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Blockchain, adoption, and financial inclusion in India: Research opportunities

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ABSTRACT

The economic development of rural India requires connecting remote villages to local and global supply chains. Yet, high rates of financial exclusion inhibit rural Indians from participating in these supply networks. We review the literature on financial inclusion, adoption, and blockchain in India, and posit that to resolve financial exclusion, the four challenges of geographical access, high cost, inappropriate banking products, and financial illiteracy need to be overcome. Next, we argue that blockchain technologies hold the potential to overcome most of these challenges. However, for blockchain technologies to become the cornerstone of financial inclusion initiatives, an understanding of technology adoption in India is needed. To guide the development of such understanding, we develop a research agenda on the antecedents of adoption, adoption patterns, and outcomes of adoption. Answering these research questions will lead to a nuanced understanding of adoption of blockchain-based technologies in rural India. The practical contribution of this paper is the discussion of how blockchain can alleviate the issue of financial exclusion in rural India, thereby providing a basis for a solution that could connect rural Indians to global supply chain networks. The theoretical contribution lies in the identification of knowledge gaps that should be answered to achieve financial inclusion of rural Indians.

1. Introduction

> "*All the scientists and technologists should work in appropriate region, specifically the rural technologies, to transform Indian rural sector*" - *A. P. J. Abdul Kalam, former President of India*

To Abdul Kalam, the key to India's growth lies in empowering rural India trough technology. In 2017, rural India housed more than 68% of the nation's population and 72% of the workforce (Chand, Srivastava, & Singh, 2017). This amounts to over 700 million people that live, work, and consume in rural India (Census of India, 2001). However, as many of these villages are badly connected to local and global supply chains, the ability of rural Indians to participate in global financial, trade, and labor markets is limited. This is a major impediment to economic growth that caused rural India to fall far behind urban India on virtually all indicators of progress, i.e., GDP, employment, poverty, literacy and even, health (Mukunthan, 2015). The key difference between rural and urban India is the access to global supply chains. While urban citizens enjoy access to global markets for services, goods and labor, rural Indians remain disenfranchised. Thus, for rural India to develop, access to supply chains is required.

The development of mature supply chain networks in rural India hinges on financial inclusion. *Financial inclusion* refers to the "access to appropriate, low cost, fair and safe financial products and services from main-stream service providers" (Varghese & Viswanathan, 2018, p. 2). Without access to financial services, such as bank accounts and government programs, rural Indians cannot connect to supply chain networks as they lack the ability to make or receive electronic payments for products and services. In 2014, this was the reality for over 415 million Indians, rendering India to be one of the world's largest "unbaked" populations (Harjani, 2015). To address this issue, the Indian government immediately set financial inclusion as a national priority (Banerjee, 2016).

The financial inclusion initiatives that followed were successful in providing more rural Indians with bank accounts but have not yet progressed to having rural Indians actually *using* banking products and services. This is because rural Indians still lack physical access to financial institutions, financial products and services are too costly to use, or simply do not meet the needs of the targeted population who are often helplessly illiterate about financial topics. Due to these challenges, more than 190 million people remain without a bank account (World Bank, 2017) and only 23 percent of the rural Indians who have

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bank accounts use them regularly (NAFIS, 2017). Thus, financial inclusion remains a pressing problem that hinges on addressing these related issues.

Blockchain technology holds the potential to connect rural Indians to local and global supply chains by resolving some of the issues faced by financial inclusion campaigns. As we will make the case, their unique abilities afford blockchain-based solutions to deliver (1) financial products and service digitally to the doorstep, (2) cut down the costs of engaging in financial transactions, and (3) provide more suitable products. Further, do to their distributed nature, blockchains can help rural Indians to connect to global markets. However, the general capability of blockchain technology to resolve these issues does not ensure such efforts will be successful. For example, while mobile banking applications ought to improve access for rural Indians, they have only received marginal adoption (NAFIS, 2017). What is required is an understanding how this unique technology can receive widespread adoption among a demographic as unique as the rural Indian population.

Technology adoption research is one of the most mature streams of IS research (Venkatesh, Thong, & Xu, 2016). However, the research on adoption on blockchain and general technologies in rural India is still highly limited. As most blockchain adoption research focuses on the adoption by professionals (e.g., Kamble, Gunasekaran, & Arha, 2018; Queiroz & Wamba, 2019), it is unclear how rural Indians would adopt such a technology. Although general adoption research in rural India sheds some light on the phenomenon of adoption and how adoption brings about economic benefits (e.g., Venkatesh & Sykes, 2013; Venkatesh, Sykes, & Venkatraman, 2014), this stream of research has not examined new, complex technologies such as blockchain. Although it can be expected that blockchain technologies deliver distinct benefits that could provide a thrust in technology adoption (Huges et al., 2019), it is typical in underprivileged communities, such as in rural India, to use simple and established, rather than more complex, technologies. This is an issue because the scant research on blockchain and financial inclusion has suggested that blockchain adoption might be a complex endeavor (Larios-Hernandez, 2017; Swan, 2017). Thus, although the topic of adoption has received considerable research attention, adoption of *blockchain-based solutions* by *rural Indians* holds its own contextual challenges that have not been understood (see Johns, 2006, 2017).

Against this backdrop, this paper develops a research agenda that raises questions that, if answered, will inform our understanding of how blockchain-based financial inclusion initiatives can be successful in rural India. By drawing from existing adoption research, our research agenda highlights gaps that broadly relate the antecedents of adoption, different adoption patterns, and outcomes of adoption *in the specific context of blockchain and rural India.* Tackling new contexts, especially in developing countries and more so India, has been identified as an important direction for future research in this mature area (Venkatesh, Rai, Sykes, & Aljafari, 2016). Moreover, Huges et al. (2019) caution that the application of blockchain technologies requires a careful examination of whether the technology brings about distinct benefits that aid the resolution of the problem at hand. To that end, our work serves the dual outcomes of (a) highlighting blockchain as a potential solution to the issue of financial inclusion, and (b) proposing a research agenda that will be a valuable spring broad for research on technology adoption in general and blockchain in particular in developing countries, especially India.

