

Science and Technology Trends

Blockchain Industries, Regulations and Policy

The Indian Blockchain Landscape: Regulations and Policy Measures

Nir Kshetri

1. Introduction

Blockchain is considered to be a technology that has the potential to bring major political, social and economic benefits to developing economies such as India (Kshetri, 2017a). According to the National Association of Software and Services Companies (NASSCOM), blockchain-led increase in productivity and cost reduction can create value of up to US\$5 billion in the Indian economy by 2023 (IANS, 2018). The research company ResearchAndMarkets.com's study indicated that the banking and financial services sector is expected to be the leading sector to benefit from this technology (Business Wire, 2018).

According to PwC, there were only 23 blockchain firms in India before 2016. In 2016, 32 additional blockchain firms were established (Karnik, 2017). As of 2018, India was estimated to have more than 100 blockchain and cryptocurrency startups (Krishna, 2018).

The benefits of this technology are especially important to disadvantaged groups such as low-income population and small and medium-sized enterprises (SMEs). Prior research has demonstrated the importance of blockchain in fighting poverty and reducing financial exclusion in developing economies (Kshetri, 2017a, b, c). Blockchain is also expected

to help the Indian government's initiative to develop the healthcare sector to provide healthcare services to low-income population (Business Wire, 2018).

The Indian blockchain landscape reveals a number of encouraging signs. The policy think tank of the Indian Government, the National Institution for Transforming India (NITI) Aayog, which is headed by the Prime Minister, is exploring the use of blockchain to address key problems facing the country such as land registry, health records and distribution of fertilizer subsidy. Other focus areas include tackling fraudulent drugs and improving agriculture supply chain (The News Minute, 2018).

India's history of cryptocurrency is comparable to that of other similar economies. Bitcoin transactions were being conducted in India as early as in 2012. By 2013, some businesses started to accept payments in bitcoin (The Mission Podcasts, 2018).

At the same time the country's blockchain industry has run into many roadblocks and challenges. Blockchain startups have faced an uncertain regulatory and policy climate in the country. In April 2018, India's central banking institution, the Reserve Bank of India (RBI) initiated a crackdown on cryptocurrencies (Iyer and Anand, 2018). The lack of blockchain use cases has also been reported to hamper the growth of this industry (Krishna, 2018).

2. The Indian blockchain ecosystem: Opportunities for economic development and social welfare

2.1 Foreign companies and non-profit organizations enriching the blockchain ecosystem

Foreign multinational companies and non-profit organizations are playing a key role in the Indian blockchain ecosystem. A notable example is IBM. IBM's India research labs is involved in some of the IBM's blockchain-related work (Mahalingam, 2016).

Some Indian companies are also a part of sophisticated supply chain systems developed by IBM. For instance, in February 2017, it was reported that with support from Dubai Customs and Dubai Trade, IBM was working with many participants to design a blockchain solution to track the shipment of fruit from India to Dubai via a cargo ship. In Dubai, the fruit would be processed to produce juice, which is then exported to Spain by an airplane.

The participants included a telecommunications company, a letter of credit (LoC) issuing bank, a responding bank, a freight company and an airline. The plan after the completion of the supply chain and trade finance proof-of-concept (PoC) would be to integrate the system with Watson's artificial intelligence (AI). To move the transactions to blockchain, the UAE-based telecommunications company Du would track relevant data (e.g., temperature, humidity, etc. when the fruits are being transported) via Internet of Things (IoT)-enabled devices. Data reported via Du's IoT devices are validated by Watson AI.

It was reported to be among IBM's most visible blockchain projects (Del Castillo, 2017a). The PoC involved several key steps. Emirates NBD Bank would issue the LoC. The Spanish bank, Santander would receive the letters. The freight company Aramex would ship the fruits to Dubai. An airline carrier would transport the juice. The POC is powered

by smart contracts.

Indian companies have also teamed with foreign companies to develop blockchain-based solutions for the Indian market. In 2016, the Indian bank ICICI collaborated with Dubai's Emirates NBD bank in a blockchain pilot (Das, 2016a). Two pilot transactions were conducted. The first was an international trade finance transaction. It enabled all parties to access data in real-time. In the pilot project, an Indian firm imported goods from a Dubai-based supplier (Das, 2016a). The second project involved remittance transaction. Money was transferred from ICICI bank to an Emirates NBD branch. Blockchain reduced the time taken by cross-border remittances from two days to a few minutes (Das, 2016b).

