How can blockchain-based lending platforms support microcredit activities in developing countries? An empirical validation of its opportunities and challenges

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Abstract

The aim of this paper is to explore the opportunities and challenges of using blockchain technology to support microcredit activities of microfinance institutions operating in developing countries. Microfinance is widely regarded as a tool for poverty alleviation and a means of integrating the unbanked population into the financial system. Using expert interviews from several industries including microfinance and blockchain, we explore the potential and challenges of blockchain-based platforms in microcredit settings. The findings suggest that blockchains could create credible financial profiles for lenders, automate contracting through smart contracts and attract funds at lower costs. However, coordination complexities, strategic issues, and privacy concerns are key challenges to blockchain implementation. The study advances the understanding of blockchain applicability in the microcredit space and carries practical significance for microfinance institutions as to how blockchain can — in combination with mobile money — improve operational efficiency and strengthen governance on microcredit activities.

Keywords: Blockchain, financial inclusion, microfinance, microcredit, micro-lending, mobile money, unbanked population.

1. Introduction

Financial inclusion has been an essential topic in economic development over the last two decades (Demirguc-Kunt & Klapper, 2012; Hussain et al., 2023; Kumar et al., 2015). Financial inclusion means individuals, who do not have a bank account in a formal banking system, can access a range of essential financial services through a mobile handset (GSMA, 2014). World Bank estimated in 2017 that around 1.7 billion adults are unbanked worldwide (The World Bank, 2018). These unbanked people do not have any account (e.g., transaction or savings) with a commercial bank (Grimes et al., 2010). As a result, they are more likely to suffer multiple forms of social exclusion, further increasing their poverty level (Aduda & Kalunda, 2012).

Microfinance is defined as providing small loans (also called 'microcredit') to poor and rural entrepreneurs to improve their living standards (Elliot Esi et al., 2018). Typically, these loans are collateral-free, disbursed in a group, and members of the group are jointly liable for the repayment (Kringlen, 2016). Generally, the target group is the rural population not served by traditional financial institutions (Agnihotri, 2013; Uwamariya, 2018). Thus, microfinance is an essential societal development tool that facilitates financial inclusion services for the poor (Schmidt & Sandner, 2017). Microfinance also supports a financial system with the spirit of empowering women by giving them access to a variety of financial services (Odoom et al., 2019). The organisations that provide microfinance services are called Microfinance Institutions (MFIs), operating within a global microfinance market of US$228.8 billion in 2023 (Fact.MR, 2023).

Grameen Bank, BRAC, and Kiva are some of the biggest MFIs in the world. These MFIs attempt to fulfil the financial needs of the poor living in isolated areas (Sriram, 2005). However, it needs to be noted that MFIs charge relatively high interest rates (e.g., 25%) for loans that are as low as $75 (Parvin et al., 2020) and, on average, below $2000 (Al-Azzam & Parmeter, 2021; Dhib & Ashta, 2021), and various academic and practitioner observers postulate that many MFIs prioritise financial goals over social objectives (Blanco-Oliver et al., 2023; Quayes, 2021)

Microcredit activities of MFIs often combine mobile money that operate independently from traditional banking through mobile network operators or in partnership with network operators to exchange payments and store value (Schilling & Seuring, 2023). Mobile money refers to a payment concept that allows its account holders to use a mobile handset to deposit, withdraw, and transfer money from a network of transactional agents (Dermish et al., 2011). Mobile money service providers engage countrywide agents to facilitate instant money transfers for their mobile wallet account holders. Account holders of mobile money services can initiate basic financial transactions without having a bank account (Dorfleitner et al., 2019; GSMA, 2014; Nan, 2019). 'bKash' in Bangladesh, 'M-PESA' in Kenya, 'Oxigen' in India, and 'Dialog eZ Cash' in Sri Lanka are some of the most notable mobile money service providers in the world (GSMA, 2014). Therefore, mobile money provides an alternative channel for delivering financial services to unbanked population (Afshan & Sharif, 2016; Avom et al., 2023). Mobile money also benefits MFI's borrowers as it permits timely repayment of loan instalments from any location and to be compliant with loan conditions (Angelucci et al., 2015). In addition,

through a widespread network of agents, mobile money providers can effectively serve remote clients (Reeves & Sabharwal, 2013).

MFIs face various challenges related to their microcredit activities, and the related dual mission to balance social mission with commercial performance (Chen & Wang, 2024; Simo et al., 2023). They suffer from high operational and oversight costs on loan disbursement and collection due to information asymmetry (Caudill et al., 2009; Tadele et al., 2018). The opportunistic behaviour of dishonest borrowers allows microcredit borrowers to access multiple loans from several MFIs (Mia, 2017). In addition, MFIs' lack of visibility on borrowers' loan utilisation causes high credit risk (Schicks, 2014) as microcredit loans are primarily collateral-free (Conning, 2000). Also, MFI staff may be biased or involved in money misappropriation (Ali et al., 2017). Microcredit products predominantly target rural female borrowers, yet the burden of loan repayment often renders them vulnerable, particularly as they frequently rely on their husbands to fulfill regular instalment obligations (Brau & Woller, 2004). This dependency can result in adverse consequences. Finally, poor people are the bearers of high-interest charged by MFIs over conventional financial institutions (Rosenberg et al., 2013), which means the world's poorest are the payers of the highest cost of capital (Kringlen, 2016).

Blockchain technology may be a solution to these problems due to its decentralised and shared data infrastructure that allows connected users to trace the entire transaction process in real-time (Gan & Lau, 2024; Wang et al., 2019). The immutability feature of blockchain ensures trust since all transactions are recorded chronologically and hence cannot be altered (Nguyen et al., 2021). Trust is highly relevant for financial services as a lack of trust increases uncertainty, resulting in higher interest rates if passed on to the customers (Barr et al., 2008). Furthermore, in a peer-to-peer lending model where no intermediary is involved, blockchain can reduce behavioural bias in loan allocation and improve monitoring efforts for bad loan recoveries (Gonzalez, 2019).

Blockchain's benefits have been explored in crowdfunding (Muneeza et al., 2018; Nguyen et al., 2021) and entrepreneurial financing (Chang et al., 2020; Kowalski et al., 2021). According to Casilli and Posada (2019), platforms are software or hardware infrastructures through which users and organisations can create applications, services, and communities. Traditional crowdfunding platforms suffer from fraud risk, a lack of trust, and a communication gap between borrowers and lenders (Freedman & Nutting, 2015; Saadat et al., 2019). Blockchain is considered by Saadat et al. (2019) as a means to increase the lender's confidentiality through maintaining anonymity. Conventional crowdfunding platforms, being an intermediary between lenders and borrowers, charge a platform fee (often 4-5% of the total amount raised) and a payment processing fee (e.g., 3% of each transaction) (Kumari & Parmar, 2021). The usage of blockchain, as proposed by Kumari and Parmar (2021), can reduce platform charges and processing fees by eliminating the role of intermediary in the fundraising process. Blockchains can also be used in combination with smart contracts to increase trust between transacting parties as smart contracts execute automatically pre-defined activities whenever certain conditions are met (Devine et al., 2021; Saadat et al., 2019).