2. Background

In this paper, we explore how blockchain technology may help overcome many of the financial inclusion challenges faced by rural India. To support this case, we first provide the necessary background by summarizing the current state of knowledge in this research domain. We systematically searched for all papers related to financial inclusion, India, and blockchain[1] . The following sections present a narrative synthesis of the current state of the literature (Pare, Trudel, Jaana, & Kitsiou, 2015). Then, we argue how blockchain solutions can overcome the challenges for financial inclusion, followed by a discussion of the research gaps in blockchain adoption research in rural India.

2.1. Financial inclusion in India

As noted earlier, *financial inclusion* refers to the "access to appropriate, low cost, fair and safe financial products and services from mainstream service providers" (Varghese & Viswanathan, 2018, p. 2). Without such access, the financially excluded cannot take advantage of the most basic financial instruments, such as affordable credit, remittances, insurance products, or even simple saving accounts. The ones being left out are mostly marginal farmers, migrants, ethnic minorities, seniors, and women (Varghese & Viswanathan, 2018). For example, in 2017, the percentage of households with at least one member having health insurance was only 6 percent and only 26 percent of women had saving accounts (NAFIS, 2017).

Due to financial exclusion, affected citizens need to rely on medieval practices (Table 1). In lieu of bank accounts, the common practice is to store cash at home. In lieu of access to credits and insurance, the common practice is to rely on savings or to borrow money from friends and family (NAFIS, 2017). These practices put affected citizens at a disadvantage. Savings are more susceptible to theft or loss; parents cannot provide guarantees for school fees for their children; borrowers in need may not be able to get sufficient credit from friends or family; and lenders are at risk for credit losses. Thus, financial exclusion is a grave economic disadvantage burdening already impoverished populations.

2.2. Challenges to resolving financial exclusion in India

Achieving financial inclusion requires overcoming four key challenges (Table 2): The first key challenge, Challenge 1, is geographical access (Varghese & Viswanathan, 2018). India as a country is characterized by a large rural population. In these rural regions, the physical access to financial institutions is often impeded due to long distances and poor infrastructure, with only 5% of the rural population having a commercial bank branch within reach (Varghese & Viswanathan, 2018). Consequently, only 23 percent of rural Indians make regular use of ATMs (NAFIS, 2017). These circumstances prevail across India where geographical access is a key challenge in all Indian states (Sethy & Goyari, 2018).

Challenge 2 is cost. In 2017, the average rural Indian household consists of 5 people and has a combined income of about 8000 INR, i.e., about $110 USD (NAFIS, 2017). This means that on, average, the rural population needs to make ends meet with less than $1 USD per person per day. Hence, even small costs (e.g., $1–$2 USD) have substantial impacts on the finances of these households. Reasons for financial exclusion can hence simply be the cost of inclusion, such as too high interest rates (Arun & Kamath, 2015) and high transaction costs for low value transactions (Varghese & Viswanathan, 2018). This means that even if the financially excluded are aware of financial products and can physically access them, they might not be able to afford them.

Challenge 3 relates to inadequate financial products and services. The first issue relates to the low eligibility to products such as formal loans (Banerjee, 2016). Due to a lack of bank accounts, guarantees, and financial history, the financially excluded are disenfranchised because

[1] We used Web of Knowledge to search for papers published in the last 5 years with the keyword combinations of (i) "Financial inclusion" and "India," (ii) "Financial Inclusion" and "Blockchain," and (iii) "India" and "Blockchain." The searches returned (i) 75 papers, (ii) 3 papers, and (iii) 2 papers, respectively.

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Table 1
Consequences of Financial Exclusion.

Lack of…	Coping Practice	Consequences
Bank accounts	Store money at home	Risk of theft or loss. Impedes ability to provide guarantees and credit history.
Access to credit	Use savings or borrow money from friends and family	Risk of not having access to needed financial resources. Risk for lenders. Impedes opportunities for entrepreneurial ventures
Insurance	Use savings or borrow money from friends and family	Risk of not having access to needed financial resources. Risk for lenders.

Table 2
Key Challenges to Financial Inclusion.

Key Challenges	Description
1. Lack of geographical access	Great geographical distances to financial institutions and lack of physical infrastructure.
2. High cost	High interest rates for credits and loans. High transaction costs for low value transactions.
3. Inappropriate products	Current products and services do not fit the need of the affected demographics. I.e., because payment terms are not flexible enough or require credit history or guarantees.
4. Financial illiteracy	Lack of awareness, financial education and support.

they do not meet the formal requirements of financial institutions. Whereas formal loans require fixed repayment plans and guarantees, informal loans afford more flexibility as they are built upon trust and relationships. In light of incidents in which banks miscalculate interest rates and enforce paybacks, the financially excluded may fear formal products (Banerjee, 2016). Often, the offered financial products and services just do not meet the needs and circumstances of financially excluded citizens (Bansal, 2014). These citizens might be financially excluded in spite of physical access to banks and low costs because they lack eligibility or simply prefer informal solutions.

Challenge 4 relates to financial literacy. In rural India, financial literacy is low. The NAFIS survey found that only 11.3 percent of rural households have good financial literacy (NAFIS, 2017). This means that rural Indians lack awareness of the availability and benefits of financial products and services (Bansal, 2014). Moreover, even if aware, inept financial literacy causes confusion about the condition of loans and interest rates (Banerjee, 2016). Financial literacy is hence a key obstacle that impedes the financially excluded from taking advantage of financial products and services, even if they were accessible, affordable, and adequate.