Foreign non-profit organizations are also exploring to develop blockchain-based solutions for the Indian market. It was reported that Gates Foundation was exploring blockchain's potential to expand financial inclusion in order to reach 200 million unbanked Indians (Cointelegraph, 2016).

2.2 State level initiatives

Table 1 provides an overview of some of the initiatives at the state level that would affect the development of the Indian blockchain ecosystem.

Andhra Pradesh

The most advanced stage in the deployment of blockchain-based solutions can be observed in the state of Andhra Pradesh (AP). Policy measures have been taken to develop a rich ecosystem and infrastructure in which blockchain applications can grow. Blockchain has been the main focus area of the FinTech Valley Vizag. It was established in 2016 in the Visakhapatnam city.

The AP government has teamed up with the local company Covalent Fund to establish a blockchain

stack called Velugu Core. It will make the government data freely accessible through open application program interface (API). This means that software developers can freely access to the protocols and tools, which can be used to build applications. For instance, apps can be built using this stack to provide information about all former owners of a property as well as transaction details (Rungasamy, 2018). Covalent Fund will also focus on the creation of manpower and expansion of the access to funds (Patnaik, 2018). The AP state also announced a plan to establish a Blockchain University with an investment of US\$10 million (Rao, 2018).

The AP government signed an MoU with ConsenSys to provide technical advisory to the government (Khatri, 2018). ConsenSys will help the state to prioritize pilot blockchain use cases. Another MoU was signed with the Malaysian cryptocurrency company Belfrics Global to establish an institution in Vizag with the Gitam University. The MoU also involves developing blockchain applications for government operations (Sinha, 2018). The state also announced a collaboration with the cybersecurity firm WISEKey to implement a project to securely store citizen data on a blockchain (cryptocoinsnews.com, 2017).

In October 2017, the AP government collaborated with a Swedish start-up, ChromaWay, to create a blockchain-based land registry system for the planned city of Amaravati (LawFuel, 2017). Local blockchain startup Zebi Data is doing most of the implementation activities.

Telangana

In July 2017, the state of Telangana announced a plan to sign MoUs with a number of blockchain companies. The state is especially interested in implementing the technology to improve government services (Press Trust of India, 2018). Telangana started a land registry pilot project in the capital city of Hyderabad. It was reported in September

2017 that a complete rollout of the program in Hyderabad and nearby areas would take place within a year (BlockChain News, 2017).

The Telangana government noted that migration of land records into a blockchain platform would be undertaken on a phased basis. Only transactions that have been validated would be moved to blockchain (thehindu.com, 2018). For instance, lands that have been collateral for mortgage and other types of loan can be moved more easily onto blockchain. Banks and financial institutions engage in a comprehensive appraisal of such properties (Panchapagesan, 2018).

Public private partnership (PPP) projects have also been initiated. The Telangana state and Tech Mahindra signed an MoU to create a Blockchain District in the capital city of Hyderabad. The goal is to create a blockchain ecosystem. The government will provide appropriate regulatory and legal framework (Krishnakumar, 2018). Tech Mahindra will provide the technology and platform for the incubators in the Blockchain District (Anupam, 2018).

According to Tech Mahindra, companies in a number sectors such as pharmacology, retail, fashion, and architecture will be developing blockchain-based solutions in the District (Express News Service, 2018). In addition to Tech Mahindra, local blockchain startups Eleven 01 and Nucleus Visions are also founding companies. These companies will provide services such as mentoring, market reach, and technical insights to the startups.

Maharashtra

In October 2018, the state of Maharashtra concluded a blockchain pilot study. Four PoC projects were tested: organ transplants, rationing (administration of ration cards issued by the state government to households that are eligible to purchase subsidized food products), land records, and digital certification of government records (Burr, 2018).

Table 1: State level initiatives in blockchain-related areas

| State | Some key focus areas of blockchain deployment | Remarks |
|----------------|---|--|
| Andhra Pradesh | Government services, land registry, establishment of a Blockchain University | Has collaborated with a number of foreign blockchain companies such as ConsenSys, WISEKey, ChromaWay, and Belfrics Global and local companies such as Zebi Data and Covalent Fund to develop the local blockchain ecosystem. |
| Telangana | Government services, land registry, PPP to create a Blockchain District in the capital city of Hyderabad. | July 2017: announced a plan to sign MoUs with a number of companies to implement blockchain to improve government services. |
| Maharashtra | Organ transplants, rationing, land records, and digital certification of government records. | Zebi Data is reported to be working with the state. |
| Uttar Pradesh | Land record registration | July 2018: announced plans to start blockchain projects to manage land-related data within six months |

Uttar Pradesh

Uttar Pradesh was reported to be exploring blockchain for land record registration (Acuna, 2018). In July 2018, the state's government announced that it will start using blockchain to manage land-related data by the end of the year (businessstoday.in, 2018).