Although Liu et al. (2020) and Liu et al. (2023) identify blockchain-based lending as a highly relevant research topic, the prior microfinance literature has not adequately explored blockchain in microcredit activities for MFIs. Many blockchain studies are conceptual and the literature on blockchain adoption concerning financial inclusion initiatives such as rural finance or microfinance is highly limited (Larios-Hernández, 2017; Schuetz & Venkatesh, 2019; Swan, 2017). For example, Larios-Hernández (2017) discuss blockchain entrepreneurship's potential to bring financial services closer to financially excluded people. Schuetz and Venkatesh (2019) highlight research opportunities regarding financial inclusion and blockchain. Similarly, Swan (2017), anticipates financial inclusion as one of the key economic benefits of blockchain. While these review papers provide valuable insights, Liu et al. (2023) call for empirical research to explore how blockchain might impact microfinance. We address this research gap by focussing on how blockchain can support microfinance activities in developing countries, as well as the challenges of adopting blockchain in microfinance using an empirical approach:

RQ1: How could blockchain support microcredit activities in developing countries?

RQ2: What are the challenges that prevent blockchain-based microfinance platforms?

To the best of our knowledge, this is the first empirical study to advance our understanding of blockchain applicability in the microcredit space. We use semi-structured interviews with microfinance and blockchain experts (N = 15) to answer the research questions. The findings suggest that blockchain can create a credible financial profile on which lenders can trust and this may allow poor people to obtain funds at a lower cost. While blockchain technology can address many current issues in microcredit activities, coordination complexities, strategic issues and privacy concerns present as key challenges to its implementation.

The remainder of the paper is structured as follows: Section 2 provides an overview of microcredit operational challenges and blockchain technology. Section 3 describes the research method. The findings are presented in Section 4 and followed by a discussion in Section 5. Section 6 summarises theoretical and practical implications along with the study's limitations. This section also suggests avenues for future research and concludes the paper.

2. Related literature

In this section, we take a closer look at the challenges of microcredit activities in developing countries, blockchain technology, and the related challenges that may prevent its application in microfinance.

2.1 Challenges of microcredit activities

The literature highlights several practical challenges concerning microcredit activities of MFIs operating in developing countries. Multiple borrowing is a substantial challenge in microcredit activities and occurs when a household member borrows from more than one MFI (Lahkar & Pingali, 2014). The lack of an inter-organisational centralised record system (credit bureau) for storing borrower profiles within MFIs contributes to this problem (Mia, 2017; UNCDF, 2019). It is estimated that two-thirds of all micro-financed households in Bangladesh borrow from several MFIs without declaring existing loan commitments (Ali & Hatta, 2012; Ali et al., 2017; Gehlich-Shillabeer, 2008).

Another microcredit challenge is MFI staff's engagement in financial misconduct (e.g., intentional omission of loan instalment recording) or preference for wealthier borrowers to disburse loans (Ali et al., 2017). Some MFIs also avoid lending to borrowers who do not have a source of income (Khan, 2009), which is against the spirit of microfinance. Poor visibility on loan utilisation is another common problem in microcredit activity. Many surveys show that 46% of disbursed loans are utilised to pay off personal debt and 28% of loans are spent for domestic purposes (Lalitha & Soujanya, 2019). The wide diversity among borrowers increases information asymmetry as MFIs have limited capacity to track borrowers' activity with loan money (Tadele et al., 2018; Tayo et al., 2017).

The microcredit industry has a high operating cost structure for its doorstep nature of 'banking' (Ahmed, 2004), i.e., delivering services to their beneficiaries living in rural areas (Caudill et al., 2009; Mersland & Strøm, 2010). As a result, the industry faces higher loan collection costs that are also exacerbated by adopting a short-interval loan collection policy. Traditionally, MFIs deploy field staff for loan disbursement and collection, which is a highly human-intensive field operation. Engaging a large pool of field staff results in additional operational overheads (Reeves & Sabharwal, 2013). This human-dependent operation also limits MFIs' ability to increase their service outreach and causes sub-optimal services to their borrowers (UNCDF, 2019). MFIs charge high-interest rates over conventional banking to meet high operational costs, which is a criticism of current microcredit activities (Convergences, 2018). This results in the world's poorest being payers of the highest cost of capital (Kringlen, 2016). Furthermore, the strict loan repayment conditions of microcredit make many poor borrowers destitute (Cons & Paprocki, 2010), and in some cases, the pressure of weekly loan repayment leads to suicidal actions (Hossain et al., 2009).

Microcredit programmes are also criticised for their focus on females and rural-based populations. Some scholars have argued that there may be a "mission drift" as MFIs increasingly prefer better off customers than their original customers (Mersland & Strøm, 2010). The Microfinance Barometer report found in 2018 that of 139.9 million borrowers, 80% were women, and 65% were rural borrowers (Convergences, 2018). MFIs exploit female borrowers by imposing harsher credit rationing (e.g., granting smaller loans) than for men (Brana, 2013; Garikipati et al., 2017). Moreover, female borrowers endure profound mental anxieties and bear physical assault by their male partners when they depend on their husband's income for weekly loan repayments (Cons & Paprocki, 2010; Das et al., 2016; Hermes & Lensink, 2011; Khan, 2015). MFIs were also found to be negligent towards the needs of the urban poor (Dey, 2015) and part of the reason is the group lending principle. This principle of lending is based on the social capital concept, which works better among rural populations as social ties support the concept of social capital (Häuberer, 2011). Social capital is synonymous with social collateral, which substitutes for the missing tangible collateral (i.e., security deposit) for microfinance (Conning, 2000). Although the group lending model minimises information asymmetry for MFIs, the participating borrowers in the group lending are deprived of their independence (Ito, 2003). The group lending model helps each borrower better understand the financial capacity and moral behaviour of other members within the group; however, group lending creates peer pressure, occasionally leading to violent action against the default member by the other group members (Ito, 2003). The group lending model also triggers

an adverse selection problem as it fails to differentiate risky and safer borrowers; thus, it imposes the same interest rate and loan conditions on each group member, which is an unfair treatment for good borrowers (Moro Visconti, 2019). While studies such as Phan et al. (2023) indicate that microcredits significantly reduce vulnerability to poverty in Vietnam, the shift towards profitability challenges the initial mission of social outreach (Quayes, 2021).

2.2 Blockchain technology and smart contracts

Blockchain is a particular type of data infrastructure in which information is stored inside the blocks, cryptographically interconnected, chronologically ordered by time-stamping algorithms (Gipp et al., 2015; Pajila et al., 2021) and governed by a decentralised consensus mechanism (Hawlitschek et al., 2018). Blockchain allows transactional data to be recorded, synchronised and shared securely across the distributed network (Natarajan et al., 2017). Any new block is added when a certain number of nodes have approved it (the process of reaching consensus), which makes central certifying authority redundant (Rashideh, 2020; Wang et al., 2019). Once a block is appended to the blockchain, it cannot be altered since all blocks are signed with a digital signature created by a cryptographic hash function and each of these blocks includes the hash details of the previous block (Hirsh & Alman, 2020; Natarajan et al., 2017). Hash functionality creates the chain part of a blockchain and makes blockchain immutable which generates trust on the data stored on the blockchain (Seebacher & Schüritz, 2017). Blockchain ensures non-repudiation (participants cannot deny the transaction) of information through security measures, such as the digital signature, identity authentication and time stamping (Fang et al., 2020). Digital signatures in blockchain systems use asymmetric encryption (the usages of pairs of public and private keys) that maintains the secrecy of information (Seebacher & Schüritz, 2017). The shared data infrastructure of blockchain allows access to real-time synchronised information for ensuring transparency (Atlam & Wills, 2019).

