



The Role of Blockchain in Improving Land-users' Rights

(Can blockchain solve corruption problems in land administration in developing countries? - The case of India)

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**A thesis submitted for the Joint Master's degree in
Global Economic Governance & Public Affairs (GEGPA)**

**Academic year
2020 – 2021**

July 2021

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Introduction

Objectives and preliminary research

The thesis aims to evaluate and deeply analyze how blockchain, a new and revolutionary technology, may improve the field of land administration and land records in the aim of combating corruption phenomena, and overall, how this could positively affect property rights in the developing countries, and especially in India. The decision to focus the research on this topic came after a long process that started from the investigation of possible uses of Blockchain in the Italian public administration, especially as regards infrastructure projects, therefore, to solve corruption episodes concerning procurements. The main point of the research work has gradually shifted to a more specific area of public administration, in particular, that of the land registries and land administration, and also it took a more international focus, leaving Italy to analyze the situation in developing countries and in particular in India, where this new technology could have a bigger impact on the achievement of the Sustainable Development Goals (SDGs), in particular for what concern property rights and land sustainability, while improving, in general, the services given by governmental institutions. The first part of the research will deepen the functioning of blockchain, in particular, what are the main features in terms of transparency and immutability, and then what may be the problems that could lead to application's failure, then we will see which are the main examples that have already take place and which were their results, this will introduce to the central topic, here will be analyzed the Indian situation (concerning property rights and digitalization), and how a cadastre system based on a blockchain architecture is being implemented in Andhra Pradesh (AP), concluding with an investigation on the latest innovations and the process on how the research has been conducted.

Influences from De Soto's Economic Theory

The economic theories on global development and in particular the work on property rights assumed by Hernando de Soto¹ between the 90s and the beginning of the 2000s, had a great impact on this work, De Soto's theory on property rights assume that if this are insecure, they reduce owners' incentives to make long-term capital investments and limit their capacity to use their assets as collateral to acquire loans, as well as financial capital investments (*Williamson, 2011*). Capital formation and economic growth are hampered by a lack of access to finance and future investments. De Soto was the first one, back in 2015, to theorize the possibility of using Blockchain technology to develop efficient land records, improving the property rights in developing countries (*Techonomy, 2015*).

Blockchain and its main features

Blockchain can be described as a network that combines a very high number of computers, each of which follows a series of mathematical rules. This type of structure allows the development of applications impossible to obtain with other existing systems (such databases). More precisely, blockchain is a protocol of rules that guarantees specific properties to the applications based on it, the clearest definition to describe this technology is that of a digital ledger, decentralized and distributed on a network, structured as a chain of registers ("Blocks"), from value transactions to entire digital applications (*Chiap, Ranalli and Bianchi, 2019, p.36*) New blocks can be added to the blocks already present in the chain, but on the contrary, it is not possible to modify or remove previous blocks already added to the chain (Immutability of transactions).

¹ Hernando de Soto Polar (1941) is a famous Peruvian economist who focuses his studies on the informal economy and the relevance of property and company rights for development. Numerous heads of state have praised his work on the developing world, particularly for his book "The Mystery of Capital and the Other Path." He currently serves as the president of the Institute for Liberty and Democracy (ILD), a Lima-based think tank dedicated to encouraging economic development in developing countries. <http://www.ifoldsflip.com/i/598242-techonomy-magazine-2015/23>

The most known example of this technology is Bitcoin, the first cryptocurrencies ever created. However, Bitcoin is only one of the possible blockchain's applications. Blockchain is a "chain of blocks," with each block representing a set of records. Each of these records could be a cryptocurrency, a property plot, or even a person's identity. If the traditional Internet is the "Internet of information," then blockchain is the "Internet of value" (*UNOPS, 2018, p.131*). As a result, the technology has the potential to transform the way value is stored and transferred. In this ecosystem, encryption and consensus protocols could ensure security and immutability. The result should be a system that will be open, neutral, reliable, and with a high degree of security. The Blockchain can be a system with great potential to guarantee a new level of reliability in online applications which today enjoy a low rate of trust, precisely due to the lack of a reliable system that allows the interaction, exchange of value, and documents on completely virtual platforms.

A sector in transformation

Blockchain technology has developed for most of the time without any regulation, indeed most of the lawmakers and regulators have yet to properly comprehend the cryptocurrency phenomena, while on the other hand, they are being pressed to review present legislation to integrate blockchain technology and safeguard consumers from fraud. Despite reservations about the feasibility of cryptocurrencies, the underlying technology Blockchain is widely expected to transform the way value is stored and transmitted. Therefore, this thesis will not take into consideration cryptocurrencies (which is the sector where blockchain is used the most) and will look instead at the wider usability and applicability of blockchain in international development with a specific focus on land administration. To strengthen and increase the quality of the current cadastre, some states are trying to develop a decentralized system for land-record based on blockchain.

Blockchain and the usability in Land Administration

This document will try to analyze the most salient aspects in the use of blockchain on land administration, what are the advantages it could bring in terms of decrease corruption problems, and what are the challenges that still need to be solved, consequently, the research will deepen the Indian case, focusing the analysis on the latest innovations and the remain steps that need to be taken for a concrete development of a functioning blockchain cadastre. In conclusion, will be considered how this could affect the population (property rights), and if it could become an example for other developing realities. Land Administration is considered to be among the most corrupt institutions in the world, UN-Habitat (*Zevenbergen 2012*) observed that land offices are among the most unreliable and less transparent in most of countries. Corruption exists where there is a lack of transparency, this lack begets numerous land challenges, which include: land tenure insecurity, high cost of land transactions due to informal payments, reduced private sector investment in land, less revenue for the state, increased land grabbing by officials, increased land conflicts, landlessness, and inequity in land distribution (*P. Ameyaw, 2020*). If we will be able to find a solution to these problems and guarantee the control of territory more effectively, we may resolve some of the most pressing challenges in today's world, as well as make it easier for states to protect the environment.