We suggest that these challenges must be overcome gradually (Fig. 1). With resolving each challenge, the portion of financially excluded will shrink. However, we believe there is a hierarchy to these challenges. Resolving the challenge of access must come first because lowering the cost, creating adequate products, or increasing literacy will have little impact when products are not available in the first place. Second, the availability of low cost products must be achieved first before adequate products can be offered because even adequate products will be meaningless if they are not affordable. Third, adequate products must be offered before the population is literate, because literacy will have no impact if there are no suitable products on the market (or if there are no suitable products about which citizens should be literate).

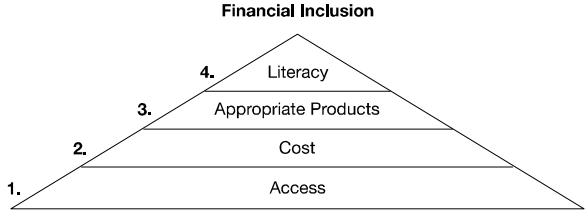

Fig. 1. Steps toward Financial Inclusion in India.

2.3. On-going initiatives toward financial inclusion

In 2014, financial inclusion became a national priority of the Indian government. This led to the launch of *Jan Dhan Yojana*, a government initiative to tackle Challenge 3 by providing basic banking services to every household in India (Banerjee, 2016). In this program, bank accounts can be opened with zero balances and overdraft credits are granted after six months. Further, customers need not provide valid identification to open accounts and can benefit from accident and life insurance. As a result of this initiative, over 340 million bank accounts have been opened.[2] In wake of this program, public and private financial institutions have begun to tackle Challenge 1 by increasing the number of branches across rural India and expanding their mobile banking.

An older and successful government initiative was promoting microfinance. Since the 1990s, the Indian government promoted microfinance institutions as a means to tackle Challenge 3 by providing small credit without the need for previous personal savings, guarantees, or credit history. Microfinance institutions have been successful such as with increasing the self-employment rate of low-income women (Bhatt, 2006) and also helped alleviating financial inclusion in China (Leong, Tan, Xiao, Tan, & Sun, 2017).

Despite the successes of these initiatives to achieve much needed improvements, the problem of financial exclusion remains grave. Despite the large number of new bank accounts opened, many of them remain dormant (Banerjee, 2016) as the rural poor remain constrained by access and literacy issues (Sen & De, 2018). The efforts toward increasing access remain similarly insufficient, as still only 5 percent of the rural population have a commercial bank branch within reach (Varghese & Viswanathan, 2018). The potential solution to that issue, mobile banking, has similarly had low adoption rates with only 1.4 percent of households using mobile banking (NAFIS, 2017). As a result, bank-driven efforts to increase financial inclusion has not led to any drastic improvements (Nanda, 2017). Further, microcredit remains expensive and inadequate, with interest rates between 15 percent to 30

[2] This is the latest official number drawn from the initiatives' government website https://www.pmjdy.gov.in/account on January 23rd, 2019.

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percent being the norm (Ehrbeck, Leijon, & Gaul, 2011) and often with inflexible repayment terms (Banerjee, 2016).

To achieve financial inclusion, it appears other solutions are needed. Solutions that tackle all challenges in tandem by increasing access, reducing cost, and raising the adequacy of financial products and services.

2.4. What is blockchain?

The advent of blockchain technologies provide a potential solution to the first three challenges of financial inclusion. In simple terms, the term blockchain refers to distributed digital ledgers (Lacity, 2018b). These ledgers employ consensus protocols to create a single version of truth. Recorded entries cannot be altered due to encryption protocols, rendering the digital ledger immutable. What is posted to the blockchain can be regarded as the one, unchangeable truth. These features render blockchain technologies as attractive technical solutions for facilitating transactions between parties that often have different interests such as lenders and borrowers or suppliers and customers. The first blockchain ledger was implemented by Nakamoto (2008) to support the electronic cash system Bitcoin.

Blockchain can be characterized by three specific features (Wang, Singgih, Wang, & Rit, 2019). First, blockchain is a distributed technology that increases the visibility and transparency of the stored transactions (Lacity, 2018b; Wang et al., 2019). Second, as an immutable ledger, blockchain ensures a single version of truth that helps building trust in the stored information (Queiroz, Telles, & Bonilla, 2019; Wang et al., 2019). Third, a blockchain allows for the automatic execution of transactions (Lacity, 2018a).

These features allow blockchain to realize a range of benefits (Huges et al., 2019) that are aligned with supply chain management objectives (e.g., Kshetri, 2018; Queiroz et al., 2019; Queiroz & Wamba, 2019; Ying, Jia, & Du, 2018). For example, because a blockchain is distributed and immutable, it effectively eliminates the need for intermediaries (Huges et al., 2019; Lacity, 2018a). Further, a blockchain allows for the automated execution of contracts (Huges et al., 2019; Wang et al., 2019). Without intermediaries and with automated execution of contracts, blockchain-based supply chains can operate more efficiently and with lower costs (Queiroz et al., 2019; Ying et al., 2018). Unsurprisingly, recent supply chain research thus sees much potential for the application of blockchains (see Queiroz et al., 2019 for a recent review of blockchain research in the supply chain literature). Importantly, the objectives for supply chains align with the challenges of financial inclusion. Further, recent research sees much potential for blockchains to aid the UN's sustainable development agenda that includes finding solutions that address impoverishment and inequality including, for example, preventing the exploitation of rural Indian farmers (cf. Huges et al., 2019). To expand on this notion, we discuss next how the unique features of blockchain help overcoming the Challenges 1, 2, and 3 of financial inclusion in India.