Moreover, blockchain provides an enabling platform for smart contracts — a set of logic rules written as a code script, which can be embedded into the blockchain to regulate the execution of a transaction (Kumari & Parmar, 2021; Sultan & Lakhani, 2018). In a smart contract, the logical workflows of a transaction are defined, and these workflows are self-executing based on satisfying the predefined conditions (Kumari & Parmar, 2021). Three elements of a smart contract that make it distinct are autonomy (self-operating capacity once it is launched), self-sufficiency (ability to arrange resources such as processing power or storage), and decentralisation (distributed and self-executing across network nodes) (Swan, 2015).

2.3 Blockchain technology in microcredit operations and its challenges

Research suggests that the technical characteristics of blockchain technology can bring benefits to the microcredit industry. Blockchain can be utilised to create a shared microcredit ledger on borrowers' lending information among MFIs to reduce the problem of information asymmetries, moral hazards and multiple borrowings (Schmidt & Sandner, 2017). Having a borrower's transaction history in an unmodified state facilitated by blockchain can be used for assessing creditworthiness for availing loan facility (Schmidt & Sandner, 2017). Blockchain can also ensure non-repudiation, especially in developing countries where the regulatory and legislative environment for rural finance is lacking (Shah & Patel, 2017). The blockchain's digital signature feature can be used to authenticate a borrower's loan history, which could be

used for a credit scoring model for microcredit platforms. In this context, blockchain can replace traditional lending intermediaries with analytics-driven credit decisions (Mahajan & Srivastava, 2019).

Since MFIs encounter challenges in verifying the identities of their borrowers, Lalitha and Soujanya (2019) propose a blockchain-based (Know Your Client) architecture, in which borrowers can securely store and share their information with any microcredit financial institution at a reduced cost. Furthermore, to resolve the negative aspects of current microcredit activities, such as higher interest rates and stringent loan repayment conditions, Khara et al. (2020) suggest a blockchain-based microcredit system for farmers to enable investors to provide microcredits while allowing farmers to choose their preferred interest rate and loan repayment schedule. Additionally, Saadat et al. (2019) proposes to use blockchain in combination with smart contracts to execute pre-defined activities whenever certain conditions are met and this self-functionality can eliminate the need for trust between transacting parties.

However, blockchain is also associated with substantial implementation challenges including scalability (the system's capacity to maintain performance when usage increases (Toufaily et al., 2021)), interoperability (lack of a common system architecture to connect blockchain framework with legacy systems (Toufaily et al., 2021)), data privacy concerns (Namasudra et al., 2021), potential security vulnerability (polarisation of transaction recording on blockchain commonly referred to as a 51% attack (Namasudra et al., 2021; Swan, 2015; Yli-Huumo et al., 2016)) or 'hidden centrality' (when a specialist group having sophisticated hardware with huge computing power holds full control of the majority of the network's computing power (Drescher, 2017)). Moreover, demand for huge power and its immature technical state (Avital, 2018; Beck & Müller-Bloch, 2017) are hindering wide scale implementation. Apart from these technical challenges, various other factors influence blockchain adoption such as organisational mindset and ecosystem readiness, availability of financial resources, information technology (IT) infrastructure, technical expertise and people's acceptability, and performance expectancy (Dutta et al., 2020; Min, 2019; Toufaily et al., 2021). Furthermore, lack of top management knowledge (Holotiuk et al., 2017), misunderstanding of blockchain's technical and strategic value (Toufaily et al., 2021), public perception towards blockchain due to Bitcoin scandals (Swan, 2015), regulatory, environmental and governance issues (Vincent, 2019) impact the feasibility of blockchain-based projects.

3. Research method

Since previous research on blockchain's potential in microcredit is conceptual, we chose an exploratory research design using interviews to answer the research questions. In the following section, the qualitative methodology adopted in the paper is explained.

3.1 Sampling and participant's selection criteria

While the sample included a diverse set of developing countries, we did not seek to investigate the underlying political, economic, and social factors that lead to poverty and issues around financial inclusion in each country. Nevertheless, many developing countries face common problems such as low levels of education, particularly among woman, small scale farming and

ethnic fragmentation, which coupled with low population density, low income and geographic barriers contribute to the problem of the unbanked population (Brady, 2019; Kim et al., 2018).

Participants were recruited using a purposeful sampling strategy in combination with 'snowballing' (Brand & Slater, 2003; Suri, 2011). Participants were recruited via LinkedIn or were directly approached via a publicly available email address on the organisation's website that had either a background in MFI or blockchain. Among the MFI experts, two had a focus on mobile money (see Table 1). The sample contained three females and twelve males.

The participant selection process focuses on the expertise in relation to microfinance, mobile money, and blockchain-based microcredit platforms. In the following, we explain our recruiting in relation to all three groups of participants:

1. Participants with experience in microfinance

Participants with a background in microfinance were sourced from developing countries characterised by a significant unbanked population and a substantial presence of microfinance operations. This included Bangladesh, Tanzania, Kenya and Vietnam. All these countries have large microfinance markets in terms of the number of borrowers (Convergences, 2018).

2. Participants with experience in mobile money

Two mobile money experts were chosen from a mobile money company that facilitated microcredit distribution and collection for MFIs. Both had extensive working experience in microcredit operations and mobile money usage for microcredit management. These participants were selected from Bangladesh because mobile money adoption was piloted in some MFIs during the time of the data collection. The participants had detailed knowledge about this initiative.

3. Participants with experience in blockchain-based microcredit platforms

Participants in this group were recruited based on their experience in blockchain-based microcredit platforms and related concepts such as crowd-lending, micro-insurance, international money transfer, and cryptocurrencies. The country was not a selection criterion for these participants as an online platform can be based in a developed country even if it provides global services that individuals in developing countries access.

Table 1 summarises the participant's geographical location, organisational designation, experience area and justification for this study.

Interviewee label	Location	Designation	Experience area	Details of Experience
MFI-1	Bangladesh	Senior Manager	Microfinance	Over a year of experience in microcredit internal audit at a renowned MFI and was involved in mobile money integration for its microcredit activities.
MFI-2	Tanzania	CEO & Director		Over 10 years of experience in the operation of mobile money for microcredit activities.