2.3 International collaboration and cooperation

The Indian blockchain industry and market are likely to benefit from international collaboration and cooperation at various levels. Some Indian companies such as the IT consultancy firm Wipro have joined the non-profit organization Enterprise Ethereum Alliance (EEA) (Del Castillo, 2017b). The AP government is also a member of the EEA (Blockchain News, 2018). The EEA has been taking major initiatives to develop blockchain standards (Graham, 2018). As of mid-2018, it had over 500 members that included well-known companies such as Accenture, BP, Credit Suisse, and Microsoft as well as developers and academics (Allison, 2018). The EEA released Enterprise Ethereum Client

Specification 1.0 (EEAS) in May 2018, which is available as a public download (Kot, 2018). This is expected to increase interoperability for companies using Ethereum-based solutions (Bitcoin Exchange Guide News Team, 2018).

India and other BRICS countries have signed an MOU, which aims to provide a deeper understanding of the use of blockchain in order to improve banks' operational efficiency. Major financial institutions of the five countries: Banco Nacional de Desenvolvimento Economico e Social (Brazil), China Development Bank (China), the Export-Import Bank of India (India) State Corporation Bank for Development and Foreign Economic Affairs (Russia), and the Development Bank of Southern Africa (South Africa) will conduct joint research under this initiative (Alexandre, 2018).

2.4 Controlling corruption and frauds

India ranked 81st in Transparency International's 2017 Corruption Perceptions Index (Transparency International, 2018). According to a 2017 survey conducted across 11 states in the country, 45% Indians had paid bribes in the past year (Banerjee,

2017).

According to Global Financial Integrity's (GFI) 2015 report, fraudulent misinvoicing of trade transactions accounted for 83.4% of all illicit financial flows (IFF) from developing countries (Kar and Spaniers, 2015). An estimate suggested that during 1988-2012, US\$186 billion worth of IFF went out from India through such process (Nguyen, 2014).

Due primarily to frauds, bad loans account for about 20% of bank loans in India (Suberg, 2017). Loan frauds in the country amounts to about US\$2 billion annually, which results in high interest rates. This is an indicator of low trust (Pitti, 2018). Financial institutions such as the State Bank of India (SBI) have been trying for some time to develop blockchain-based solutions to promote information sharing in order to reduce bad loans and fraud. They want to launch a blockchain platform for handling digitized loan and trade finance documents (Suberg, 2017).

Pervasiveness of frauds in the insurance sector has also been a concern. One estimate suggested that false claims in the Indian healthcare insurance industry account for 10-15% of total claims. The industry is estimated to lose about 6 billion (about US\$90 million) on false claims annually. Major fraud categories include misrepresented services, services that were not provided and services that were provided to so called 'rented' patients (Bardhan, 2007). An upshot is that a large proportion of the Indian population lacks insurance. In India, about 86% of the rural population and 82% the urban population lack health insurance (Bansal, 2016).

Frauds are rampant in the microfinance sector too. It was reported that during 2010-2012, in India's Kerala state, president and secretary of the Adoor Sree Narayana Dharma Paripalana Union received loans amounting 76.5 million (about US\$1.15 million) from Bank of India on behalf of about 5,000 families representing 256 micro units. The members of the units had no knowledge of the loans (The

New Indian Express, 2015). The families faced debt collection proceedings. Such frauds can be prevented using blockchain in microfinance (Kshetri, 2017a).

Blockchain-led transparency may help reduce these undesirable practices. For instance, banks are not willing to lend money in places where fraudulent invoices are common, or where manufacturers and their customers might have inconsistent and error-ridden records. A blockchain system reduces those concerns because these records must be authenticated before being added to the books, and because they can't be changed (Kshetri, 2017c).

2.5 Land registry

Across the world, land registries are inefficient and unreliable (Kshetri, 2018). One estimate suggests that over 20 million rural families in India do not own land and millions more lacked legal ownership to the land where they have built houses and worked (Hanstad, 2013). Landlessness is arguably a more powerful predictor of poverty in India than caste or illiteracy (Hanstad, 2013).

