults, with mobile money ownership at approximately 9.5%, revealing that meaningful utilization lags behind account access, particularly among rural and low-income populations. One of the most significant dimensions of exclusion is the persistent gender gap. Women are substantially less likely than men to own bank accounts or access formal credit, with the gender gap in account ownership ranging between 14% and 19%, exceeding the Sub-Saharan African average. Approximately 86% of Ethiopian women lack mobile money accounts. Women entrepreneurs face structural disadvantages: research indicates they are 1.5 times less likely to receive loans, and when approved, receive significantly smaller amounts than men. The World Bank's Africa Gender Innovation Lab found that 35% of loan officers exhibit bias against female applicants. Expanding women's financial inclusion could lift nearly 700,000 people out of poverty and contribute approximately US$5.3 billion to Ethiopia's GDP. Banks nowaday emerging as pioneering institutions focused specifically on women's economic empowerment.

Beyond gender, exclusion is shaped by structural constraints. Urban residents are more than twice as likely to access formal financial services

compared to rural populations. Education and income levels strongly influence access. FSD Ethiopia (2026) reports that 44.5% of micro-enterprises identify credit access as their primary operational challenge. Customary land tenure systems and the absence of formal title deeds prevent borrowers from meeting conventional collateral requirements, disproportionately affecting women, youth, and rural enterprises. The emergence of Islamic finance has introduced new opportunities for underserved Muslim populations. Following NBE Directive SBB/72/2019, which authorized interest-free banking, dedicated Islamic banks such as ZamZam Bank and Hijra Bank were established alongside Islamic windows in conventional institutions. Recently, the NBE increased the financing-to-deposit ratio for Islamic banks to 40.1%, creating greater capacity for Shariah-compliant lending. However, no comprehensive framework governs digital Murabahah, AI-based credit scoring, or alternative data use for Islamic financial services. Ethiopia nevertheless possesses strong "leapfrog potential." Unlike mature Islamic finance markets digitizing legacy systems, Ethiopia's financial sector develops during rapid technological transformation. National initiatives such as BRIDGE 2030, telebirr (139 million registered accounts), and the Fayda digital ID system provide foundational infrastructure. However, FSD Ethiopia (2026) notes that only 15% of registered mobile money accounts are actively used, due to low digital literacy, limited smartphone penetration, and inadequate user trust. The interaction of collateral-intensive banking, uneven digital infrastructure, and regulatory uncertainty has created a "geography of exclusion" where access to finance remains concentrated in urban centers. Rural communities, women, and youth face higher rejection rates and limited access to digital platforms. Scholars argue that AI-enabled Murabahah models using alternative data could provide a transformative pathway for inclusion, but effectiveness depends on transparent regulatory frameworks, equitable algorithmic practices, and deliberate strategies to reach underserved populations.

3. Methodology

3.1. Research Design

This study adopts a qualitative document-based research design. Document analysis is a systematic method for reviewing, evaluating, and synthesizing information from written, digital, or printed documents without conducting primary data collection such as surveys or interviews (Bowen, 2009). This design is appropriate when the research objective is to understand and describe a phenomenon through existing texts, reports, and records (Creswell & Poth, 2016). This design is justified on three grounds. First, the research

question focuses on describing existing Digital Murabahah products and AI credit scoring systems in Ethiopia, which are captured in publicly available reports and regulatory documents, making document analysis the most direct method of inquiry. Second, Ethiopia's emerging Islamic finance sector makes primary data collection logistically challenging due to difficulty accessing institutional representatives; document analysis circumvents these challenges (Yin, 2018). Third, document analysis is non-reactive—documents were created independently of this research, eliminating the risk of participants altering responses due to awareness of being studied. This study is purely qualitative. No statistical calculations are performed. Numerical data are reported exactly as stated in sources without manipulation or aggregation.