2.5. Opportunities for financial inclusion through blockchain-based solutions

2.5.1. Addressing challenge 1: access

Challenge 1 is addressed through the fact that blockchain is a digital technology. Hence, a blockchain-based financial solution can be delivered through mobile applications. Although adoption of mobile banking apps has been low among rural Indians, the willingness to use mobile banking applications is 38 percent (NAFIS, 2017). This suggests that Challenge 1 can be overcome with mobile banking if the other Challenges are addressed too. As we will argue, blockchain technology holds unique potential for addressing Challenges 2 and 3 (Table 3).

2.5.2. Addressing challenge 2: high cost

One of the key advantages of blockchain technology is its ability to remove the need for the intermediary. Because the ledger is distributed across participants and governed via a consensus protocol, third parties are not needed to facilitate transactions (Lacity, 2018a). This is an important lever in reducing transaction costs that are usually driven up by third-party fees. In contrast, blockchain-based transactions can be facilitated with very low transactions fees. For example, blockchain implementations, such as Noahcoin[3], help Filipino workers in Japan perform remittance payments at a much lower cost than traditional banks. Similar would be true for Indian foreign workers or even for low value transactions in India.

Table 3
How Blockchain Resolve Challenges to Financial Inclusion in India.

Challenge	Features	Implication
2: High cost	Distributed	Lower transaction cost, faster settlement
3: Inadequate products	Immutable	Provides financial history
	Distributed	Access to global markets, direct transactions
	Smart contracts	Guarantees for transactions

Another key factor is that blockchain reduces the time that is needed for transactions to be settled. While a traditional bank transaction may take several work days to be settled, blockchain transactions may settle within minutes, thus substantially reducing settlement times (Baruri, 2016). This is important because long settlement times might discourage the adoption of financial services when immediate money transfer is needed. Hence, blockchain technology allows to significantly drive down the monetary and time costs associated with conducting financial transactions.

2.5.3. Addressing challenge 3: inadequate products and services

Blockchain-based solutions might offer more suitable products to customers in three ways: (a) digitalizing existing practices, (b) resolve current problems, (c) open up new opportunities to users. First, as we have discussed, the blockchain allows for fast and cheap transactions without the need for an intermediary. By replicating the direct, immediate nature of cash-based transactions, blockchain-based solutions can support the informal, peer-to-peer nature of current financial practices in rural India. For example, they could discuss terms of borrowing with their family manners in an informal fashion (i.e., flexible payment terms), but utilize a blockchain solution to facilitate the funds transfer. The familiar fashion in how to conduct transactions will reduce uncertainty and techno fear, with the direct nature of blockchain-based transactions promoting the adoption of blockchain based technologies for financial services in India.

Second, beyond digitizing existing practices, blockchain resolves further problems. A key issue for unbanked citizens is to provide credit history and guarantees to lenders. However, because the blockchain is an immutable ledger, it can serve as a reliable source of credit history. If blockchain-based solutions were adopted, even for informal transactions, the history of these transactions can provide evidence of credit worthiness. Further, the use of smart contracts, referring to automated transaction protocols, can provide guarantees to individual and institutional lenders, i.e., by enforcing loan repayments once funds are available. For these reasons, the social lending platform Kiva is introducing blockchain technologies in an effort to help the financially excluded in Africa (O'Neal, 2018).

Finally, blockchain-based solutions would not be restricted to domestic institutions. Because the ledger is distributed across all participants, rural Indians can easily transact with anyone who is participating. This allows for access to global financial markets with a greater variety of products and services. Further, the global nature of

[3] https://noahcoin.org.

blockchain allows taking advantage of global product and labor markets. With the ability to make and receive cross-country payments, rural Indians can begin to purchase overseas products, ship their produce overseas, or undertake digital work. Overall, the availability of a global banking solution would allow for rural Indians to be connected to the global financial, goods, and labor markets.

2.6. Gap in research

Research on blockchain as a means to alleviate financial exclusion has not recognized the importance of adoption. Although there are studies that have recognized the potential of blockchain to be a keystone technology for future financial inclusion initiatives (Larios-Hernandez, 2017; Swan, 2017), these studies are conceptual and do not deal with the actual application of a blockchain-based solution to the problem. Swan (2017) discusses opportunities and challenges for blockchain from a government perspective, Larios-Hernandez (2017) takes the perspective of entrepreneurs and discusses the challenges for designing a blockchain-based solution for rural Indians. However, none of these studies have examined the actual adoption of a blockchain-based solution by rural Indians. This is a shortcoming of this yet emergent literature because *adoption* is the crucial factor that determines how technology can generate favorable outcomes. For example, Venkatesh and Sykes (2013) show that actual use of a technology influences economic benefits rural Indians can reap from that technology. However, existing financial inclusion campaigns consistently struggle with adoption. Multiple studies provide accounts that technologically driven initiatives with mobile banking apps, tele-centers, and information kiosks are faced with the challenge of achieving widespread adoption and consequent use among rural Indians (e.g., Gollakota, 2008; Karjaluoto, Shaikh, Saarijarvi, & Saraniemi, 2018; Rao, 2008). Thus, the extent to which a blockchain-based solution will be successfully adopted by this special demographic remains unknown.

Although research on adoption in India is a growing body of research (e.g., Tarafdar & Vaidya, 2006; Venkatesh & Sykes, 2013), this literature has either not focused on rural Indians or not focused on blockchain. For example, Kamble et al. (2018) and Queiroz and Wamba (2019) researched the adoption of blockchain technology in India but they studied adoption by Indian professionals, not rural Indians. Similarly, various studies have investigated technology adoption in rural India, but not focused on blockchain (e.g., Gollakota, 2008; Gupta & Jain, 2014; Pal, 2009; Venkatesh & Sykes, 2013). However, evidence from these studies suggests that the adoption of ICTs hold much potential to connect rural Indians to global supply chain networks (Ali & Kumar, 2011). To the extent that rural Indians differ from Indian professionals, and to the extent that blockchain technology differs from other technologies, there is a need for research on the adoption of blockchain-based applications by rural Indians. This need is situated in the broader gap on blockchain research that studies the actual application of this emergent technology (Risius & Spohrer, 2017).