MFI-3	Kenya	CEO & Director		More than 18 years of experience gained from working at an MFI across three developing countries: Kenya, Bangladesh and Afghanistan, including mobile money within microcredit activities.
MFI-4	Bangladesh	Head of Internal Audit and Compliance		More than 5 years of internal audit experience at microcredit activities gained from working with two MFIs
MFI-5	Bangladesh	Jr. Asst. Director		Worked over 5 years at the internal audit division for two MFIs
MM-1	Bangladesh	General Manager	Mobile money	FinTech Specialist with an experience of over 6 years in a leading financial services firm developing digital lending solutions.
MM-2	Bangladesh	GM & Head, Remittance Operation		Over 10 years of experience in mobile money, including cross-border payments and wallet-based remittance operations.
BE-1	Thailand	Founder	International money transfers	Founder of a company that uses a blockchain-based banking and payment platform. Over 12 years of experience in high-risk payment processing.
BE-2	Mexico	Cofounder	Crowdfunding for coffee farmers	Experience of over 4 years as a Cofounder of a company that uses a blockchain-based lending platform connecting coffee producers with global lenders.
BE-3	Mexico	Senior Architect	Electronic Invoicing	IT professional with an experience of over 8 years engaged in defining a road map for Mexican Federal Government's Internal and External Revenue Service to build a central database and a single source of all commercial tax invoices.
BE-4	Kenya	Software Engineer	Microfinancing for SMEs	Software engineer with over 6 years of experience engaged in developing a blockchain technology-driven lending platform to provide microfinance to food kiosk owners.
BE-5	USA	Cofounder	Fintech and Cryptocurrency	Cofounder of a Fintech company with over 12 years of experience working with tech companies and institutions to create digital transformation and building new decentralised finance solutions.
BE-6	Kenya	Research Manager	Microfinancing for SMEs	Over 6 years of experience engaged in leading a machine learning and blockchain technology-driven lending platform to provide microfinance to food kiosk owners.
BE-7	Indonesia	Chief Executive Officer	Micro-insurance	Experience in the deployment of blockchain solutions for a leading technology company. CEO of a company that allows loan providers to make evidence-based credit decisions without the need for a credit score that is suitable for individuals and SMEs who do not have any credit history.

BE-8	Canada	Blockchain Academic	Bitcoin & Fundraising	An expert of blockchain-based business models for social impact.

Table 1: Background of the participants

3.2 Data collection and analysis

This study uses semi-structured interviews for data collection. Interviews aim to identify new microfinance challenges and determine blockchain solutions for those as well as challenges that were already mentioned in the literature. All interviews were conducted via Zoom[1] due to the constraints on physical movement during the COVID-19 period and the wide geographic location of participants between November 2020 and June 2021. The duration of audio-recorded sessions ranged from 25 to 35 minutes. Participants were provided with an explanation of the purpose of the research project, which aimed to understand how blockchain technology can support microfinance activities and its challenges. Questions differed depending on the background of the participant (e.g., microfinance or blockchain). While participants provided examples from their own domain of expertise and industry (e.g., blockchain), the focus of the interviews remained on microfinance as explained to the participant at the beginning of the interview. The interview protocol is presented in Appendix A. Interviews were conducted in English and Bengali. The latter was first transcribed and then translated into English with the support of a bilingual expert. The transcripts were analysed using NVivo 12 Pro.

Maxwell (2004)'s iterative phases of data coding were followed when analysing the interview data. The literature review guided the start of initial coding, followed by open coding based on interview data. The interview transcripts were thoroughly analysed to identify recurring categories. Codes were created and then grouped into categories based on similar responses from the participants. While creating codes, the researchers regularly referred to the reviewed literature. This was done to check whether the codes used in this study matched the themes identified in extant literature or whether new codes emerged from the data. Open coding was followed by axial and selective coding to identify broader categories, themes and sub-themes (Corbin & Strauss, 2008). The analysis was conducted in a repetitive manner, going back and forth between the codes and the emerging themes to best describe the data. To ensure intercoder reliability, two researchers analysed the data separately. Based on the results, two themes were merged, and theme definitions were revised. This was followed by a second round of coding, which resulted in an intercoder reliability of 95.56%.

Challenges emerged concerning the two research questions of the paper: how blockchain technology can support microcredit operations (RQ1) and the challenges of adopting blockchain in microfinance (RQ2). The challenges were identified based on the existing literature and the interviews that were conducted. Overall, 17 challenges were identified and aggregated into six categories. Three categories relate to the challenges of current microfinance operations (R1), while the remaining three summarise the challenges of adopting blockchain in microfinance (R2). Figure 1 depicts the relationship between challenges, categories, and

[1] https://zoom.us/.

research questions that emerged from the coding process. We follow the same structure in the next section, where we discuss the results in detail.