1. A Background on Blockchain

1.1 Main features of Blockchain

1.1.1 Disintermediation and Decentralization

Blockchain is distinguished by the fact that it is a decentralized, distributed, and immutable ledger. (*The internet of Value – Exchange, Deloitte Report, 2016, p.2*) It is decentralized processing on many “nodes,” or computers connected to the blockchain network, ensures that transactions are not validated by a single deciding authority. This reduces the chance of corruption or rent-seeking behavior by a single actor and entities, this is possibly thought the peer-verification of transactions (on public blockchains) or validated by several authorized users (on private blockchains²). *In some circumstances, the decentralized nature of public blockchains where peer-validation replaces third-party middlemen could increasingly reduce transaction costs and perhaps transaction time.* (GZ_1, p.1, q.4), this makes more difficult the tampering of documents because the actors involved in the process are many and independents.

Thanks to the possibility to disseminate data over multiple nodes, the distributed component has major consequences for disaster recovery. If one node is destroyed (in case of an earthquake or a flood), the data can be restored from other nodes on the blockchain (*UNOPS, 2018*)

² A private blockchain restricts processing to members or employees of the organization but opens use to consumers, while a public blockchain enables anyone to participate in any capacity. (<https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-internet-of-value-exchange.pdf>)

1.1.2 Immutability

The blockchain's immutability is perhaps the most appealing characteristic to stop the tampering of documents and certifications. Each block is linked to the preceding block using a cryptographically safe technique that provides information about the preceding block (*Figure 1*). As a result, unlike a traditional ledger, which is structured by page numbers that have nothing to do with the content of the page, the blockchain's "blocks" contain a hash that represents the previous block's contents.

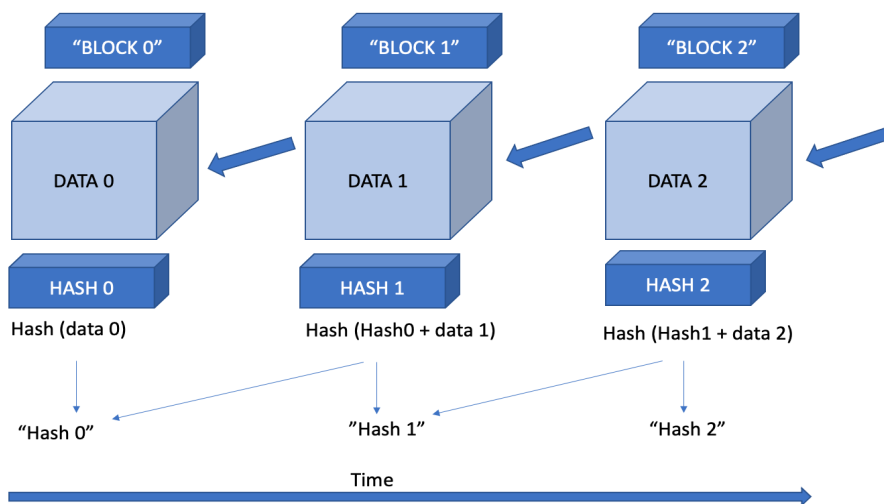


Figure – 1 (The hash function in connecting new blocks) - Own Made on PowerPoint.

This means that changing a record in the past without breaking the entire chain is mathematically and virtually impossible. Even if this were to occur, it would not go unnoticed by the other nodes. At the same time, it is worth noting that blockchain immutability is a relative concept and that collusion and "51% assaults"³ are feasible, though prohibitively expensive, and time-consuming. (*Yaga et al. 2018, p.45*)

³ A "**51 percent attack**" on a blockchain occurs when a group of miners controls more than 50% of the network's mining hash rate. Attackers possessing a majority of the network's control can prohibit other miners from completing blocks, suspending the recording of new blocks. (Bacon et al. 2017)

1.1.3 Cryptography

Cryptography refers to the practice of secure communications in a hostile environment (internet), this technology plays an important role in the Blockchain environment. Public key cryptography is a cryptographic system widely used on the internet and, on the blockchain, it has the task of generating addresses and authenticating transactions using Digital Signatures, one of the most popular applications of public-key cryptography. The basic idea is to use a pair of keys in mathematical relation to each other: A randomly generated private key, which must remain secret (therefore protected). A public key is mathematically derived from the private key, which can be shared with anyone. (*Yaga et al. 2018, pp.13-14*)

Keys are nothing more than extremely large numbers which are usually represented in hexadecimal (0-9 and a-f to represent numbers 10-15). Generating a public key from a private one is computationally easy while reversing this operation is practically impossible. With the most powerful computers around, however, it would take thousands of years to solve a calculation of this size. This technology guarantees several properties that are now fundamental to guarantee security in an unsafe environment such as the internet, they are:

- **Encryption** (information encoding)
 - **Authentication** (the veracity of identity)
 - **Integrity** (any subsequent changes invalidate the signature)
 - **Non-repudiation** (an operation cannot be denied after having signed)
- (*Ibid*)

Encryption works like this, if Luca wants to send a message to Vicky and make sure that only she can read it, Luca just encrypts the message with Vicky's public key, thus

doing only the owner of the private key connected to that public key (Vicky) may be able to decrypt the message.

Asymmetric-key algorithms and hash functions are the two types of cryptographic algorithms used in blockchains. Hash functions are employed to give each participant the capability of a single view of the blockchain. The SHA-256⁴ hashing method is commonly used as the hash function in blockchains. Hash functions play an important role in connecting blocks and ensuring the integrity of the data stored within each block. Any change to the block data can cause inconsistency, causing the blockchain to become invalid. The avalanche effect, a feature of hash functions, is used to meet this criterion. According to this, even a minor modification in the input to the hash function will result in a completely unrelated output when compared to the original. (Sahu 2021)

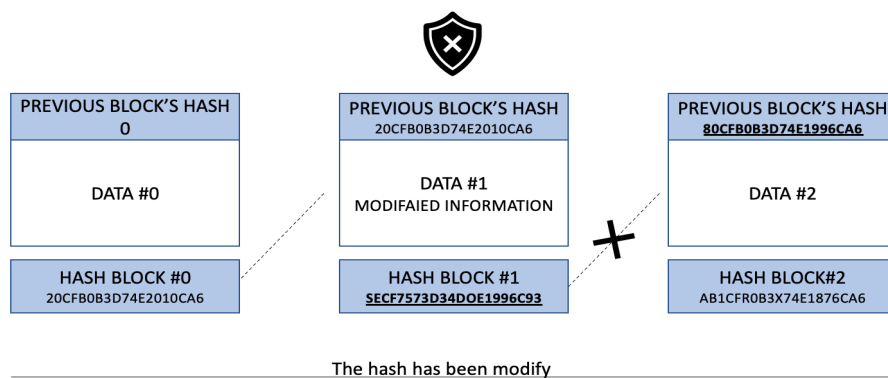


Figure 2 - (Data modification invalid) - Own Made by PowerPoint.