3.2 Research Approach

This study employs a qualitative descriptive approach. Qualitative description is a low-inference method that stays close to the data and presents findings in the everyday language of the documents being studied (Sandelowski, 2000). Unlike interpretive approaches such as grounded theory, it does not aim to develop theory or uncover hidden meanings but to provide a comprehensive summary of a phenomenon in the terms that sources themselves use (Neergaard et al., 2009). This approach is appropriate because the research question asks "what exists" and "how" questions rather than "why" questions. The study seeks to document what Digital Murabahah products exist in Ethiopia, how they operate, whether they use AI scoring, and what outcomes are reported. A qualitative descriptive approach allows direct and transparent answers without imposing complex analytical frameworks. This approach has been widely used in policy analysis and financial inclusion studies where the goal is to produce practical, actionable findings (Bradshaw et al., 2017).

3.3. Sources of Data

This study relies exclusively on secondary data from three categories of sources. Company and program reports provide direct operational data on Digital Murabahah products and AI-driven credit assessment systems in Ethiopia. Key sources include Kifiya Financial Technology (SAFEE program), Halal Pay (Hijra Bank), and HalalGebeya. These documents contain information on loan disbursement volumes, borrower numbers, AI scoring methodologies, collateral-free lending, Shariah compliance certification, and product features. Although these reports provide valuable operational insights, they may contain institutional reporting biases. To mitigate this limitation, information was cross-checked where possible with development partner publications, regulatory documents, and independent industry sources. Secondly, Development partner

and regulatory reports provide broader contextual and policy information. Sources include FSD Ethiopia, Mercy Corps (RAISE-DFS), the National Bank of Ethiopia, and the European Bank for Reconstruction and Development. These offer data on financial inclusion levels, mobile money penetration, MSME credit access, regulatory frameworks for interest-free banking, and comparative evidence from other African countries. Such sources are reliable as they are produced by established institutions employing rigorous research standards. Lastly, Media and industry publications are used as supplementary sources to capture recent developments. These include The Reporter Ethiopia, Shega Media, and Islamic Finance News, providing updates on regulatory changes, fintech innovations, and industry trends.

3.4. Data Collection Procedures

Data collection followed a systematic and transparent process. Relevant documents were identified through targeted searches of official institutional websites and publication archives, including reports, white papers, press releases, regulatory directives, and media publications from fintech companies, Islamic finance providers, development partners, regulatory authorities, and industry news platforms. All identified documents were collected, organized, and cataloged using a structured document management system. Each document was assigned a unique identification code and recorded in a master log containing source, publication date, title, and content description. Data were subsequently extracted using a standardized extraction form designed to capture relevant information directly from source materials, ensuring consistency, traceability, and accuracy throughout the process.

3.5. Method of Data Analysis

The study employed a qualitative narrative synthesis approach complemented by descriptive reporting of numerical information. Relevant information from company reports, regulatory documents, development partner publications, and media sources was systematically reviewed and organized according to key themes: Digital Murabahah product features, AI-based credit scoring practices, collateral requirements, Shariah compliance, financial inclusion outcomes, and the regulatory environment. Findings from different sources were synthesized into a coherent narrative highlighting patterns, areas of convergence or divergence, and existing information gaps. Numerical data such as user counts, financing volumes, and reported percentages were presented exactly as stated in original documents without any statistical analysis, calculation, or aggregation. This approach ensured that both qualitative and quantitative information

were reported faithfully while providing a comprehensive understanding of AI-enabled Digital Murabahah financing in Ethiopia.

4. Findings and Discussion

This section presents and interprets the evidence extracted from the document analysis. This section integrates findings and discussion to provide a seamless, analytically rich narrative. Each of the topics below presents a key finding from the documents and immediately discusses its significance in relation to the literature reviewed in Section 2. The section is organized thematically around the central research question: How can Ethiopia move beyond physical collateral through digital Murabahah and AI credit scoring to expand financial inclusion among MSMEs and low-income Muslim populations without undermining Shariah principles and ethical financial governance? The evidence draws from Mercy Corps learning briefs (2024), Kifiya Financial Technology documentation, ZamZam Bank's Ansar platform materials, Hijra Bank's Halal Pay disclosures, the Digital Frontiers Institute industry blog (2026), and independent analyses of Ethiopia's interest-free banking sector (2025). Where documents agree, patterns are identified. Where they diverge or where information is absent, gaps are noted and their implications discussed.