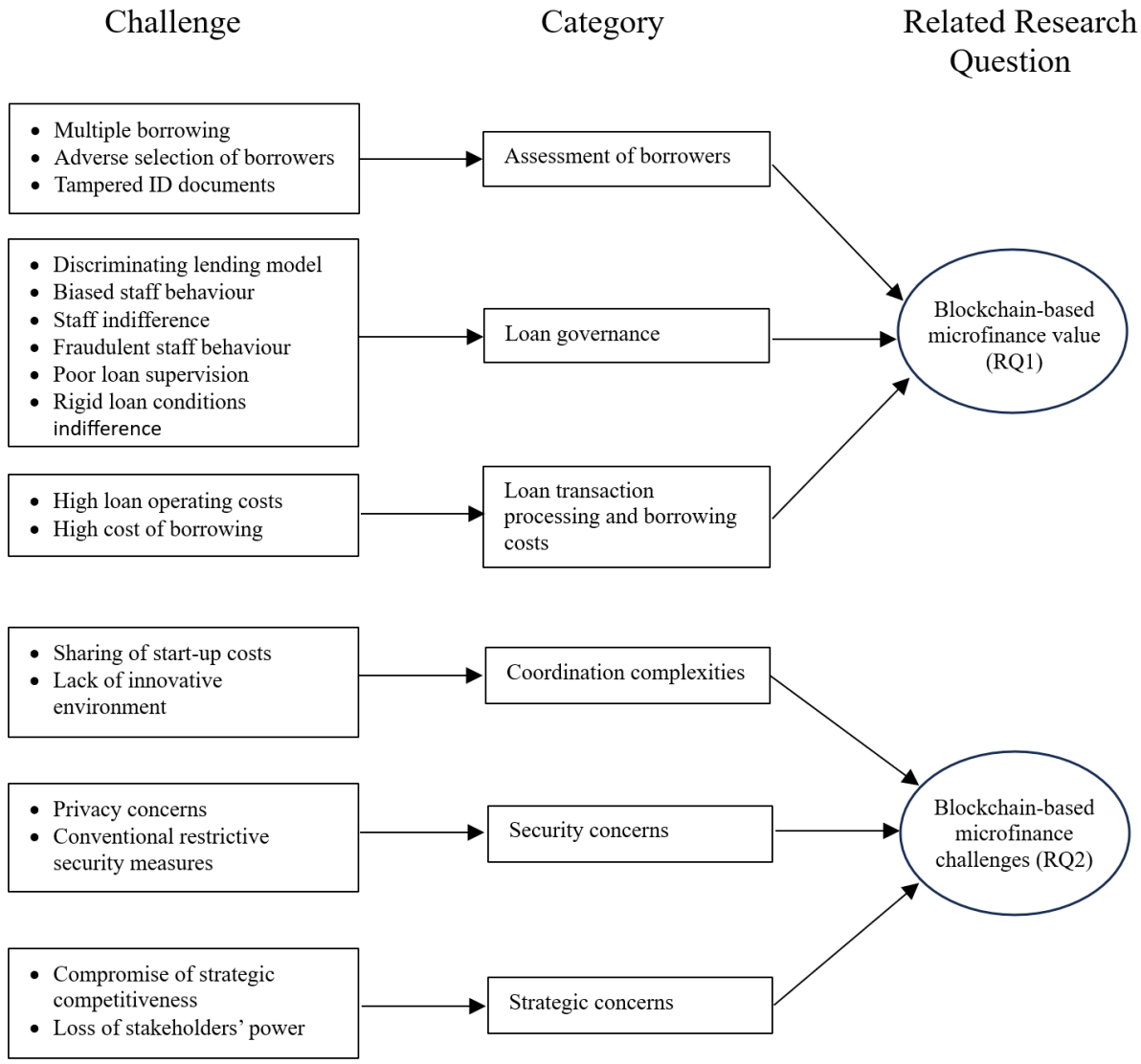

Figure 1: Data analysis and structure

4. Results and discussion

In this section, we present and compare our findings against the existing literature and outline how blockchain technology can bring value to microfinance operations by mitigating the existing challenges. We also identify eleven challenges in relation to adopting blockchain-based microfinance solutions, covering three distinct categories. Eight challenges were already mentioned in the literature, while three previously unreported challenges emerged from the interviews (see Table 2).

4.1 Potential of blockchain to support microcredit activities

4.1.1 Assessment of borrowers

In line with previous studies such as Mia (2017) and UNCDF (2019) Participants with a microfinance background confirmed that the absence of a central credit database enables multiple borrowings as MFIs' internal systems fail to identify the loan history of a borrower with other MFIs. Similarly, VanBastelaer (2002) and Simtowe et al. (2006) reported that the lack of a central credit database creates a challenge for MFIs to assess the creditworthiness of borrowers. Our findings, confirm these challenges.

Another problem concerning assessing borrowers arises from weak identity verification processes. ID fraud is a global challenge in the finance industry. It increased by 83% from 2020 to 2022 and accounted for 5.3% of global digital fraud in 2022 (TransUnion, 2023). The experts reported that ID verification is a particular issue for MFIs as they assess their borrowers' identity primarily using identification cards (IDs) provided by the government. However, in developing countries such as Bangladesh, MFIs do not have adequate access to the national identification database to authenticate the submitted IDs at the time of loan application, making it easy for borrowers to commit fraud by submitting tampered ID documents. MFI-1 stated:

"*[…] sometimes they [borrowers] manipulate NID[2] numbers. They do this with the help of a local computer shop and change some digits of those IDs, leaving other information intact and then submit it to another branch where he[/she] is not known to that MFI personally. So, this is difficult to identify as there is no NID verification system." (MFI-1)*

Blockchain technology has features to address borrowers' identification and verification challenges. The blockchain experts agreed that a central credit database on financial profiles of loan applicants can be built on blockchain to strengthen the identity verification of borrowers.

"[developing a lending platform] that can be done with other technologies, of course, that's undoubted, you can definitely do that with a standard database. But what it [blockchain] does here, which you cannot [do] is the trust, a single point of truth that all parties can definitely rely on, which is really important in environments where data isn't always accurate." (BE-6)

If the database contains NID data, then it would prevent borrowers from falsifying NID numbers and each loan would be assigned to the corresponding NID of the borrower. This would make it more difficult for potential borrowers to hide existing loan commitments.

[2] NID stands for National Identification (NID) card.

4.1.2 Loan governance

The interviews suggest that several shortcomings in relation to loan governance that were previously mentioned in the literature (see section 2.1) could be addressed through blockchain. This includes staff that may discriminate based on gender or urban segments (Brana, 2013; Garikipati et al., 2017) and prioritise wealthier borrowers (Ali et al., 2017; Khan, 2009). We add to these known challenges "staff indifference" referring to an inadequate due diligence on the part of the MFI staff or a lack of knowledge of loan options with negative effect on the borrower. One expert (MFI-2) stated:

"[the] main challenges are related to staff, who are dealing with the clients. These staff have to provide financial literacy to the borrowers, but if they are negligent, or if the respective staffs are not willing to take financial education, then it is not possible to make our client literate."

In addition, MFIs set staff incentives to motivate field staff to expand their lending business while their staff resort to inappropriate behaviour, including arranging necessary documents on behalf of ineligible borrowers to portray them as eligible for obtaining loans.

"To get the incentive, sometimes they manipulate borrower's data and fulfil the target." (MFI-1)

MFI staff may also assist borrowers to apply for an additional loan to pay off outstanding amounts or withdraw borrower's security money to meet the loan realisation target.

"[…] they (MFI staff) withdraw their (borrowers) savings and deposit them to increase loan collection amount. This withdrawal happens when borrowers migrate places leaving the security money." (MFI-5)

While statistics regarding the frequency of inappropriate staff behaviour and opportunism are not reported in the literature, the significance of these issues for the sector has been acknowledged in recent studies focussing on corruption in the microfinance sector (e.g., Azim & Kluvers, 2019; Kebede et al., 2023). Blockchain has a potential to improve loan governance in relation to these issues. According to BE-4 and BE-6, once relevant information is stored on the blockchain, a trusted credit score (using machine learning algorithms) can be developed for automating credit decisions. So, the analytics-driven lending decision built on blockchain can facilitate loan automation and ensure equal loan availing opportunities.

"[…] you can run models [programmes] on these trusted data, [then] you can come up with credit scores [which are] dynamically adjustable, also the credit limit. (BE-4)

Participants also stated that inadequate loan supervision is a reason for poor loan governance. Especially, when borrowers live in places remote from the MFI's branch office.

"[…] We have a geographical demarcation of our areas […], but who lives at the end of that area may feel discouraged to deposit money coming to office. Similarly, staff face problem in collecting that single loan after travelling such a long distance." (MFI-5)

This aspect has also been described in the literature (Benavides, 2018; Tadele et al., 2018). However, while blockchain cannot reduce the geographical challenges, the recording of every

payment on the blockchain improves visibility, which, in turn, improves the loan supervision. In addition, participants (BE-4, BE-6) outlined the benefit of blockchain in predicting borrowers' loan repayment behaviour. When a borrower's repayment history is stored on the blockchain, it becomes easier to predict the borrower's behaviour toward loan compliance by applying tools (e.g., machine learning) on past transactions stored on the blockchain (BE-4), further supporting the loan supervision as problematic borrowers can be identified early.

Smart contracts could be used to mitigate the negative effects of several of the identified challenges as they reduce human involvement, which in turn reduce dependency on field staff on loan collection activities. For instance, blockchain experts described the potential usage of smart contracts to automate loan sanctioning workflows, i.e. starting with the application, determining loan repayment terms and conditions (e.g., interest rate, maturity date), and finally, fund disbursement and collection (BE-4, BE-6). Thus, smart contracts built on blockchain could be used to release funds subject to fulfilment of loan conditions, which can automate loan governance. The experts referred to a pilot study in which blockchain and smart contracts were used successfully to provide microfinance to individual borrowers to open food kiosks in a developing country. In this context, BE-6 stated that blockchain increased the reliability of the contract details, including the date the contract takes place, loan amount, repayment dates, and terms and conditions.