1.1.4 Private and Public Blockchains

A Distributed Ledger Technology (DLT) is what Blockchain is. These are divided into two main typologies, the first is called Permissionless (open DLTs or Public Blockchain) such as the one on which are based Ethereum or the Bitcoin blockchain,

⁴ The Secure Hash Algorithm (SHA) is a hashing algorithm with a 256-bit output size that is used in several blockchain technologies (SHA-256). This algorithm is supported by hardware on many computers, making it quick to compute.

the second one is called permissioned (closed DLTs or Private Blockchain), this type of blockchain tend to exist between institutions that know each other, such as commercial banks, public administration, or businesses. Hybrids of both groups have been created as well. (Hileman & Rauchs, 2017) In a Distributed Ledger environment information is stored by a distributed method on computers called "nodes". Given that blockchain is a decentralized peer-to-peer⁵ system with no central decision-making process, consensus serves as a dynamic mechanism for achieving an agreement in place of a central authority. Proof of Work (PoW) and Proof of Stake (PoS) are two of the most common forms of consensus procedures discovered.

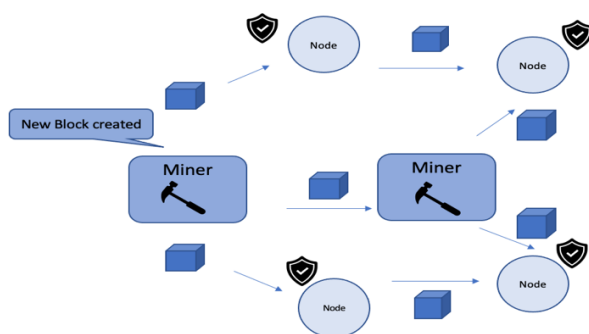


Figure – 3 (the process of validating blocks in a PoW environment) - Own Made by PowerPoint.

1.1.5 Proof of Work

The consensus process in the Proof of Work is to solve a complex computational challenge (mining) to add a block of new transactions or information to the blockchain, with the first computer or "miner" capable of achieving the challenge receiving a reward. This procedure is proven to be particularly energy-consuming, to the point where it is becoming a global matter of concern (climate change). This is due not only

⁵ A Blockchain system runs on top of the Internet, on a peer-to-peer network of computers that all run the protocol and have an identical copy of the transaction ledger, allowing for P2P value transactions without the use of an intermediary by machine consensus. The blockchain is a file – a shared and public ledger of transactions that records all transactions from the first block (genesis block) to the present day. (Voshmgir 2020)

to the large amount of energy consumed by the mining process but also to the fact that only countries with large and relatively affordable energy sources will be able to benefit from mining's economic incentives, creating a geographic gap between countries. (*Voshmgir 2020*)

1.1.6 Proof of Stake

The Proof of stake model, on the other hand, bases the generation of new blocks on the amount of stake a user has. Stakes (tokens) can be used in a variety of ways in the blockchain system, including random selection of staked users, multi-round voting, and a coin aging scheme. Users with greater stake, regardless of the method, are more likely to create additional blocks. (*Yaga et al. 2018, p.29*)

On a blockchain, almost anything can be recorded. One of the main advantages of distributed ledger technology is that it ensures the authenticity of information once it has been saved, as long as the information encoded is true. If any data is tampered in one of the nodes, the remaining nodes will detect the error.

In this environment, two parties can deal in a blockchain ecosystem without knowing each other and without the need for a trusted mediator. Regulators face a particularly difficult task when it comes to user privacy in financial transactions. The notion of "know-your-customer" (KYC) conflicts against "privacy," one of blockchain technology's fundamental concepts. (*Ibid, p.30*)

1.1.7 Transparency

For interested parties, transparency allows all transactions on the blockchain to be publicly viewable and transparent. Furthermore, transparency may be the most significant feature of blockchain because it is impossible for a single party to modify the network's data without being detected. This is the joint effect of transaction immutability and decentralization. The validation of each transaction is the responsibility of all network users (miners). The platform, which refers to public blockchains, can stay very transparent and trustworthy as a result of this, it is different in the case of private blockchains which may not guarantee the same level of

transparency as the public ones, private blockchains are more centralized than public blockchains, but they have advantages such deliver substantially faster throughput and performance at lower computing costs, this may be a positive output in the use of the technology for public administrations. The choice to adopt a private or public blockchain depends a lot on what is the objective that arises, if we want to cut costs and make transactions faster and we can afford to neglect transactions, then it will be more convenient a private blockchain, while if we want to increase transparency and combat corruption phenomena, in that case, a public blockchain would guaranteeing higher transparency and immutability. (*Sladić et al. 2021*)

1.1.8 Smart Contracts

Smart contracts are self-executing programs that are triggered when predetermined requirements or conditions are met and are stored on a blockchain. They have a minimal memory footprint since they can be replicated across numerous nodes. When creating smart contracts, one of the most important factors to consider is security. Furthermore, a combination of public and private keys ensures the signature mechanism. If a user loses or makes their private key public, they may not be able to retrieve it, leaving their blockchain assets vulnerable to theft or permanent loss. (*Yaga et al. 2018, p.35*)