3. Research opportunities

Blockchain applications hold a general potential to accelerate India's financial inclusion initiatives. By overcoming Challenges 1, 2, and 3, blockchain-based mobile banking applications could allow the financially excluded to take advantage of attractive, fair, and low-cost financial products and services. However, for such applications to become reality and alleviate financial exclusion in India, many interrelated research questions need to be answered. Due to the special context of rural India and blockchain technology, research is needed to understand how such applications can be adopted and how their potential of eliminating financial exclusion can be achieved. We see three specific areas that require in-depth research (Fig. 2), these being antecedents to adoption, modes of adoptions, and the impacts of adoption.

3.1. Antecedents to adoption

In the endeavor to alleviate financial exclusion in India through blockchain-based solutions, it is crucial to understand the factors that drive and inhibit the adoption of such solutions. Certainly, the IT features of a potential application will be a decisive factor for widespread adoption. With features, we specifically refer to affordances that are enabled through blockchain technology such as direct transfer of funds or access to global markets. IS research has paid significant attention to affordances such as the affordances that drive the adoption of green IS (Seidel, Recker, & Vom Brocke, 2013). Hence, there is a unique opportunity to contribute to the affordances literature by studying the specific affordances that drive the adoption of blockchain-based solutions among rural Indians. The benefits of blockchain technologies identified by Huges et al. (2019) can serve as a springboard into the reasons why rural Indians would adopt blockchain-based solutions. Beyond usefulness, we believe that usability is a key concern. Not only is usability an important factor in users adoption (e.g., Venkatesh, Thong, & Xu, 2012; Venkatesh, Rai et al., 2016; Venkatesh, Thong et al., 2016), but also existing research has already shown that the effect of usability differs between cultures (Hoehle, Zhang, & Venkatesh, 2015). We see a need for research to further investigate the role of usability for special demographics such as rural Indians. With a majority of rural

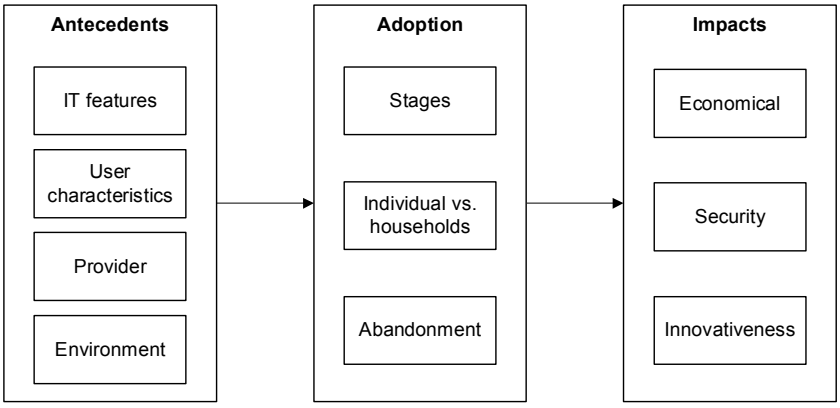

Fig. 2. Research Opportunities on Adoption of Blockchain-based Banking in India.

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Indians being late adopters of IT, usability might be a key obstacle in the adoption of blockchain-based solutions. Hence, the question:

RQ1. *What IT features drive adoption through increasing usefulness and usability*?

The rural Indian population is a very unique user demographic. We believe that the special user characteristics of this demographic will have a profound impact on how these users adopt the technology. The impact of user characteristics on adoption is already a popular research stream. Existing studies have explored how elderly (e.g., Niehaves & Plattfaur, 2014), women (e.g., Venkatesh & Morris, 2000), or less technological literate people adopt technology (e.g., Aggarwal, Kryscynski, Midha, & Singh, 2015). However, few studies have explored the special demographics of rural India, where especially education and income play a major role in individuals' ability to adopt and use technology (Venkatesh et al., 2014). With the majority of rural Indians being remote, uneducated, and poor, it remains poorly understood how these populations approach technology. It will thus be important for future research to answer the following question:

RQ2. *What user characteristics (e.g., location, age, education, income) drive adoption*?

The adoption of a blockchain-based banking app may be heavily dependent upon the provider. A potential technology-based solution could be provided by the government, private or public banks, or third-partiers within or outside India. The provider will not only impact how users develop trust in the solution (Gefen, Karahanna, & Straub, 2003), but also what support can and will be provided. Studies have suggested that users' adoption behavior is influenced by the availability of peer and institutional support structures (Sykes, Venkatesh, & Gosain, 2009; Thatcher, Loughry, Lim, & McKnight, 2007). Specifically, in rural India, where information is disseminated orally (Venkatesh & Sykes, 2013), it remains unclear how providers can effectively stimulate adoption. As Gollakota (2008) describe, just providing rural Indians with technology does not guarantee successful adoption. Thus, to ensure the success of technology-based initiatives, research must answer the following question:

RQ3. *What provider characteristics (e.g., support, trust) drive adoption*?

Whether a blockchain-based solution will be successfully adopted will also depend on external variables (Venkatesh et al., 2012; Venkatesh, Rai et al., 2016; Venkatesh, Thong et al., 2016). To support the use cases that blockchain-based applications make for rural Indians, a great number of other users and financial product and service providers need to adopt the application. Further, these financial service providers need to make adequate offerings. Hence, the utility of the application depends on network externalities and market characteristics. We thus need to answer the following question:

RQ4. *What environmental variables (e.g., network externalities, market characteristics) drive adoption*?