Another issue that emerged in the interviews are rigid loan conditions as MFIs are less considerate to the financial condition of poor borrowers during loan collection, a phenomenon that is also described in the literature (Cons & Paprocki, 2010). A participant (BE-02) explained that smart contracts supported by blockchain can tailor loan conditions according to the borrower's needs. For example, on the participant's crowd-lending platform — where loans are sourced from a crowd of investors instead of banks — farmers apply for loans in a group through a local agent. Their loans are segmented from the period of cultivation to harvesting. Smart contracts are used to release money subject to fulfilling the conditions set in each cultivation step. The farmer is required to pay off the loan amount once they complete the sale of their harvest. Another participant (BE-4) also explained that blockchain enables dynamical adjustments of lending conditions (e.g., interest rate, loan tenure, credit limits) using smart contracts.

"[…] we provide two [lending] options, they [borrowers] could either pay in four days or eight days. […] And then we're charging them at 1% interest, or 2%. 1% if you pay in four days and 2% if you've paid in eight days, [you can] code [computer programming] those loan options within the blockchain." (BE-4)

4.1.3 Loan transaction processing and borrowing costs

Microfinance suffers from high loan operating costs due to door-to-door service to the rural population, short interval of loan collection, and human-intensive field operation (e.g., Kringlen, 2016; Yeow et al., 2018). One participant (BE-2) mentioned that loan management, which is traditionally managed by staff could be better handled by smart contracts. According to the participant, blockchains can be used to create transaction platforms where necessary controls (e.g., checking that a new loan is within the loan limit) can be set up. Thus, blockchains

can reduce the dependency on MFIs staff in loan sanctioning activities which could reduce labour costs and automate decision-making.

"[…] everything that was administration, office secretary, accounting, all that [can be] substituted by blockchain programming [and] by smart contracts." (BE-2)

Finally, a main problem of microfinance are the high interest rates that range from 24-35% (BFP-B, 2018; Kneiding & Rosenberg, 2008). The experts envisaged that traditional financial institutions would likely join the blockchain network to extend their lending business as they can comfortably rely on the system-driven credit decision. Such participation would increase competition among lenders, resulting in access to cheaper sources of finance for the poor.

"[…] it would be like a 'marketplace'. So, there are the reasons why we would want blockchain, not just for one bank to finance [the borrower], maybe, there'll be multiple banks, you [would] get offers from different banks who will compete on that [interest rates]." (BE-4)

However, it needs to be stated that a more precise profiling of customers via the blockchain is not necessarily desirable. While some customers may be better off, others may not be able to secure a loan, thereby contradicting the social mission of microfinance. In addition, it remains uncertain if cost reductions would be passed on to borrowers as MFIs could also use them to increase their profits.

Table 2 lists the identified microcredit challenges and suggests possible blockchain solutions.

Category	Related Challenge	Description	Related literature describing the problem	Sample quotes supporting new aspects	Possible Blockchain solution
Assessment of borrowers	Multiple borrowing	Borrowers avail multiple loans by hiding existing loan information.	Mia (2017); UNCDF (2019)		Borrower's information can be stored on a central blockchain to develop a shared microcredit ledger.
	Adverse selection of borrowers	Imperfect information on potential borrowers results in failure to differentiate creditworthy borrowers.	VanBastelaer (2002); Simtowe et al. (2006)		
	Tampered ID documents	Borrowers may forge ID documents to commit ID fraud.	NA	*"[…] documentation is a major challenge in microfinance sector, always they are working with less documentation; word of mouth is main, even little verification is enough." (MFI-2)* *"[…] sometimes they [borrowers] manipulate NID[3] numbers. […], this is difficult to identify as there is no NID verification system." (MFI-1)*	
Loan governance	Discriminating lending model	MFIs discriminate against female borrowers by imposing harsher credit rationing and against urban segments.	Brana (2013); Garikipati et al. (2017);		Analytics-driven lending decisions based on blockchain can facilitate loan automation to ensure fair and balanced borrowing opportunities. In addition, the application of smart contracts built on blockchain can reduce human involvement and thereby reduce the dependency on field staff on loan collection activities.
	Biased staff behaviour	MFI's staff may prioritise wealthier borrowers.	Ali et al. (2017); Khan (2009)		
	Staff indifference	Inadequate due diligence and lack of product knowledge of staff.	NA	*"[the] main challenges are related to staff, who are dealing with the clients. These staff have to provide financial literacy to the borrowers, but if they are negligent, or if the respective staffs are not willing to take financial education, then it is not possible to make our client literate." (MFI-2)*	
	Fraudulent staff behaviour	MFI's staff resort to illegal tactics to meet their loan disbursement and collection target to secure incentive.	NA	*"[…] there is a quarterly target, if the branch managers or officers satisfy specific target then they can get an incentive. To get the incentive, sometimes they manipulate borrower's data and fulfil the target. They also give loan to some person who is not eligible for that kind of loan. […] just to fulfil the target." (MFI-1)*	

[3] NID stands for National Identification (NID) card.

	Poor loan supervision	The small size of loans and geographic challenges hinder the visibility on loan utilisation.	Benavides (2018); Tadele et al. (2018)		Blockchain improves visibility by storing business transactions and set loan financing conditions based on that transaction for better control on loan utilisation.
	Rigid loan conditions	MFIs are less considerate to the financial condition of poor borrowers for loan collection.	Cons and Paprocki (2010)		Loans can be customised by applying smart contracts to align the interest of borrowers and lenders.
Loan transaction processing and borrowing costs	High loan operating costs	Microcredit costs are mainly driven by door-to-door service to the rural population, short interval of loan collection and human-intensive field operation.	Caudill et al. (2009); Mersland and Strøm (2010); Kringlen (2016); Rosenberg et al. (2013); Reeves and Sabharwal (2013); Yeow et al. (2018)		Smart contracts can be built to automate loan administration to reduce operational costs.
	High cost of borrowing	Microcredit borrowers bear high interest rates.	BFP-B (2018); Kneiding and Rosenberg (2008)		Borrower's profile stored on blockchain can create trust among lenders that can attract cheaper sources of finance for reducing borrowing costs.

Table 2: Microcredit challenges and related blockchain-based solutions

4.2 Challenge of blockchain technology for microcredit

To answer the second research question, we investigate the challenges that impede the introduction of blockchain technology to microcredit. A total of six challenges were identified of which four were previously not identified in the literature.

4.2.1 Coordination complexities

Addressing coordination complexities stands as a pivotal challenge in leveraging blockchain solutions for microcredit support. The initial hurdles encompass establishing a lending platform and formulating a cost-sharing agreement among involved parties, which presents a considerable complexity. As one participant emphasised, the fruition of a lending platform hinges upon the successful onboarding of diverse stakeholders, including MFIs and suppliers as some MFIs refrain from directly lending to borrowers. Instead, they opt for a collaborative arrangement wherein MFIs directly channel funds to suppliers. These suppliers subsequently provide goods to the borrower, ensuring that funds are directed towards their intended purpose while simultaneously minimising transaction costs. As a result, the blockchain network must maintain effective collaboration among all parties. In addition, the continuity and success of blockchain-based lending platforms depend on the retention/increase of parties on the blockchain network, mutual understanding among the parties, transaction cost efficiency, and the right credit decision led by analytics.