Smart contracts are deterministic in the sense that the outcome is foreseeable when given precise input and a certain start value. (*Rikken et al. 2017, p.22*) As a result, smart contracts are not "smart" and are incapable of performing any intelligent action, such as performing a contract or legal act. It is worth noting that the blockchain is only able to access information within its own context. If the data source is corrupt, the blockchain has no way of correcting it or determining the data source's credibility. Once code has been deployed on a blockchain, it cannot be changed unless the code contains functions that allow it to be changed, or if the code contains functions that allow it to be corrected,

or in case the blockchain participants encourage the network to do a "hard fork"⁶, or a split in two blockchains. (Bacon et al. 2017)

While waiting for the provisions of a contract to be completed, smart contracts can be utilized as a source of value storage. Smart contracts are not foolproof, and the code itself is vulnerable to human error, which can have disastrous repercussions and result in significant financial loss. On the other hand, if properly structured, Smart contracts have the ability to eliminate inefficiencies and flaws inherent to real-world systems. (Bacon et al. 2017, p.33)

1.2 How Blockchain can improve land-administration

The sections that follow are about blockchain and land administration⁷, a topic that has caught the interest of both blockchain technologists and international development specialists, Blockchain's applications cover a countless number of fields, including land administration. The applications, benefits, and limitations of this new technology are continually being explored and challenged. As a result, the purpose of these parts is to highlight the benefits and drawbacks of blockchain technology in a field that has a substantial impact on governance. Few countries such as Georgia and Sweden are already experimenting with land-registers based on a Distributed Ledger Technology, others have programs to do the same and a number of those are developing countries (India, Ghana, Honduras, etc.). *Land administration is one of the most interesting fields*

⁶ A hard fork is a new software update implemented by a blockchain or cryptocurrency's network nodes that is incompatible with the existing blockchain protocol, causing a permanent split into two separate networks that run in parallel. Unlike soft forks, which are essentially backwards-compatible updates, hard forks establish a permanent change in a blockchain protocol's rules, with each version propagating their own transactions and blocks. (Yaga et al. 2018)

⁷ The term Land Administration (LA) was coined in 1993 by the United Nations Economic Commission for Europe (UNECE). ("The Concept of Land Administration | Guide for Monitoring and Evaluating Land Administration Programs | Food and Agriculture Organization of the United Nations" n.d.)

for the development of this new technology, indeed the possibilities to bring a disruptive impact in the old systems of land records could improve the life, as well as the property rights of millions of people all around the world (VT_4, p. 1, q. 4).

Disintermediation and immutability are certainly the most interesting features of blockchain, if the processes and the infrastructures needed to make this system working will be implemented correctly, then this could save important economic resources both to citizens and governments, this will surely improve the relations between the institutions and citizens, cutting unnecessary expenses and helping in fighting corruption in land-record administrations, facilitating investments and the possibility to overall improve the ease of doing business and see property-rights fully recognize (Ibid, q.5).

Virtual authentication is the most basic use on a public blockchain in land management. Due to disintermediation, the public blockchain may conceivably execute virtual authentication at a lower cost than requiring a notary to prove past ownership while transferring a property. Most land registry applications, however, at least until now, appear to be on private blockchains, where only approved organizations or persons have access to the system and are assigned predefined roles to clear transactions in accordance with their legally specified functions. This can be seen in the cases of the Swedish Mapping Cadastre and Land Registration Authority, which has developed a cadastre based on a private blockchain in collaboration with ChromaWay⁸. While the public blockchain is more visible and resistant to tampering, the private blockchain comes with the seal of approval from piloting governments who will ensure that transactions on the blockchain network are legal. Transactions are unlikely to be regarded as lawful without government approval.

⁸ ChromaWay was founded in Sweden during 2014 to commercialize Colored Coins, the open-source project founded and led by ChromaWay CEO Alex Mizrahi. Colored Coins was the first viable way to issue arbitrary digital assets, "tokens", on the Bitcoin blockchain. This was the start of "blockchain 2.0", uses for blockchain beyond cryptocurrencies. <https://chromaway.com/>

1.2.1 Land Management

Land management is under increasing strain due to the continued population increase, climate change, natural disasters, wars, and large-scale economic globalization. Sustainable land management aims to balance environmental, economic, and social concerns in order to benefit current and future generations while preserving and improving the quality of land resources. Land-related disputes aside, major socio-economic, financial, and environmental challenges affect the land services hampering the efficiency of land management. Insecure land tenure; lack of access to resources and agricultural advisory services; insufficient incentives and environmentally destructive land use; insufficient systems to collect land-based taxes and apply the revenue to improve public services; and inaccessible, unequal, and uneconomic procedures and transactions are just a few examples. (*IPCC S.R, United Nations, 2020*)

1.2.2 Corruption in Land Administration

Where land governance is lacking, significant levels of corruption often grow, as seen across the world. Low levels of openness, accountability, and rule of law are common characteristics of poor land governance. *Land distribution is unequal, tenure is insecure, and natural resources are poorly managed under such a regime. As a result, social stability, investment, broad-based economic growth, and long-term development are jeopardized (MB_6, p.1, q.4).* Corruption in the land industry can be described as "pervasive and lacking effective controls". Due to a shortage of transparency and asymmetric knowledge, elites can capture and create opportunities for corruption. (*Corruption in the land sector, FAO, 2011*) While existing digital systems have enhanced access to information and boosted openness, blockchain may be able to provide additional benefits. Indeed, in a blockchain environment when a transaction has been performed, it cannot be erased from the blockchain due to its immutable nature, resulting in a tamper-proof record. Any change to an existing record or transaction would cause the tampered block's hash value or unique identifier to become incompatible with those of other blocks in the chain. Tampering with a public

blockchain, as previously mentioned, will be both costly and time-consuming, creating disincentives to changing information.