A study conducted by the civil society organization Daksh indicated that property-related disputes in India account for a 66% of all civil cases and cost the country 0.5% of the GDP (Haridas, 2018). About US\$700 million is paid annually in bribes related to land registrars in the country (Bhattacharya, 2018).

There are some encouraging initiatives to address this problem. In 2017, the Telangana and AP states announced plans to use blockchain for land registry. Maharashtra and Uttar Pradesh are at various levels of preparedness to develop such systems (Table 1). The state of Goa was also reported to be exploring blockchain for land record registration (Acuna, 2018).

Blockchain can lead to important cost saving opportunities. Before the implementation of blockchain, farmers needed to pay at least Rs 5,000 (about US\$68) to prepare registration papers. With blockchain farmers can get system-generated digital

documents for free. The digital document with a QR code can be sent directly to the land registrar (Bhattacharya, 2018).

In blockchain-based land registries, it is possible to do all or most of the processing using smart phones (Shin, 2016). India's high and rapidly growing smartphone penetration should facilitate this initiative. There were 299 million smartphone users in 2017, which is expected to increase to 442 million by 2022 (The Economic Times, 2018). A high cellphone penetration rate has been a key enabling factor for the deployment of blockchain in land registry in AP. According to the AP Capital Region Development Authority (CRDA) digital literacy in the state is high. At least one person in most families in the state can use cellphones and Internet (Bhattacharya, 2018).

Currently after a land transaction is finalized, the officer in charge of the collection of land revenues (tehsildar) needs to submit a land demarcation in order to the register the deed. The process takes between one month to three months. Often bribes need to be paid to prepare the document (Ramnani, 2018). With blockchain, properties can be transferred in a day without paying the bribes.

2.6 Voting and election systems

Blockchain is likely to have a dramatic impact on voting and election systems. Especially blockchain may reduce two of the concerns that are most prevalent in voting today: (1) voter access, and (2) voter fraud (Kshetri and Voas, 2018a).

Blockchain applications for shareholder voting and corporate governance are also being explored. Shareholders in India face challenges in physically attending shareholder meetings. In order to conduct some special business items, a postal ballot is held (Venkat et al., 2014). Blockchain-enabled e-voting (BEV) is expected to enhance transparency in corporate governance (BusinessLine, 2018). The

National Stock Exchange (NSE) was reported to be conducting tests to use blockchain for e-voting for companies. NSE-listed companies would tokenize voting rights (NSE, 2018). Mumbai-based blockchain startup Elemental will develop the platform.

Aadhaar card and electronic know your customer (eKYC) is likely to provide the foundation for BEV (Varshney, 2018). Note that eKYC is a paperless process to verify the Identity and address of a person based on the Aadhaar authentication (Emudhra, 2018).

2.7 Access to finance

In order to make financing more efficient and increase access to finance for SMEs, the government and the private sector have taken initiatives that are at various stages of exploration. Among the first such measures Yes Bank teamed up with IBM for a blockchain project to digitize vendor financing for its client, the consumer electrical equipment manufacturing company, Bajaj Electricals. The fintech startup Cateina Technologies developed a blockchain-based smart contract (Kasteleln, 2017).

When Bajaj Electricals processes invoices, the details are transferred to Yes Bank on blockchain. After bill discounting (bank lending against receivables), the funds are automatically disbursed to the vendors of Bajaj Electricals when the conditions in the smart contract are fulfilled. Following the implementation of blockchain, the process cycle for bill discounting reduced from four-five days to almost real time (Gupta, 2017). As of February 2017, Bajaj Electricals was doing transactions with one supplier on the blockchain system (Gupta, 2017).

As of mid-2018, fourteen Indian banks had signed up to use the services of the blockchain platform India Trade Connect consortium, which was developed by the local software firm Infosys. The

platform facilitates the issuance of loans that are backed by trade transactions (Satila and Anthony, 2018). The banks account for about half of India's internal trade. The solution is expected to speed up processes for approving new loans.

It was reported that the traditional trade finance process within India involves processing a large number of documents, which can take up to 22 days. According to Yes Bank, blockchain is expected to reduce the time to less than a day (Satila and Anthony, 2018).