Although these general factors will all adoption rates, a key question is to what extent one factor may compensate for another. For example, how much can good usability (IT features) compensate for a lack of technological literacy (user characteristic)? To what extent can explanations (IT features) increase users trust in the technology (provider)? When does access to attractive products (environment) outweigh usability problems (IT features) or illiteracy (user characteristics)? Answering these questions will be important to understand how technology-based initiatives can overcome not only Challenges 2 and 3, but also Challenge 4. Hence, we propose the following question:

RQ5. *How do antecedents to adoption interplay and interrelate in the context of adopting a blockchain-based mobile banking application*?

3.2. Adoption

The next challenge is to understand how the adoption of blockchain-based banking solutions would unfold among rural Indians. A first consideration is to what degree these technologies are adopted. To close the gap between financially excluded and included, some rudimentary adoption of basic features while keeping most of the traditional practices in place might not be sufficient. It is hence important to understand which features users adopt first (i.e., storing wealth, transferring money), and whether and when they migrate to the adoption of more advanced features (i.e., purchasing products online, taking loans from strangers). Hence, an important question is:

RQ6. *Which features are adopted first? How does the adoption of specific features change over time*?

Given the digital divide in India, it is questionable whether such blockchain-based solutions should be adopted by *every* individual. Because not every rural Indian (i.e., elderly, impaired, or impoverished) has had excessive experience or access to current digital technologies, their technological illiteracy can be a key obstacle to adoption. While prior research has suggested that US households adopt technology for personal use, work, or opportunities for children (Brown & Venkatesh, 2005; Venkatesh & Brown, 2001), household adoption in rural India might be driven by other factors such as by children so as to enable opportunities for the parents and the elderly. Along those lines, Zhang and Maruping (2008) propose that culture may affect what drives household adoption. To understand the specifics of household adoption in rural India, we suggest exploring the following questions:

RQ7. *How is adoption facilitated in a household? Is it one per person? The head of the household? How would other members adopt*?

Beyond the initial adoption, it is important to understand if and why a blockchain-based technology would be abandoned. Just as the majority of bank accounts opened under the *Jan Dhan Yojana* initiative became inactive after initial activation, it is reasonable to expect a similar fate to befall other technology initiatives. Some research has suggested that technology can be abandoned for a number of reasons, such as when initial expectations are not met (Bhattacherjee, 2001), when the technology is too inconvenient (Steinbart, Keith, & Babb, 2016), or when users overestimated their own abilities to use the technology efficiently (Aggarwal et al., 2015). Likely, there are context-specific reasons for which rural Indians abandon technology after adoption. Hence, there is an opportunity to add novel knowledge by exploring the question:

RQ8. *What leads rural Indians to abandon or discontinue their adoption*?

3.3. Outcomes

To the end of alleviating financial exclusion, future research must study how the adoption of blockchain-based solutions improve the conditions for the financially excluded. A key factor that we need to understand are hence economic impacts. Some research has already reported that technology use can improve the income of rural Indians (Venkatesh & Sykes, 2013), or that technology can reduce infant mortality (Venkatesh, Rai et al., 2016; Venkatesh, Thong et al., 2016). Although these studies report findings that answer *whether* adoption can improve the lives of rural Indians, there remains much opportunity to study in how blockchain can be leveraged to further these outcomes in a scalable fashion. For example, how do rural Indians have more money at their disposal after adoption (i.e., trough lower transaction cost, better saving products or investments)? How does technology protect rural Indians from blows of fate? Future research must hence answer the following question:

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RQ9. *How does adoption lead to economic impacts (i.e., more money, less risk) for individuals*?

Aside from economic impacts, the adoption of blockchain-based banking solutions will have substantial security impacts. While storing money digitally increases the security of funds against physical theft, it opens up rural Indians to a vast array of cybersecurity threats. Cyberthreats, such as phishing scams or malware (Jensen, Dinger, Wright, & Thatcher, 2017), can defraud rural Indians. Research has shown that users with low experience with cyberthreats are especially susceptible (Wright & Marett, 2010). Thus, rural Indians are specifically at risk because of their limited experience and technological literacy. Hence, successful adoption of blockchain-based applications entails mitigating cybersecurity because without that the benefits will not outweigh the risks. We thus suggest the following question:

RQ10. *How does adoption impact the security (physical as well as information) of rural Indians*?

The adoption of blockchain-based banking will allow rural Indians to access global markets. Such access allows for vastly new opportunities. From trading products, taking up employment, to partnering with foreign firms, rural Indians will have unprecedented potential for novel, innovative ventures. It will be important to understand the role technology-based interventions have on encouraging and enabling the innovativeness of rural Indians. Hence, we [propose the following question:

RQ11. *How does adoption influence the innovativeness of rural Indians*?

Taken together, these research questions formulate a research agenda that will allow future studies to make substantial contributions to the current literature on blockchain adoption and financial inclusion in rural India. The main contribution of our work is thus to (a) explain how a blockchain-based solution could overcome the challenges of financial inclusion in India, and to (b) guide future research to make theoretical contributions to the literature. Although (a) is important to guide research efforts toward an opportunity that could alleviate the pressing issue of financial exclusion that is currently suffered by hundreds of millions of Indians, (b) is important to provide structure and direction to the currently emerging and thus highly unstructured blockchain literature. Further, we hope to spur future research on blockchains in the contexts of this important issue.