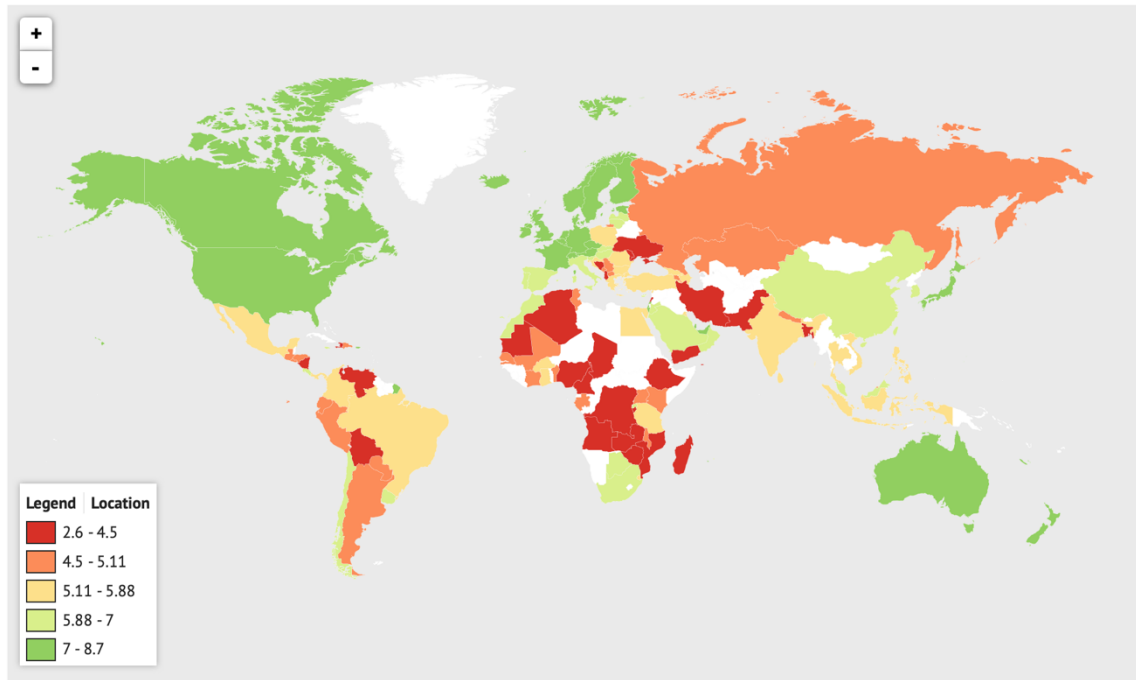


Figure 4 - (“Map of Countries by International Property Rights Index, 2020 - Knoema.Com” n.d.) Knoema Data Provider, 2020 – The Index goes from a minimum of 0.0 (very low property rights) to a maximum of 10.0 (very good level of property rights). In this map we can observe how India’s rank shows a medium level, this means that steps were made by the government to increase the security of property rights, but still there is space for further improvement of the land cadastres.

Land registries, on the other hand, are projected to use private blockchains. Authorized users have additional control over these private blockchains. More control also means that such blockchains may be more vulnerable to tampering by colluding participating nodes, rendering the immutability component obsolete (GK_5, p.1, q.3). However, even on a public blockchain, a private blockchain might be constructed so that people have view-access to anonymous characteristics like transaction time and cost, adding an added degree of accountability (Ibid). This approach would provide a blockchain-based land registry with not only the main benefits of a public blockchain—such as faster

transaction verification, error correction, and greater security from external attacks — but also more transparency and accountability by incorporating elements of peer-to-peer validation through citizen engagement. (*How Safe Are Blockchains: It Depends*, Harvard Business Review, March 7, 2017, [https:// hbr.org/2017/03/how-safe- are-blockchains-it-depends](https://hbr.org/2017/03/how-safe-are-blockchains-it-depends)) This is a significant advantage over current systems, in which paper and digital records can be altered with few repercussions. As a result, blockchain has the potential to improve transparency and minimize corruption in the land sector if correctly utilized.

1.2.3 Land records require a High Level of Security

Between 50% and 75% of a countries' wealth is considered to be in the form of land or real estate assets. (*Byamugisha 1999, p.9*) The land is one of the most significant factors of production that contributes to a variety of economic sectors. Furthermore, the land is frequently the poor's only asset. As land administration ICT systems and records grow more digital, cybersecurity becomes increasingly crucial in protecting people's ownership of their single most valuable asset. When digital systems are breached, land and property records are at risk of being hacked and modified. Due to its high immutability and the fact that records cannot be tampered with, blockchain technology adds an extra degree of protection. In land administration, this characteristic of the blockchain is projected to grow more prominently in the future. Still, security problems remain, the DAO (Digital Decentralized Autonomous Organization) breach is a clear example that demonstrate that Blockchain may not be completely safe from breaches, a vulnerability in the code exposed the organization (Ethereum Blockchain), and a consistent part of its funds have been stolen because of an error in its smart contracts' codification. Since its invention, there have been a number of security breaches regarding the blockchain environment but in the last years, many developments have been done and the quality and the security of this technology have been increasingly improved. (*Morganti, Schiavone, & Bondavalli 2018, pp.87-88*)

1.2.4 A high degree of Resilience for Data

The distributed nature of blockchain, it may be used for a critical application in land administration: disaster recovery of land records and information. Currently, servers

carrying land rights information must be physically guarded in the event of natural disasters or wars. While disaster recovery centers are becoming more widespread, they, too, include servers that are vulnerable to the same risks as the original databases. Data loss would be considerably reduced by blockchain's capacity to spread data across all participating nodes. In the event of a natural calamity, blockchain could enable quick data recovery and assist the country and the market in returning to normal function faster than present methods. This is crucial for a seamless post-disaster recovery, which can be slow and difficult. To verify the robustness and practicality of blockchain-based catastrophe recovery, pilots would be required. (Shuaib et al. 2020)

1.2.5 Affordable Services Access

Another key difficulty in land administration is that around 70% of the world's population lacks reasonable land administration services, such as land or property registration. (Malaysia's experience in transforming land administration, World Bank Report, 2017, p.9) While notarization and registration fees vary by country, they can sometimes amount to several months' worth of salary. It's still uncertain whether blockchain will be able to reduce transaction costs. The hypothesis is based on disintermediation on public blockchains. The cost to the citizen is likely to drop if the consensus process can act as a third-party mediator, such as a notary. On private blockchains, estimating the impact of transaction fees is more complex. To determine the marginal cost of executing common land administration functions on the blockchain, pilots would need to be conducted. In addition, the fixed expenses of establishing and maintaining a private blockchain-based land register must be factored in, still, the tools in terms of immutability and transparency could solve those costs that arise from corruption behavior (Shuaib et al. 2020).