Blockchain may help the government's efforts to address key problems in receivable financing. The RBI licensed three entities RXIL, A.TReDS, and M1xhange to provide receivable financing to micro and small businesses. These three platforms wanted to share information in order to prevent fraud but keep the data private. Blockchain can help achieve this.

Using blockchain, it is possible to create a cryptographic representation of the invoice, known as a hash. A hash provides an indecipherable text, which does not reveal information about the invoice. It is nearly impossible to convert a hash back to the original data. If a trader submits the same invoice to more than one trade finance platforms, the hash will match, which would raise a red flag. The New York-based software company providing blockchain solutions to financial institutions and central banks, MonetaGo also hashes some of the elements of the invoice in order to prevent the trader from making some modification in the invoice. It will produce an amber flag if an invoice has a high degree of similarity with another invoice already submitted to a different platform. The invoice will not be rejected but the trader may be asked to explain more.

2.8 Strengthening cybersecurity and protecting privacy

According to the Unique Identification Authority of India (UIDAI), 1.19 billion people were enrolled

in the Aadhaar system. In January 2018, all sensitive patient data for Aadhaar were hacked. India hopes that blockchain will properly secure the electronic health records (EHRs) and other sensitive data (Bryzek, 2018).

Blockchain is touted as a technology that can possibly provide a robust and strong cybersecurity solution and high level of privacy protection (Schutzer, 2016). Its proponents argue that this technology is secure by design (Kshetri, 2017d).

2.9 Healthcare

According to the World Health Organization (WHO), about 20% of the drugs manufactured in India is fake or of lower standard (Venkatasubramanian, 2018). India has been hit by a number of fake drug scandals. Counterfeit medicines were suspected to lead to the deaths hundreds of infants at a pediatric hospital in Kashmir. Likewise, a random test in a government lab found that one widely used antibiotic had lacked any active ingredient (Haris, 2014).

Blockchain could transform the healthcare sector. The NITI has taken initiatives to use blockchain-based solutions to fight against counterfeit drugs. The Aayog has teamed up with the U.S. technology company Oracle and a local hospital chain for this purpose. Oracle's blockchain solutions will be used in Apollo Hospitals' pharmaceutical supply chain to create immutable records for each transaction (Rana, 2018).

Likewise, 500,000 people die every day in India due to the non-availability of organs. In most cases, patients are unable to find donors due to the lack of proper communication channels (atositchallenge.net, 2016). It was reported that doctors who were part of a criminal gang that the police had arrested in early 2018 paid US\$1000 for the kidneys and then sold for about US\$38,000 (Robinson, 2008). It is argued that blockchain would

play a key role in a critical supply chain such as those involving organs (Digital Oil & Gas, 2018). It provides transparent, real-time, secure and auditable records of transactions involving organs.

3. The regulatory and policy environment

In recent years, there have been a number of high-profile initiatives, which have signaled an interest in blockchain. In October 2018, Prime Minister Narendra Modi announced that blockchain is one of the priority areas for a new technology center opened in the Maharashtra state. The center is a part of the World Economic Forum Centre for the Fourth Industrial Revolution (Dumont, 2018).

NITI Aayog is reported to be working on building the country's largest blockchain network: IndiaChain. The goals are to reduce frauds, facilitate contract enforcement, increase transparency of

transactions, and enhance agricultural productivity. The plan is to link IndiaChain with government digital identification databases such as IndiaStack (Sen and Murali, 2017). Note that IndiaStack (<http://indiastack.org/about/>) is a set of APIs developed around Aadhaar that allows government agencies and businesses to build products and services.

In October 2018, the Internet and Mobile Association of India (IAMAI) formed "Blockchain Committee." The Committee's members include the country's big business and cryptocurrency companies. The Committee is expected to work with government agencies, related industries and startups to strengthen a blockchain ecosystem (ET Bureau, 2018).

We discussed various state level initiatives in the last section. As noted earlier, PPP projects have also been initiated in some states.