4. Conclusion

By resolving challenges to financial inclusion, blockchain technology holds the potential to connect rural Indians to local and global supply chains. To unfold their potential, blockchain-based solutions require extensive adoption by rural Indians. As technology adoption (and specifically blockchain technology adoption) in emerging markets such as rural India remains under-researched, an attractive opportunity for high-impact research emerges. To guide research efforts into this direction, we propose several research questions on the antecedents, outcomes, and patterns of blockchain-technology adoption in rural India. Answering these questions will lead to important contextual knowledge that can guide blockchain-based financial inclusion campaigns which will connect rural Indians to global financial, trades, and labor markets.

References

Aggarwal, R., Kryscynski, D., Midha, V., & Singh, H. (2015). Early to adopt and early to discontinue: The impact of self-perceived and actual IT knowledge on technology use behaviors and end users. *Information Systems Research, 26*(1), 127–144.

Ali, J., & Kumar, S. (2011). Information and communication technologies (ICTs) and farmers' decision-making across the agricultural supply chain. *International Journal of Information Management, 31*(2), 149–159.

Arun, T., & Kamath, R. (2015). Financial inclusion: Policies and practices. *IIMB Management Review, 27*, 267–287.

Banerjee, M. M. (2016). "We routinely borrow to survive": Exploring the financial capability of income-poor people in India. *Social Work, 61*(4), 349–358.

Bansal, S. (2014). Perspective of technology in achieving financial inclusion in rural India. *Procedia Economics and Finance, 11*, 472–480.

Baruri, P. (2016). *Blockchain powered financial inclusion.* Retrieved fromhttp://pubdocs.worldbank.org/en/710961476811913780/Session-5C-Pani-Baruri-Blockchain-Financial-Inclusion-Pani.pdf(Accessed 03 February 2019).

Bhatt, E. (2006). *We are poor but so many: The story of self-employed women in India.* New Delhi: Oxford University Press.

Bhattacherjee, A. (2001). Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly, 25*(3), 351–370.

Brown, S. A., & Venkatesh, V. (2005). Model of adoption of technology in households: A baseline model test and extension incorporating household life cycle. *MIS Quarterly, 29*(3), 399–426.

Census of India (2001). *Area and population.* Retrieved fromhttp://censusindia.gov.in/Census_And_You/area_and_population.aspx(Accessed 7 February 2019).

Chand, R., Srivastava, S. K., & Singh, J. (2017). *Changing structure of rural economy of India implications for employment and growth.* Retrieved fromhttps://niti.gov.in/writereaddata/files/document_publication/Rural_Economy_DP_final.pdf(Accessed 7 February 2019).

Ehrbeck, T., Leijon, M., & Gaul, S. (2011). *Myths and reality: Cost and profitability of microfinance.* Retrieved fromhttps://www.themix.org/publications/microbanking-bulletin/2011/03/myths-and-reality-cost-and-profitability-microfinance(Accessed 01 February 2019).

Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: An integrated model. *MIS Quarterly, 27*(1), 51–90. https://doi.org/10.2307/30036519.

Gollakota, K. (2008). ICT use by businesses in rural India: The case of EID Parry's Indiagriline. *International Journal of Information Management, 28*(4), 336–341.

Gupta, R., & Jain, K. (2014). Adoption of mobile telephony in rural India: An empirical study. *Decision Sciences, 45*(2), 281–307.

Harjani, A. (2015). *World sees massive drop in unbanked population: Report*Retrieved fromhttps://www.cnbc.com/2015/04/15/world-sees-massive-drop-in-unbanked-population-report.html(Accessed 7 February 2019).

Hoehle, H., Zhang, X., & Venkatesh, V. (2015). An espoused cultural perspective to understand continued intention to use mobile applications: A four-country study of mobile social media application usability. *European Journal of Information Systems, 23*(4), 337–359.

Huges, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., & Akella, V. (2019). Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management, 49*(December), 114–129. https://doi.org/10.1016/j.ijinfomgt.2019.02.005.

Jensen, M. L., Dinger, M., Wright, R. T., & Thatcher, J. (2017). Training to mitigate phishing attacks using mindfulness techniques. *Journal of Management Information Systems, 34*(2), 597–626.

Johns, G. (2006). The essential impact of context on organizational behavior. *Academy of Management Review, 31*(2), 386–408.

Johns, G. (2017). Reflections on the 2016 decard award: Incorporating context in organizational research. *Academy of Management Review, 42*(4), 577–595.

Kamble, S., Gunasekaran, A., & Arha, H. (2018). Understanding the Blockchain technology adoption in supply chains-Indian context. *International Journal of Production Research, 57*(7), 1–25.

Karjaluoto, H., Shaikh, A. A., Saarijarvi, H., & Saraniemi, S. (2018). How perceived value drives the use of mobile financial service apps. *International Journal of Information Management*. https://doi.org/10.1016/j.ijinfomgt.2018.08.014 (in press).

Kshetri, N. (2018). 1 Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management, 39*(April), 80–89.

Lacity, M. C. (2018a). *Enterprise blockchains: Eight sources of business value and the obstacles in their way.* Retrieved fromhttps://walton.uark.edu/enterprise/downloads/blockchain/LacityBlockchainsExplained.pdf(Accessed 1 February 2019).

Lacity, M. C. (2018b). *A manager's guide to blockchains for business: From knowing what to knowing how.* Warwickshire, UK: SB Publishing.

Larios-Hernandez, G. J. (2017). Blockchain entrepreneurship opportunity in the practices of the unbanked. *Business Horizons, 60*, 865–874.

Leong, C., Tan, B., Xiao, X., Tan, F. T. C., & Sun, T. (2017). Nurturing a FinTech ecosystem: The case of a youth microloan startup in China. *International Journal of Information Management, 37*(2), 92.

Mukunthan, A. (2015). *Rural India is far behind urban India in every Indicator of progress.* Retrieved fromhttps://factly.in/rural-india-behind-urban-india-in-progress-indicators/(Accessed 7 February 2019).