1.2.6 Tangible Examples

Georgia: In 2016, Georgia's National Agency of Public Registry signed a Memorandum of Understanding with Bitfury, a prominent blockchain implementation enterprise, to enter the blockchain-based property rights market. Two findings were drawn from a recent review of the projects (Shang & Price, 2019). The authors emphasized the importance of data quality as well as widespread engagement with a

target population. Georgia's blockchain-based system registered over 1.5 million land titles in 2018. Georgia also emphasized the value of mining, it figures as one of the largest contributors to commercial mining, according to a World Bank press release, owing to cheap energy prices and tax exemptions (*The World Bank, 2018*). As a result, the adoption of blockchain-based projects has gained traction among people. Furthermore, communities such as the Georgian National Blockchain Agency and the Georgia Blockchain Coalition have contributed to the public debate on the subject. Centrality is gained by education, which is a significant part of the process of implementation, education is a vital condition for the success of the blockchain-based public initiative, as *Shang and Price (2019, p.77)* demonstrate. As well as the quality of data, the power of a blockchain-based land registry system would have been severely limited without correct data, as poor-quality information placed on the Blockchain would make third-party verification of land titles problematic. Furthermore, since the beginning of the project, Georgia has collaborated with worldwide experts to correctly process the enormous quantity of data and be able to educate administrators and employers on the new technology. This highlights a crucial truth about Blockchain-based government solutions: while the technology can ensure the security and immutability of data, it cannot replace the institutional infrastructure required to maintain data quality.

Sweden: The Swedish proof-of-concept was completed between June 2016 and June 2018, with Lantmäteriet, Sweden's mapping, cadastral, and land registration authority, as the main sponsor. Lantmäteriet is a government institution that specializes in Swedish geography and property information. A collaboration of business experts, technological suppliers, and financial institutions backed the project. Kairos Future (company), Telia (ID Provider), ChromaWay (technology provider), SBAB Bank, and Landshypotek were the winners, in that order. (*Proskurovska and Dörry, 2018*)

The contract protocol may be disseminated through third-party vendors or directly through registry-designed apps, with only the parties to the contract having access to the data in the contract. The contract would not completely execute until the data and signing conditions were met. Given the large number of people participating in the conveyance process in Sweden, this last function was considered extremely useful. The

proof-of-concept indicated a considerable reduction in the number of manual procedures required for a property transaction (from 34 to 13), as well as increased transparency for all parties involved, in terms of being able to check on the progress of a transaction at any point during the process; and smart contract-based dissemination of the standard property transfer protocol. The fact that Swedish law prohibits the use of electronic signatures for property transactions was noted as a key problem during the proof-of-concept evaluation, which is obviously a big barrier in terms of growing the project to the production level. The blockchain network and smart contract proof-of-concept protocol have been trialed and externally tested as of now. Once the digital signature restrictions are addressed, more progress can be made. (*Bennett et al., 2021*)

These are the first two cases that have given the opportunity to experts and governments to analyze what are the main innovations that this technology can lead to the field of land records, which is why countries that have the aim of developing a system based on Distributed Ledger Technology look at these first two examples with interest, also following similar development processes. In the second chapter we will see the Indian case, where, in the state of Andhra Pradesh, the government signed an agreement with ChromaWay (*Ibid*). The state government directly called the Swedish start-up to develop his own land register based on a Blockchain architecture, which if not identical to the Swedish one will certainly use some of the innovations set up by the latter at home. What must be considered is that each land registry has special characteristics, each country is different, the division of the land and the systems used to sell and acquire it has been developed over the course of centuries, for this reason, it will be interesting to see how the institutions and the companies involved will manage their blockchain architectures to satisfy the single cases, all this could lead to several innovations even outside the cadastre sector.

1.2.7 Other Considerations

The improvement of land property rights is crucial for poverty reduction in developing countries. In Africa, for example, land productivity is directly linked to poverty alleviation, although a trustful land-record system allows people to feel secure about the ownership of their properties, enabling investments and activity, making those land

productive, and able to sustain the population's needs. Land ownership entails access to basic infrastructure, jobs, and financial services, among other things. While property rights are essential to people's livelihoods, land ownership is a complicated process governed by a variety of legal agreements at the municipal, state, and national levels, as well as international treaties. As the policy and legislative community develops its capability to handle the underlying workings of blockchain technology, a slew of new questions has arisen, casting doubt on past pronouncements about the technology's merits and limitations. Given the multiple current pilots, blockchain appears to have the potential to help land administration systems overcome some of the issues that have plagued them. However, if technology is employed in the absence of a strong legal and governance framework, it has the potential to exacerbate current problems. (*Blockchain: background, challenges and legal issues, DLA Piper 2018*)

The use of digital tools to address development issues is nothing new. However, they have frequently been marred by failure. The digital principles for development are a set of nine living standards that aim to help technology-enabled initiatives incorporate best practices (*Principle for digital development, <https://digitalprinciples.org/>*) These suggestions could help Blockchain Technology avoid making the same faults as previous technology solutions. To secure the optimal outcome for end-users, blockchain technology should prioritize ethical design, especially when these users are the most vulnerable parts of society, such as refugees, children, the disabled, and women. The governance model, how identities are generated, the authentication and verification technique, data ownership and access, and security are all important questions to examine when creating a blockchain solution.