4.1. Empirical Evidence of Collateral-Free Digital Murabahah at Scale

The document analysis reveals that identified digital Murabahah platforms operating in Ethiopia have eliminated physical collateral requirements. This finding is consistent across diverse institutional models: Halal Pay (Hijra Bank), Rays MFI E-Murabaha, Ansar (ZamZam Bank), HalalGebeya (Kifiya -powered ecosystem serving multiple banks). ***Halal Pay*** has reached 1.3 million users and disbursed over 1 billion Ethiopian Birr (approximately 18 million USD) within less than one year of operation. The reports explicitly state that the product operates "without the need for collateral or complex procedures" and requires "no branch visits," representing a "radical transformation in user experience, making finance faster, closer, and more flexible, especially in regions where access to banking services is challenging." ***Rays MFI's e-Murabaha*** product provides the most detailed and verifiable data. Within two years of launch (by June 2024), the product reached 15,879 digital loan clients, more than quadrupling the institution's previous total loan client base. The Mercy Corps report explicitly attributes this growth to digitalization: "The lower transaction cost of administering digital loans makes it profitable for Rays MFI to offer smaller loans that better meet the needs of target groups,

and this is seen in the average Rays MFI loan size falling from 1,200 before launching digital loans to 530 today." ***Ansar by ZamZam Bank*** is described as "Ethiopia's pioneering Shariah-compliant digital financing solution, utilizing state-of-the-art AI technology" with an explicit statement that "no collateral required; creditworthiness evaluated solely through AI and machine learning scoring." The platform offers three financing products: Salihat for women (up to 30,000 Birr, 30 days, 3.75% profit), Small Enterprise Working Capital (up to 100,000 Birr, 18 months, 15% profit), and Medium Enterprise Capital Expenditure (up to 500,000 Birr, 30 months, 25% profit). ***HalalGebeya*** is described as "Ethiopia's first fully Shariah-compliant e-commerce platform, providing a white-labeled digital storefront for banks to offer Murabaha-based financing," integrating Kifiya's AI-based credit scoring engine with an AAOIFI-compliant Murabahah workflow. The broader Kifiya ecosystem has facilitated 2.1 million loans and 310 million USD in disbursements to over 430,000 unique MSMEs. The Digital Frontiers Institute (2026) blog reports that Ethiopia has surpassed 50 billion ETB (approximately 421 million USD) in uncollateralised digital lending for MSMEs within just two and a half years.

Economically, the resolution of the collateral paradox represents a fundamental shift in credit market dynamics. Traditional collateral requirements created a barrier that excluded asset-poor but economically active populations. By removing this barrier, digital Murabahah has unlocked previously dormant productive capacity. The 56% reduction in average loan size (from 1,200 to 530) indicates that digitalization has made smaller, more accessible loans economically viable. This has direct implications for MSME growth, job creation (15,000+ jobs reported), and household savings accumulation (60% vs 17% in non-program areas). From a market development perspective, the success of early movers (Halal Pay, Rays MFI) has catalysed at least five other commercial banks into entering the market, indicating sustainable competitive dynamics. The elimination of physical collateral appears to provide a practical response to the 'collateral paradox' identified in Islamic finance scholarship. From the lens of the Maqasid al-Shariah perspective, this finding is profoundly significant. Mehmood et al., (2024) argued that collateral-intensive Islamic banking contradicts the preservation of wealth (hifz al-mal) for all members of society and the promotion of economic justice (al-'adl). Digital Murabahah in Ethiopia demonstrates that Islamic finance can realign with its ethical foundations when transaction costs are sufficiently reduced. The fact that 74% of e-Murabaha borrowers were first-time borrowers indicates that digital Murabahah is reaching precisely the populations that collateral-based Islamic finance excluded. This is not merely a technical achievement but a normative one: Available evidence suggests that Ethiopian digital Murabahah has made

significant progress toward realizing the inclusive objectives long associated with Islamic finance.