"[…] if you don't have the right parties involved – big banks, big FMCGs [Fast-Moving Consumer Goods], it becomes very difficult to get off the ground. So that's actually a big issue, the sharing of costs of launching it [the platform] and initial start-up costs." (BE-6)

Another participant (BE-1) explained that an inadequate testing environment for innovative blockchain projects limits blockchain implementation among tech-minded organisations. According to him, a sandbox regulatory environment would help FinTech innovators to test their innovative projects without incurring bureaucratic costs. So, the participant suggested that governments should build an innovation-friendly environment and extend cooperation to meet regulatory compliance for the ongoing operation of blockchain-based projects. This finding is consistent with several studies outside the microfinance domain, which found that the lack of acceptance from legal and regulatory bodies is a limiting factor for blockchain-based projects (Drescher, 2017; Hughes et al., 2019; Khanna & Haldar, 2023).

4.2.2 Security concerns

Another challenge is integrating the system with various databases using the same Application Programming Interfaces (APIs[4]) and handling security aspects while onboarding borrowers on that platform. This happens when the lending platform sources borrower's business transactions directly from the database of suppliers to maintain data authenticity.

"[…] it's the biggest barrier […] integrating with FMCGs. So, they've got a very particular set of APIs that we need to use, we need to make sure that the security aspect is handled." (BE-6)

[4] API is a communication protocol, which allows one system to connect with another entity.

The lack of an industry standard for sharing data among organisations in a blockchain environment is a challenge as mentioned by BE-7. He explained, citing an industry norm, that a financial institution's internal data security policy prohibits anyone from connecting to its Wi-Fi or using any memory stick. According to him, IT professionals of banks are concerned about protecting account holder's information, and that it is their responsibility to ensure data privacy. Therefore, IT professionals would be reluctant to approve the participation in a blockchain network where other parties may have access to bank's information. That participant further mentioned that fear of losing trade secrecy is a reason why industry partners are less interested in formulating a uniform standard through which organisational data can be accessible by the participants of a blockchain network. In a blockchain ledger, transaction details are linked to an electronic address that preserves the true identity (MIT Tech Review, 2017). Although blockchain encrypts the data, such data privacy concerns may arise if someone can establish a connection between the electronic address and the true identity (MIT Tech Review, 2017). This linkage might be possible when web trackers and cookies send personally identifiable information (e.g., name, address, and email) to websites such as Google or Facebook that track the web browser's behaviour (MIT Tech Review, 2017). This finding is in line with the proposition of Upadhyay (2020), who suggests that blockchain adoption would be limited if the partners of a blockchain network were less inclined to share information.

4.2.3 Strategic concerns

Strategic considerations may also prevent organisations from joining a blockchain network, as explained by BE-7, a participant with a background in blockchain-based micro-insurance. He shared his concerns regarding strategic considerations that prevent actors from joining a microfinance blockchain network hosted by a competitor. To strengthen his argument, he used an example of 'TradeLens', which IBM developed[5] for the shipping giant A.P. Moller-Maersk[6]. According to him, this platform initially struggled to attract other shipping container logistics companies because TradeLens was perceived as Maersk's controlled blockchain network. Other logistics companies, who are the competitors of Maersk, considered that joining TradeLens could result in a loss of governance and control, and ultimately even divulge competitive secrecy. While this blockchain example is not from a microfinance context, the participant believed that the strategic reasoning of MFIs would be similar. In particular, such resistance to joining a blockchain network is likely to arise from concerns among the competing organisations that parties in the blockchain network might have to share data that gives others a strategic advantage. This finding implies that resistance to participating in the network might arise when a microcredit platform is built by a few sponsoring parties and later other MFIs, FMCGs, and banks are invited to join.

Finally, limited external support from various stakeholders, including the government, is another reason for the slow adoption, as explained by a blockchain expert (BE-8). She expressed the belief that government and corporations have less interest in blockchain adoption in areas where it removes intermediaries due to their fear of losing control and legacy as blockchain:

[5] IBM is an American multinational technology company (https://www.ibm.com).
[6] A.P. Moller - Maersk is an integrated container logistics company (https://www.maersk.com/).

"[…] what blockchain enables is the removal of power from pre-existing power holders, they have no incentive to support the adoption of this type of technology. And so, they're going to push back on it as long as they can." (BE-8)

Table 3 lists the identified blockchain challenges that could prevent its implementation in microcredit.

Category	Related Challenge	Explanation	Related literature	Sample quotes supporting new aspects
Coordination complexities	Sharing of start-up costs	Initial start-up cost for developing a lending platform with the participation of various organisations and fixing up a cost-sharing agreement among parties.	NA	"[…] if you don't have the right parties involved, big banks, big FMCGs, it becomes very difficult to get off the ground. So that's actually a big issue, the share cost of launching it [the platform] and initial start-up cost." (BE-6)
	Lack of innovative environment	The lack of sandbox environment that encourages innovative blockchain projects.	NA	"[…] it's hard for FinTech innovators to actually test the models. Because they need a more user-friendly environment for that, so again, it's not about the technology. It's about culture. It's about regulation." (BE-1)
Security concerns	Privacy concerns	Fear of divulging proprietary information among the participating organisations on the blockchain network.	Amin and Zuhairi (2021); MIT Tech Review (2017)[7]	
	Conventional restrictive security measures	Existing security measures (e.g., in financial institutions) limit access of external organisations to internal databases.	Dutta et al. (2020) Sharma et al. (2019), Namasudra et al. (2021)[8]	
Strategic concerns	Compromise of strategic competitiveness	Concern over loss of control and governance when the network could be controlled by another competitor.	NA	"[the] supply chain blockchain written by Maersk, the 'TradeLens' is actually really a good engineering. They had a governance model […] despite the fact that Maersk wrote it, that was independent. But for the first year and a half, it was in production, nobody else but Maersk wanted to use it because it was perceived as Maersk blockchain (BE -7)
	Loss of stakeholders' power	Concerns that stakeholders are unwilling to support blockchain as it might reduce their existing power balances.	NA[9]	"[…] blockchain enables the removal of power from pre-existing power holders. They have no incentive to support the adoption of this type of technology. And so, they're going to push back on it as long as they can, and they are going to fight it as long as they can. Both, at a government level, at a corporation level." (BE-8)

Table 3: Blockchain challenges that may prevent microcredit solutions

[7] Various ways exist how data privacy may be compromised, for example, when the blockchain application uses the internet protocol, address tracking technology could be applied (Amin & Zuhairi, 2021), a linkage could be established between the electronic pseudonymous address and the true identity (MIT Tech Review, 2017), or an attacker could hack the private key assigned to each node (Namasudra et al., 2021).

[8] Interoperability refers to lack of common standards across multiple entities.

[9] Other government related factors are discussed in the literature, e.g., the slow drafting of legislation to resolve dispute of blockchain powered transactions (Goldenfein & Leiter, 2018; Upadhyay, 2020).