Blockchain technology and its uses in land administration are still relatively new and unproven. There are various "on-chain" and "off-chain" factors that need to be researched, analyzed, and evaluated, as mentioned in this chapter. Furthermore, in order for blockchain technology to gain widespread use, it must provide clear and verifiable advantages over existing digital systems. In many sectors, including land administration, experts are working to reduce poverty and increase shared prosperity.

On this front, some of the next steps include: (a) conducting more POCs⁹, such as mortgage registration, which is expected to benefit commercial banks and urban housing; (b) testing the POC with interested client countries to learn more about adapting the POC to specific jurisdictions; and (c) exploring the possibility of marrying blockchain technology with other technologies, such as IoT (Internet of Things) and the AI (Artificial Intelligence).

2. The Indian Case, How India (Andhra Pradesh) is trying to develop a new Land-Registers based on Blockchain:

2.1 Background

2.1.1 India: a Federal State

On August 15, 1947, India declared independence from British colonial rule. Apart from the British-Indian provinces, India gained independence from 562 princely kingdoms. The Constituent Assembly of India enacted the Indian Constitution on November 26th, 1949, and it went into effect on January 26th, 1950. When the Constitution was adopted in 1949 India had 14 states and six union territories, today, after several administrative reorganizations (the most recent was the 2nd of June 2014, when the state of Telangana was created), it has twenty-eight states and seven union territories. After a century of colonial rule by the British East Indian Company, the British Crown took over the administration of India in 1858, establishing a highly centralized style of government with the governor-general acting as the British government's agent. This trend toward centralization was obvious even in independent India's Constitution, which called for "a strong Centre." However, significant developments have occurred in India's history over the previous half-century, leading to growing federalism within a federal-unitary

⁹ Proof of concept (PoC), also known as proof of principle, is the demonstration of the possibility of a method or idea, or a demonstration in principle with the goal of demonstrating that a notion or theory has practical potential. A proof of concept is usually a short project that may or may not be finished.

continuum. India has been increasingly federal since the party structure was changed from a one-party to a multiparty system in 1989. (*Kulke and Rothermund, 2016*)

2.1.2 The Sociocultural Context

India is 3,287,263 square kilometers in size. It has a population of 1,352 million people, according to the most recent census (UN world population prospect, 2019). The literacy rate is 74.04% percent (GoI, 2019), and the per capita nominal GDP is \$2,099 (World Bank, 2019). The discrepancies between states reflect India's uneven development: some (Kerala, Goa, and Mizoram) are entirely literate, while others are not (the literacy rate in Bihar, for example, is below 65 percent). India contains 91 macro-areas (eco-cultural zones), 4,635 communities, and 447 languages or dialects based on interacting patterns between tribe, caste, ethnicity, religion, ecology, history, language, and administration. There are twenty-two “recognized languages” listed in the Constitution.

Since 1950, India has been a federated republic with a democratic parliamentary system of government. As reported above, India is a multi-ethnic, bilingual, and pluralistic society. The population of India has increased enormously from 361 million in 1951 to 1,352 million in 2019. At the same time, the country's nominal per capita income increased from US\$82 (World Bank, 1960) to US\$2,099 (Ibid, 2019) per year, and its literacy rate improved from 16.6 percent (Ibid, 1960) to 74 percent (Ibid, 2019). India has transformed from a poor country in 1951 to a fast-growing major economy and a powerhouse for information technology services, with a burgeoning middle class.

2.1.3 Indian’s Economic Outlook

As previously mentioned, in the past 10 years, India has experienced intensive economic growth, which was only stopped by the pandemic outbreak during 2020/21, the COVID-19 pandemic has had a mostly disruptive economic impact. According to the Ministry of Statistics, India's growth slowed to 3.1 percent in the fourth quarter of the fiscal year 2020 (*“Provisional Estimates of Annual National Income 2020-21” - <https://mospi.gov.in/>*). Notably, India had been experiencing a pre-pandemic downturn, and the current pandemic, according to the World Bank, has magnified pre-existing threats to India's economic outlook". The Indian government has announced a number

of steps to address the crisis, ranging from food security to additional cash for hospitals and state governments, as well as sector-specific incentives and tax deadline extensions. On March 26, 2020, a series of economic relief measures for the poor totaling over 170,000 crores (US\$24 billion) were announced (*The economic times, 2020*). The Reserve Bank of India announced a series of actions the next day that would make 374,000 crores (US\$52 billion) available to the country's financial sector. The World Bank and the Asian Development Bank have agreed to provide assistance to India in the fight against the coronavirus pandemic (*“World Bank Fast-Tracks \$1 Billion COVID-19 Coronavirus Support for India”*). On May 12, the Prime Minister launched a \$20 billion (US\$280 billion) economic stimulus program (*“India Will Be Key to the Global Economic Recovery”*, *indbiz.gov 2020*). The Cabinet approved several measures in the economic package, including a free food grain package, and a number of economic indices showed signals of revival by July 2020. The government announced two more economic stimulus packages on October 12 and November 12, bringing the total economic stimulus to Rs. 29.87 lakh crores (US\$420 billion) – 15% of national GDP — until October 31 (*Manoj Sharma, 2020*). This could be a crucial time for the government to develop a broader plan of reforms that give new impetus to the Indian economy. India has a great yet untapped potential for economic growth, held back by heavy bureaucratic slowness and problems of corruption within the most important institutions.