NAFIS (2017). *NABARD all India rural financial inclusion survey 2016-17.* Retrieved fromhttps://www.nabard.org/auth/writereaddata/tender/1608180417NABARD-Repo-16_Web_P.pdf(Accessed 31 January 2019).

Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system*.

Nanda, K. (2017). Bank led financial inclusion and socio economic development: The case of Indian states. *Pacific Business Review International, 10*(4), 39–49.

Niehaves, B., & Plattfaur, R. (2014). Internet adoption by the elderly: Employing IS technology acceptance theories for understanding the age-related digital divide. *European Journal of Information Systems, 23*(6) 7-8-726.

O'Neal, S. (2018). *Ahead of traditional banking: How Africa employs blockchain for financial inclusion.* Retrieved fromhttps://cointelegraph.com/news/ahead-of-traditional-banking-how-africa-employs-blockchain-for-financial-inclusion(Accessed 03 February 2019).

Pal, J. (2009). If the State provided free computer literacy, would it find takers? Evidence and proposing from Akshaya project in India. *Information Systems Frontiers, 11*(2), 105–116.

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Pare, G., Trudel, M.-C., Jaana, M., & Kitsiou, S. (2015). Synthesizing information systems knowledge: A typology of literature reviews. *Information & Management, 52*, 183–199.

Queiroz, M. M., & Wamba, S. F. (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. *International Journal of Information Management, 46*(June), 70–82.

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019). Blockchain and supply chain management integration: A systematic review of the literature. *Supply Chain Management: An International Journal*. https://doi.org/10.1108/SCM-03-2018-0143 (in press).

Rao, S. (2008). Social development in Indian rural communities: Adoption of telecentres. *International Journal of Information Management, 28*(6), 474–482.

Risius, M., & Spohrer, K. (2017). A blockchain research framework. *Business & Information Systems Engineering, 59*(6), 385–409.

Seidel, S., Recker, J., & Vom Brocke, J. (2013). Sensemaking and sustainable practicing: Functional addordances of information systems in green transformations. *MIS Quarterly, 37*(4), 1275–1299.

Sen, G., & De, S. (2018). How much does having a bank account help the poor? *The Journal of Development Studies, 54*(9), 1551–1571.

Sethy, S. K., & Goyari, P. (2018). Measuring financial inclusion of Indian states: An empirical study. *Indian Journal of Economics and Development, 14*(1), 111–118.

Steinbart, P. J., Keith, M. J., & Babb, J. (2016). Examining the continuance of secure behavior: A longitudinal field study of mobile device authentication. *Information Systems Research, 27*(2), 219–239. https://doi.org/10.1287/isre.2016.0634.

Swan, M. (2017). Anticipating the economic benefits of blockchain. *Technology Innovation Management Review, 7*(10), 6–13.

Sykes, T. A., Venkatesh, V., & Gosain, S. (2009). Model of acceptance with peer support: A social network perspective to understand employees' system use. *MIS Quarterly, 33*(2), 371–393.

Tarafdar, M., & Vaidya, S. D. (2006). Challenges in the adoption of E-commerce technologies in India: The role of organizational factors. *International Journal of Information Management, 26*(6), 428–441.

Thatcher, J. B., Loughry, M. L., Lim, J., & McKnight, D. H. (2007). Internet anxiety: An empirical study of the effects of personality, beliefs, and social support. *Information and Management, 44*(4), 353–363. https://doi.org/10.1016/j.im.2006.11.007.

Varghese, G., & Viswanathan, L. (2018). Normative perspectives on financial inclusion: Facts beyond statistics. *Journal of Public Affairs, 18*, 1–5.

Venkatesh, V., & Brown, S. A. (2001). A longitudinal investigation of personal computers in homes: Adoption determinants and emerging challenges. *MIS Quarterly, 25*(1), 71–102.

Venkatesh, V., & Morris, M. G. (2000). Why don't men ever stop to ask for directions? gender, social influence, and their role in technology acceptance and usage behavior. *MIS Quarterly, 24*(1), 115–139.

Venkatesh, V., & Sykes, T. A. (2013). Digital divide initiative success in developing countries: A longitudinal field study in a village in India. *Information Systems Research, 24*(2), 201–497.

Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and user of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157–178.

Venkatesh, V., Sykes, T. A., & Venkatraman, S. (2014). Understanding e-Government portal use in rural India: Role of demographic and personality characteristics. *Information Systems Journal, 24*(3), 249–269.

Venkatesh, V., Rai, A., Sykes, T. A., & Aljafari, R. (2016). Combating infant mortality in rural India: Evidence from a field study of eHealth kiosk imlementations. *MIS Quarterly, 40*(2), 353–380.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2016). Unified theory of acceptance and use of technology: A synthesis and the road ahead. *Journal of the Association for Information Systems, 17*(5), 328–376.

Wang, Y., Singgih, M., Wang, J., & Rit, M. (2019). Making sense of blockchain technology: How will it transform supply chains? *International Journal of Production Economics, 211*(May), 221–236.

World Bank (2017). *The unbanked*Retrieved fromhttps://globalfindex.worldbank.org/sites/globalfindex/files/chapters/2017%20Findex%20full%20report_chapter2.pdf (Accessed 7 February 2019).

Wright, R. T., & Marett, K. (2010). The influence of experiential and dispositional factors in phishing: An empirical investigation of the deceived. *Journal of Management Information Systems, 27*(1), 273–303. https://doi.org/10.2753/MIS0742-1222270111.

Ying, W., Jia, S., & Du, W. (2018). Digital enablement of blockchain: Evidence from HNA group. *International Journal of Information Management, 39*(April), 1–4.

Zhang, X., & Maruping, L. M. (2008). Household technology adoption in a global marketplace: Incorporating the role of espoused cultural values. *Information Systems Frontiers, 10*(4), 403–413.