The resolution of the collateral paradox is technologically enabled but not technologically determined. The key mechanism is *transaction cost reduction* through digitalization of loan origination, underwriting, monitoring, and collection. However, technology alone did not create this outcome. It required integration with existing institutional infrastructure, bank customer relationships, agent networks, and mobile money platforms. The Ethiopian case demonstrates that digital transformation of Islamic finance is not about replacing human processes with algorithms but about reconfiguring the relationship between technology and institutions. The success of multiple platforms using different technological approaches (Halal Pay's mobile wallet, Rays MFI's e-commerce partnership, Kifiya's white-labeled AI platform) suggests that technological diversity, not uniformity, characterizes successful digital Islamic finance ecosystems. Additionally, the resolution of the collateral paradox has direct implications for social equity. Traditional collateral requirements disproportionately excluded women (who often lack assets registered in their names), youth (who have had less time to accumulate assets), rural populations (who hold land under customary tenure without formal titles), and informal sector workers (who have no documented income). By eliminating collateral requirements, digital Murabahah has removed a structural barrier that systematically excluded these populations. The reported figures- 52% women borrowers, 68% youth borrowers, 77% of borrowers outside the regional capital- confirm that exclusion reduction is occurring in practice, not just in theory. These findings position digital Murabahah as an instrument of social justice, not merely financial intermediation.

4.2. AI Credit Scoring as Collateral Substitute

Kifiya's AI decisioning system uses five categories of alternative data: mobile money transaction history, utility and bill payments, agricultural productivity data, e-commerce and merchant transactions, and social and behavioral data. The system scores customers in seconds, with first-time applicants processed within a few minutes and repeat applicants in less than one minute. The program achieved this without pre-existing infrastructure: no functional credit bureau, limited mobile money penetration at launch, and nascent digital ID coverage. AI credit scoring addresses a fundamental market failure: information asymmetry between lenders and borrowers. In traditional credit markets, lenders cannot observe borrower creditworthiness directly, so they require collateral as a signal or safeguard. AI scoring using alternative data solves this information problem by generating predictive assessments

from digital footprints. This reduces the need for collateral, lowers transaction costs, and expands credit access. The economic significance is substantial: 430,000 unique MSMEs, 2.1 million loans, 310 million USD disbursed. These figures represent a meaningful expansion of Ethiopia's formal credit market. Moreover, the short speed of processing means that working capital can reach businesses when needed, not after bureaucratic delays that undermine its utility. The use of AI scoring in Islamic finance raises important Shariah questions that the documents partially address but do not fully resolve. On one hand, AI scoring enables the elimination of collateral, which aligns with Maqasid al-Shariah objectives of inclusion and justice. On the other hand, opacity in AI decision-making raises concerns about gharar (excessive uncertainty). If a borrower cannot understand why they were approved or rejected, does the transaction contain prohibited uncertainty? Haque Mukit et al., (2026) argue that transparency is a Shariah requirement. The Ethiopian documents do not disclose how the AI models are trained, what variables drive decisions, or whether borrowers have rights to explanation. From an ethical perspective, this is a gap that requires attention. However, it is notable that the platforms have obtained AAOIFI certification (HalalGebeya) or operate under internal Shariah boards (Ansar, Halal Pay), suggesting that scholars have found the current implementations acceptable.

This achievement is technologically remarkable because it occurred without pre-existing infrastructure that was thought to be necessary. This finding challenges the "infrastructure-first" model and suggests an alternative: partnership-first, infrastructure-in-parallel. The critical technological enablers were not consumer-facing infrastructure (mobile money, digital ID) but institutional infrastructure. This has implications for other low-infrastructure contexts: investment in partnerships and risk-sharing mechanisms may be more productive than waiting for consumer infrastructure to develop. The use of diverse alternative data sources (mobile money, utilities, agriculture, e-commerce, behavioral data) suggests that data diversity, not data volume, is the key predictive signal. This finding is consistent with machine learning literature showing that many weak signals aggregated outperform a few strong signals. AI scoring has the potential to be more inclusive than traditional credit assessments because it can assess creditworthiness in ways traditional methods cannot. A woman with no formal employment but regular mobile money transactions, a youth with no collateral assets but consistent utility payments, a rural farmer with no land title but documented purchases of agricultural inputs, all become visible to AI scoring systems. The inclusion figures suggest this potential is being realized. However, AI scoring also carries risks of algorithmic exclusion. Models trained in data from one region may

perform poorly in another. Models that correlate with ethnicity or gender may produce discriminatory outcomes even without explicit discriminatory inputs. The documents do not disclose bias testing results, so the extent to which Ethiopian AI scoring systems are inclusive across all population segments remains unknown. The social promise of AI scoring depends on deliberate governance to ensure fairness.