5. Contribution

5.1 Implications for research

We set out to explore how blockchain technology could improve microcredit in developing countries and what challenges impede its diffusion in this area. To that end, the study bridges the existing research on microfinance, in particular, microcredit activities and blockchain to advance the literature in several ways.

First, while blockchain as a technology has been discussed in prior literature to address microcredit issues, this literature is mainly conceptual (e.g., Kshetri, 2017; Lalitha & Soujanya, 2019). In contrast, we empirically examine the potential application of blockchain technology in microcredit in developing countries by interviewing microfinance, blockchain, and mobile money experts. As a consequence, we were able to determine new benefits that were not previously discussed. This includes the possibility of overcoming current problems arising from the restricted access to national databases to verify borrowers' identities and the inability of borrowers to provide evidence to support their financial capacity. A shared blockchain-based database to identify borrowers could resolve these issues. Furthermore, problems in relation to MFI staff exist that blockchain can address, such as microcredit decisions that are influenced by staff's self-interest, indifference, and inadequate loan supervision. Smart contracts built on blockchain can decrease human intervention, subsequently lessening the reliance on field staff and mitigating associated risks.

Second, we provide novel insights into several blockchain-related challenges. This includes operative aspects such as cost-sharing for the initial start-up cost for developing a lending platform and system integration among participating organisations. We also uncover concerns that such platforms could compromise strategic competitiveness because a competitor may control the network. In addition, no standards exist for the data that is required to be shared across networks. Therefore, MFIs fear that they could lose trade secrets. In addition, participants reported insufficient support from various stakeholders, including governments in relation to blockchain-based microfinance platforms.

Third, by focussing on MFIs and their role in alleviating poverty and hunger, we raise important issues in terms of the role of governments and intergovernmental organisations in supporting blockchain technology, which can inform broader debates such as the Millennium Development Goals set by the United Nations[10].

This study also paves the way for further technological forecasting since future research can analyse how the different challenges identified in this study are addressed in different countries. Once blockchain-based microcredit platforms are deployed, it would be valuable to assess how the various benefits of blockchain technology in microcredit have materialised. These insights can be used to develop related maturity models and predict the diffusion of the technology, as well as identify further challenges.

[10] https://www.un.org/millenniumgoals

5.2 Practical implications

The practical implications of this study are important because the literature has shown that microfinance programmes improve social well-being and the standard of living in developing countries (Hasan et al., 2022). The findings illustrate how blockchain can address many of the problems that MFIs face in these countries. In particular, blockchain can build trust among lenders that can be leveraged to source funds at a cheaper rate, which means that the world's poorest no longer have to bear the highest cost of capital. To realise this financial benefit, it is critical to involve multiple cross-border organisations, including financing organisations and non-governmental organisations, in the network of the lending platform.

The findings also highlight the importance of a cashless loan collection system based on blockchain technology to prevent morally compromised staff from engaging in opportunistic behaviour. To prevent field agents from bypassing organisational loan governance systems due to personal interests, smart contracts can be particularly valuable. Smart contracts can reduce human involvement, increase automation, and lower loan governance costs.

However, several challenges need to be addressed to ensure that the benefits of blockchain technology can be materialised. For example, blockchain developers must secure data privacy while onboarding various organisations on the blockchain network. It might be also challenging to integrate each organisation's internal information system with the blockchain-based lending platform.

5.3 Limitations and further research

The study identified blockchain challenges that are common to developing countries and financial inclusion. However, we did not seek to identify factors that are country specific. Instead, the main selection criterion was expertise in relation to microfinance, mobile money, and microcredit platforms, rather than specific challenges for a particular region. Future studies may wish to focus on specific regions where particular political, economic, and social problems prevail (e.g., climate change, ethnic fragmentation) that limit financial inclusion. Moreover, other studies may employ quantitative approaches, such as surveys, to determine the frequency of the identified microfinance challenges, such as ID falsification and staff indifference. This would help evaluate the costs and benefits of developing a blockchain-based lending platform.

A potential limitation of the study arises from its sample size. According to Guest et al. (2006), in purposive sampling data saturation is defined when no new information is observed. Since we were not able to gain further insights from the last interviews, we are confident that data saturation was reached. Another limitation is that interview data is highly dependent on the participants' perspectives on a phenomenon, their experience with the topic, their communicative ability, and the degree of interaction between the participants and the interviewer during the interview process. This problem was addressed by including a wide range of participants with different backgrounds and areas of expertise. However, the study was based on the perspectives of service providers, which means that all the participants are employees of an organisation. Therefore, future studies should be undertaken to include the inputs of service recipients (i.e., borrowers) and other stakeholders, including regulatory bodies. In addition, our qualitative research design aimed at the identification of microfinance

and blockchain challenges. Future research is required to weigh the relevance of each identified aspect.

Although the study identified several factors common to developing countries, these findings are likely less applicable to developed countries where a smaller percentage of the population is under-banked (Pedrini et al., 2016). Moreover, developed countries have better infrastructure, allowing greater financial inclusion and reducing the need for microfinance and related blockchain-based ledgers. This includes technical aspects such as access to computers, the internet, formal financial services (e.g., banks in regional areas), and national registers to identify borrowers' identity and credit scores. Examples of such credit scores include the FICO credit score[11] in the USA or Schufa[12] in Germany.

6. Conclusion

MFIs are critical organisations but face many operational challenges that impact their ability to provide microcredits to the poor at affordable interest rates. Although there is considerable research on microfinance and the conceptual possibilities of blockchain technology, no empirical study has investigated blockchain's operational challenges in this context. This study provides novel insights into how blockchain could facilitate microcredit as well as the associated issues that impede its diffusion in developing countries. A blockchain-based decentralised ledger could be used to create unique borrower profiles that can be used for verification and assessment purposes. It can minimise opportunistic behaviours, reduce microcredit service costs, and improve loan governance. In addition, smart contracts can be used to customise loan products and to align the interests of borrowers and lenders. However, blockchain technology also causes a set of concerns that impede its implementation. This includes coordination complexities, strategic considerations and privacy issues. Relevant stakeholders should try to overcome these problems proactively with suitable polices and industry-led research collaborations. Our results may facilitate such initiatives to enable social change.

[11] www.fico.com
[12] www.schufa.de

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Appendix A: Interview Protocol

Discussion topics	Participant's background	Key interview question
Microfinance loan operational challenges	**Microfinance**	1. How would you describe the microcredit loan operational challenges caused by borrowers and field staff?
Benefits and challenges of mobile money adoption for microfinance	**Microfinance and mobile money**	2. What are the operational challenges and benefits of using mobile money to distribute and collect microcredit? 3. How would you describe customer adoption of a mobile wallet for microcredit services?
Potential benefits and challenges of blockchain technology for microfinance	**Blockchain technology**	4. How can blockchain technology increase accessibility to financial inclusion services for the unbanked population? Please describe the application areas of blockchain and smart contracts in the microcredit space. 5. How do you think blockchain technology differs from other technologies, and how would you describe the cost efficiency of using blockchain and smart contracts? 6. What are the difficulties of developing and maintaining a blockchain-based solution? To what extent is it easy for customers to adopt blockchain-based solutions?