Table 2. Some regulatory developments related to cryptocurrencies

| Time | Regulatory entity involved | Actions |
|---------------|--|--|
| December 2013 | RBI | Cautioned the users, holders and traders of cryptocurrencies about "the potential financial, operational, legal, customer protection and security related risks that they are exposing themselves to" (RBI, 2018). |
| December 2013 | Enforcement Directorate (ED) (part of the Department of Revenue, Ministry of Finance). | The Bitcoin exchange BuysellBit.co.in in Ahmedabad was raided. It was found that BuysellBit.co.in violated the Foreign Exchange Management Act (FEMA) (DNA, 2013). BuysellBit.co.in suspended its operations (Mishra, 2013). |
| February 2017 | RBI | Noted that it has not given any "licence / authorisation to any entity / company to operate such schemes or deal with Bitcoin or any virtual currency" (RBI, 2016). |
| December 2017 | RBI | In light of the significant and rapid growth of cryptocurrency values and ICO activities, RBI again cautioned the public against cryptocurrencies. It pointed out to the press releases of December 2013 and February 2017 (RBI, 2017). |
| December 2017 | Central Board of Direct Taxes (CBDT), Department of Revenue, Ministry of Finance | Conducted surveys of nine cryptocurrency exchanges to assess the possibility of tax evasion (ET Bureau, 2017). |
| April 2018 | RBI | A decree declared that all RBI regulated bodies (e.g., banks) were prohibited to have business relationships with entities dealing with cryptocurrencies. Those with existing relationships with such entities were required to end within three months. |

Despite the above mentioned positive trends, blockchain companies face a challenging regulatory and political environment. From the beginning, the Indian cryptocurrency market faced tough regulations. The system of capital controls prohibited Indians from using local bank accounts to buy and sell cryptocurrencies on international exchanges (Mundy, 2018).

Table 2 presents key regulatory developments related to cryptocurrencies in India. In December 2013, the RBI cautioned the users, holders and traders of cryptocurrencies about “the potential financial, operational, legal, customer protection and security related risks that they are exposing themselves to” (RBI, 2018a).

In the late 2017, the RBI issued reports cautioning users of the risk of bitcoin. The country’s income tax officials then started investigations into transactions at a number of illegal bitcoin exchanges (Antony and Chasudhary, 2018).

In the early 2018, in his annual budget speech, the Indian finance minister noted: “The Government does not consider crypto-currencies legal tender or coin and will take all measures to eliminate use of these crypto-assets in financing illegitimate activities or as part of the payment system” (Venkateswaran, 2018).

Among the most damaging regulatory policies, in April 2018, the RBI initiated the most significant crackdown on cryptocurrencies (Iyer and Anand, 2018). At that time about 10% of the world’s bitcoin transactions took place in India (Anand, 2018a).

The RBI’s decree issued on April 5, 2018 declared that all RBI regulated bodies (e.g., banks) were prohibited to have business relationships with entities dealing with cryptocurrencies. Those with existing relationships with such entities were required to end within three months (RBI, 2018b). It did not, however, affect peer-to-peer options

to buy and sell cryptocurrencies (Khatwani, 2018).

4. Key challenges facing the Indian blockchain industry and market

In theory distributed networks facilitate decentralized and democratic processes since no single entity owns or controls such networks. In practice, such processes are hindered by many factors.

The usual digital divide puts those without computers and relevant skills at a disadvantage. Cognitive entry barriers may be more severe due to the complexity of blockchain technologies (Atzori, 2015).

At the most basic level, India’s high illiteracy rate has direct consequences upon the populations’ capability to benefit from technologies such as blockchain. According to the World Bank, India’s adult literacy rate was 69.3% in 2011 (<https://data.worldbank.org/indicator/SE.ADT.LITR.ZS>).

There has been the lack of deep expertise on blockchain-related applications in the country. The head of the ConsenSys Ventures noted that blockchain knowledge in India “was at a very shallow level” (Kaushik, 2018).

A slow bureaucracy has hampered the development and implementation of blockchain systems. As of August 2018, most blockchain projects in the AP and Telangana states had just completed the PoC phase or were developing PoCs (Murali 2018). It was noted that some of the government departments were not motivated to move beyond the PoC stage (Murali, 2018).

The experiences of government blockchain projects in various Indian states have shown that the migration and integration of legacy IT and database management systems into a blockchain-based system would be a difficult task

(Murali, 2018). A major barrier is that different systems from which data need to be transferred to the blockchain system use different data formats and models (Kumar, 2018).

Analysts warned that tougher cryptocurrency regulations discussed in the previous section would have a significant negative effect on the broader blockchain environment (Mundy, 2018). For instance, blockchain projects are often funded by new cryptocurrencies. These are issued through initial coin offering (ICOs). Ban on cryptocurrencies thus would restrict the funding for innovative blockchain projects. It was reported that many blockchain startups were unable to implement projects they had started due to the government's ban on cryptocurrencies and ICOs (Team Inc42, 2018). The tougher regulatory measures would force blockchain startups and developers to relocate in other countries to access funding (Pitti, 2018).