While AI-based credit scoring expands access to finance, its long-term legitimacy within Islamic finance depends on transparency, explainability, and accountability. Future research should investigate whether borrowers understand automated decisions, whether appeal mechanisms exist, and how algorithmic fairness is monitored across gender, regional, and socioeconomic groups. These considerations are particularly important because opacity in algorithmic decision-making may raise concerns regarding gharar and procedural justice.

4.3. Financial inclusion outcomes

The review reports substantial inclusion outcomes. Rays MFI's e-Murabaha achieved 52% women borrowers, 74% first-time borrowers, 77% of borrowers in the Somali Region, and 39% agricultural-related loans. The Kifiya ecosystem reports 68% youth borrowers. According to program reports, MSEs receiving e-Murabaha financing experienced revenue increases of 83%, profit increases of 43%, and the creation of more than 15,000 full-time jobs. Households in program areas had savings rates of 60% compared to 17% in non-program areas. The economic impact findings- 83% revenue increase, 43% profit increase, 15,000+ jobs created- indicate that financial inclusion through digital Murabahah translates into measurable economic development. This is not inclusion for its own sake; it is inclusion that generates growth, employment, and household resilience. The finding that 74% of borrowers were first-time borrowers indicates that digital Murabahah is expanding the credit market, not just displacing existing borrowers from one lender to another. From a macroeconomic perspective, the mobilization of previously uncollateralized productive capacity represents a net addition to economic output. The household savings finding—60% vs 17%—suggests that access to digital financial services enables households to move from subsistence to accumulation, building buffers against shocks. Moreover, the inclusion outcomes directly address the objectives of wealth preservation (hifz al-mal) and social justice (al-'adl). Wealth preservation is not only about protecting existing wealth but about enabling wealth creation for those who currently have none. The 15,000+ jobs created represent new wealth-generating capacity for thousands of Ethiopian households. Social justice is served when financial

systems reach those previously excluded—women, youth, rural populations, first-time borrowers. The 52% figure for women borrowers is particularly significant given the barriers women face. However, the variation across platforms (52% for Rays MFI vs 35% for Kifiya) suggests that inclusion is not automatic. Deliberate design, targeted products like Ansar Salihat for women, outreach through women agents, and simplified KYC produce better inclusion outcomes. This finding has ethical implications: financial institutions have a positive obligation to design for inclusion, not merely to remove barriers.

The inclusion findings are substantial but not universal. The documents do not report reach to several important populations: pastoralist communities (who are mobile and lack fixed addresses), internally displaced persons (who may lack documentation), persons with disabilities (who face additional barriers), and religious minorities (non-Muslims who may be excluded from explicitly Islamic products). The social impact of digital Murabahah is therefore real for those reached but incomplete in coverage. The 74% first-time borrower figure indicates that digital Murabahah is expanding the credit frontier, but the frontier still excludes many. The geographic concentration of success in the Somali Region (with documented challenges in other regions) suggests that context matters. Social inclusion outcomes depend not only on product design but on local institutional capacity, community trust, and infrastructure availability.

The findings have demonstrated that Ethiopia has achieved a systemic transformation in digital Islamic finance. The collateral paradox has been resolved to some extent at scale through digitalization and AI scoring. Women, youth, first-time borrowers, and rural populations are being reached at levels that would have been unimaginable in 2010. However, the experience in some regions cautions against technological determinism: institutional capacity matters as much as digital infrastructure. The governance gaps, like no AI transparency framework, no centralized Shariah authority, and no credit bureau access, threaten long-term sustainability and Shariah compliance.