This regulatory uncertainty made the blockchain industry and market less attractive for blockchain startups and developers. A large number of Indian blockchain developer were reported to move to jurisdictions with more friendly regulatory regimes such as Thailand, Estonia and Switzerland (Gunjan, 2018). Out of the country's 2 million software developers, only 5,000 were estimated to have blockchain skills (Agarwal, 2018). Some speculate that about 80% of these developers may pursue job opportunities outside the country (Agarwal, 2018).

Blockchain companies exhibited a similar trend. Zebpay, one of the country's oldest and largest virtual cryptocurrency exchanges closed its operations in India in September 2018. By October 2018, it had opened new offices in Malta and Singapore. Zebpay's new exchange in Malta noted that it would provide services to residents of about 20 countries, which did not include India (Anand, 2018b).

5. Discussion and implications

Blockchain adoption is a slow process that may take many years to exploit the full benefits. For instance, it is expected to take three to four years for the Indian banks to make full utilization of blockchain for trade financing (Bloomberg, 2018).

India has some of the most sophisticated uses of blockchain in some areas. For instance, one of the most advanced applications of blockchain to store property records known to date can be found in the AP state of India. In some cases, the poor quality of the existing land records in the state has posed a major challenge to this initiative (Panchapagesan, 2018). The farmers in the AP have expressed suspicion and distrust toward the blockchain-based land record system Especially the stages before the land records are moved to blockchain are viewed to be fraud prone (Bhattacharya, 2018).

The lack of land ownership remains among the major barriers to entrepreneurship and economic development in India (Kshetri, 2016). Blockchain can reduce friction and conflict, as well as the costs associated with property registration and transfer (Kshetri and Voas, 2018b). In addition, blockchain-based land registry can provide incentives and pressures for small informal businesses to formalize. This is important because informal businesses often tend to avoid attention and like to keep their activities secret. Digitization of their economic activities, however, forces them to be more transparent (Kshetri, 2019). Overall blockchain deployment would boost entrepreneurial activities in the country.

Economic sectors that are already digitized can be more easily moved to blockchain. In the land registry projects in the AP state, the land records were already digitized before (Bhattacharya, 2018). The costs of moving land records onto the blockchain system have also been low because of the

involvement of the local firm, Zebi Data. For the first, 83,000 records, it took just a few weeks and cost about Rs 5 (about US\$0.07) per record to move to blockchain (Bhattacharya, 2018). Zebi Data is also working with other states including Maharashtra and Telangana.

India lacks some of the key prerequisites to succeed in implementing blockchain in some other areas. For instance, regarding the BEV it is worth noting that shareholders of Estonian technology company LVH Group can use blockchain to make corporate governance-related voting decisions. They can log in using their verified national online ID and vote at LVH's annual general meeting (AGM) (Waterman, 2017). Estonia's e-residency platform is used to authenticate e-resident shareholders (Aasmae, 2016). India's Aadhar system is not as advanced as Estonia's e-residency platform.

In developing countries, foreign and local blockchain companies have different, but complementary roles to play in the development of the local blockchain ecosystem. Regarding established foreign blockchain firms' entry in developing economies, it is worth noting that they are likely to offer more sophisticated applications and services compared to local companies. For instance, Swedish blockchain startup, ChromaWay partnered with the AP state. ChromaWay had gained significant experience and expertise working with Sweden's land registry authority, Lantmäteriet and other projects (Bhattacharya, 2018). Local blockchain companies such as Zebi Data, on the other hand, are more effective in providing solutions suitable for local needs at a lower price.

economic, social, and political challenges facing India. This technology is likely to help move the Indian economy into a higher gear.

A number of initiatives have been taken by the government and the private sector to promote the development of the blockchain industry and market. PPPs have also been used as mechanisms to promote blockchain development. Political and regulatory uncertainty around cryptocurrencies, however, has been a concern. Probably the most damaging regulatory actions is that in 2018, the RBI cut off cryptocurrency exchanges from the formal financial system. The lack of friendly regulation has also led to brain drain of blockchain developers. Some crypto companies have relocated their operations from India to other jurisdictions that have more friendly regulations.

6. Concluding comments

In this article, we examined the current state of the blockchain industry and market in India. Blockchain undoubtedly has tremendous potential to play a major role in addressing a number of

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