4.4. Future Potential and Opportunities: Transforming Ethiopia's Socio-Economic Landscape Through Digital Islamic Finance

The digital Murabahah and AI credit scoring system that has emerged in Ethiopia is far more than a financial innovation. It is a foundational infrastructure with the potential to address multiple interconnected socio-economic problems that have constrained Ethiopia's development for decades. Having successfully resolved the collateral paradox and demonstrated inclusion at scale, this system now stands at a threshold. Available evidence indicates that

digital Islamic finance has demonstrated promising results in Ethiopia. The more important policy question now concerns how these initiatives can be expanded sustainably while maintaining inclusion, transparency, and Shariah compliance. The question is how far its benefits can be extended. Below are the most promising opportunities for this system in addressing Ethiopia's most persistent socio-economic challenges.

- **Unlocking the Potential of Youth and Women**

Digital Murabahah has the potential to promote financial inclusion and economic empowerment among youth and women in Ethiopia by addressing key barriers to accessing conventional finance. Given Ethiopia's large youth population and limited formal employment opportunities, AI-based credit assessment and collateral-free financing can enable young entrepreneurs to establish and expand businesses, thereby creating employment and supporting economic growth. Similarly, digital Murabahah can enhance women's participation in economic activities by overcoming constraints related to asset ownership, mobility, and access to formal credit. Evidence from existing e-Murabahah initiatives, including significant job creation and high levels of female borrower participation, suggests that expanding digital Murabahah could contribute to entrepreneurship development, income generation, poverty reduction, and broader socioeconomic and gender equity outcomes.

- **Transforming Agriculture and Rural Development**

Digital Murabahah has the potential to support agricultural transformation and rural development in Ethiopia by addressing longstanding financial constraints faced by farmers and agribusinesses. Through alternative credit assessment methods that utilize agricultural productivity and transaction data rather than traditional collateral requirements, digital Murabahah can expand access to financing for rural producers who are often excluded from formal banking services. Evidence from e-Murabahah programs indicates substantial participation by agricultural borrowers and significant outreach beyond urban centers, demonstrating its capacity to serve rural communities. Expanded access to financing can enable farmers to invest in improved inputs, equipment, and livestock, while supporting traders and agribusinesses across agricultural value chains. Consequently, the wider adoption of digital Murabahah may contribute to increased agricultural productivity, reduced rural poverty, enhanced food security, greater resilience to climate-related shocks, and broader rural economic development.

· **Formalizing the Informal Economy and Building Resilience**

Digital Murabahah can contribute to the formalization of Ethiopia's large informal economy by providing underserved individuals and small businesses with access to formal financial services. Through digital registration, borrower identification, and the creation of credit histories, the system enables previously unbanked individuals to establish a formal financial presence and gradually integrate into the broader economy. The high proportion of first-time borrowers in existing e-Murabaha programs suggests that digital Islamic finance effectively reaches populations that have historically been excluded from formal financial institutions. As borrowers build repayment records and gain access to larger financing opportunities, they may become better connected to formal markets, supply chains, and government support programs. Consequently, the expansion of digital Murabahah has the potential to enhance financial inclusion, support business growth, strengthen economic resilience, improve economic data collection, and contribute to the gradual formalization of economic activities.

· **Bridging the Geographic Divide and Strengthening Social Stability**

Finally, digital Murabahah has the potential to reduce geographic disparities in financial access by extending financial services to rural, remote, and historically underserved regions of Ethiopia through digital platforms and mobile money technologies. By minimizing dependence on physical banking infrastructure and conventional collateral requirements, it can improve access to finance for populations that have traditionally been excluded from formal financial systems. Evidence from the expansion of financial services in the Somali Region demonstrates the feasibility of reaching previously underserved communities through digital financial solutions. Greater access to credit can stimulate local economic activity, support entrepreneurship, and create employment opportunities within rural areas, thereby reducing regional inequalities and migration pressures. As a result, the broader adoption of digital Murabahah may contribute not only to inclusive economic development but also to enhanced social stability, resilience, and national cohesion through the expansion of legitimate economic opportunities across diverse geographic regions.

5. Conclusion

This study investigated how Ethiopia can move beyond physical collateral through digital Murabahah and AI credit scoring to expand financial inclusion among MSMEs and low-income populations without undermining Shariah

principles. The findings suggest that Ethiopia has begun addressing the collateral paradox through the integration of digital Murabahah platforms and alternative-data credit assessment mechanisms. Digital Murabahah platforms—Halal Pay, Rays MFI E-Murabaha, Ansar, HalalGebeya, and the Kifiya ecosystem—have eliminated physical collateral requirements, reaching 1.3 million users, 430,000 unique MSMEs, and facilitating over 2.1 million loans, surpassing 50 billion ETB in uncollateralized digital lending within two and a half years. AI credit scoring using alternative data (mobile money, utility payments, agricultural data, e-commerce transactions, and behavioral patterns) is the enabling technology, processing customers in seconds without requiring pre-existing infrastructure. The inclusion outcomes are substantial: 52% women borrowers, 74% first-time borrowers, 68% youth borrowers, and 77% of borrowers outside regional capitals, with reported revenue increases of 83% and profit increases of 43%, creating over 15,000 jobs. However, the Afar Region experience cautions that institutional capacity is a necessary condition—digital solutions cannot compensate for governance failure. The regulatory environment remains incomplete, lacking a centralized Sharia advisory board, credit bureau access, and any framework for AI governance. The evidence reviewed in this study indicates that reducing dependence on physical collateral through digital Murabahah and AI-enabled credit assessment is both feasible and potentially scalable within the Ethiopian context, but complete success requires closing governance gaps and strengthening institutional capacity in fragile regions.

6. Recommendations

Based on the study's objectives, the following recommendations are addressed to relevant stakeholders.

- NBE should establish a centralized Sharia advisory council. Create a national Sharia advisory council with authority to issue binding rulings on AI scoring, alternative data privacy, digital collateral, and automated contract validity. This would create consistency across institutions, reduce consumer uncertainty, and provide authoritative guidance for novel issues emerging from digital Islamic finance.
- Develop a Regulatory Framework for AI Governance in Credit Scoring. Issue directives requiring algorithmic transparency (disclosure of data sources and variable categories), regular bias testing across demographic and geographic segments, consumer rights to explanation of automated decisions, data protection standards for alternative

data, and accountability mechanisms for erroneous or discriminatory decisions.

- Islamic Financial Institutions and Development Partners should strengthen institutional capacity in fragile regions. Prioritize governance reform, leadership development, credit culture building, and community trust engagement alongside digital investment. Diversify institutional partnerships in fragile contexts; maintain relationships with at least two financial institutions per region to reduce single-point-of-failure risk, as demonstrated by the Afar experience.
- Institutions should mandate transparency and disclosure standards. Publish annual reports disclosing default rates, portfolio quality metrics, Shariah audit findings, algorithmic bias testing results, and model performance metrics. Follow AAOIFI disclosure standards to enable stakeholder assessment of prudential soundness and Shariah compliance.
- Set explicit inclusion targets for women, youth, rural populations, pastoralist communities, internally displaced persons, and first-time borrowers. Develop targeted products (along the lines of Ansar Salihat for women), recruit and train women agents, simplify KYC requirements, and conduct outreach through community organizations and religious leaders to reach populations currently excluded from documented outcomes.

7. Study Limitations and Future Research Directions

This study relies exclusively on secondary documentary sources and does not include primary data collection through interviews, surveys, or field observations. Consequently, the study cannot independently verify all reported operational outcomes and relies on the accuracy of information published by financial institutions, development organizations, and regulatory bodies. The findings should therefore be interpreted as evidence documented in existing sources rather than definitive causal proof of impact. Future studies should move beyond documentary evidence by employing mixed-method or case-study approaches involving borrowers, Islamic bank managers, fintech providers, regulators, and Shariah scholars. Such research would provide stronger evidence regarding borrower outcomes, algorithmic fairness, customer perceptions, and the long-term sustainability of AI-enabled Islamic finance models.

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