2.1.4 The importance of a more Trustworthy Land recording System

Apart from the pandemic, and the consequent economic crisis, over the last 20 years India's economic profile has shifted from rural-based agricultural output to urban economic activities, as well as from low-value manufacturing to high-value services (*Hammurabi & Solomon, 2017*). But still, there are grey areas remaining, mainly in the Public Administration where still reforms and innovations should be implemented, one of the areas that require more regulations is the property market and more precisely land administration, strong and reliable property rights system is fundamental to guarantee economic growth. (*Locke, 2013, p.11*) Secure tenure has been found to improve land market efficiency, increase access to formal financing, encourage investment in

physical and human capital, improve growth performance, lower macroeconomic volatility, and promote the equitable and efficient distribution of economic opportunity. *(Ibid)* Despite reform efforts such as the Digital India Land Records Modernization Programme (DILRMP), *India's present land title system still has flaws. If India is to become a global economic powerhouse, it will need a standardized property rights regime. To strengthen current systems, a decentralized, open, and transparent form of record-keeping must be implemented, as well as a legal framework capable of ensuring and enforcing property rights. Blockchain technology could be a solution to the existing record-keeping problem (VT_6, p.2, q.7).*

The world is undergoing a post-industrial digital revolution, which is characterized by information density, connection, specialization, and globalization. This new technological era has the ability to create an environment in which society is driven by shared goals rather than individual gain. *(Benkler 2006, pp.2-3)* Modi's government started in 2014 the ambitious Digital India Mission to reap the benefits of this technology-centric paradigm, whose cornerstone is the provision of trustworthy and current data to support effective delivery of government services. *(“Digital India Land Records Modernization Programme”, 2014)* Right now the information architecture that contains this data, is housed in a collection of separate databases. The existing method nevertheless makes it quite simple to change or manipulate information. This issue is particularly prevalent in the case of land records. The states' centralized management of land data and registration processes provides only a sliver of transparency and accountability. As a result, vital information is frequently missing, causing significant delays in real-time decision-making. Poor land record-keeping makes purchasing land difficult, causing trouble to the citizens and delay in private and public infrastructures and businesses. As a result of this administrative flaw, fraudulent land transfers and corruption episodes are common. *(Akhury, Vanita, 2016)* In some situations, mortgages on government-owned assets have been used by people to get bank loans.

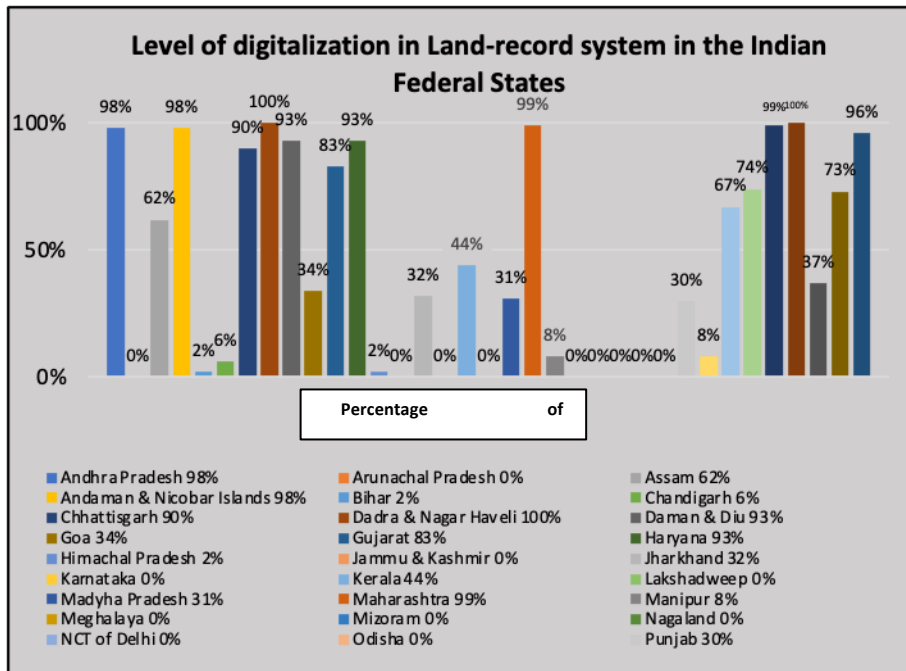


Figure 5 – (Percentage of computerization of land records in India) – We can notice that steps have been done in the past years thanks to the DILRM program, which had success in most of the Indian states. (Mishra and Suhag 2017, p. 47)

2.2 Property Rights' situation in India

Secure property rights are essential for any country's economic and social progress. In India, however, land conflicts account for around 25% of all cases handled by the Supreme Court, with 30% of those involving land acquisition (Namita, 2019). As a result, a considerable portion of the population, particularly the poor and vulnerable, has insecure tenure, posing a complicated set of issues for a successful government. All of these issues have a negative influence on the court system's efficiency as well as the country's capacity to attract investment. Despite the gravity and complexity of the problem, land governance and property rights have received little attention in India's policy research and development efforts. There are numerous causes for this, ranging from historical to political. (Venkatesan, 2020)

Historically, agricultural production taxes provided the majority of the colonial government's revenue. As this revenue decreased over time, the emphasis on rural land

administration shifted. The Indian Government did not invest in solid land management systems as Indian cities evolved in an unplanned manner. Land and housing are extremely significant assets on a political level, and when badly governed, they attract corruption and violence. Furthermore, land and houses are often deeply emotive for people, and access to them, in some circumstances, is influenced by historical beliefs and conventions. Patriarchal traditions, for example, frequently prevent women from holding property (*World Economic Forum, 2017*), despite studies showing that when women own property, their families have higher health, nutrition, and education indices (*World Bank, 2013*). Similarly, marginalized populations who own property have higher food security and are treated with more respect by local populations (*Keyman 2014*).

While India has implemented reforms in many sectors of the economy, land, and labor, which are the primary elements of production, have been partially neglected. With property conflicts accounting for up to 66 percent of all civil lawsuits (*Namita, 2019*), it is safe to assume that virtually every Indian family has been involved in one of these. The severity of the impact of the Covid-19 pandemic on individuals living in informal settlements, where the difficulties of inadequate sanitation and housing are exacerbated by the lack of security of possession, testifies the structural presence of these unresolved issues.

2.3 The Land Record system in India

After independence¹⁰ various reforms were implemented, including the Zamindari Abolition Act (confiscating land from landlords, i.e., Zamindars), the Land Ceiling Act (to allocate surplus land to the landless), tribal ownership rights, and so on. (*Mishra and Suhag, 2017*) Because land is a state matter, the system for managing land records varies from state to state. The Records-of-Rights (RoR) are kept in the *Tehsil/ Mandal* (sub-district administrative unit) office and are not updated on a regular basis. (*Ibid*) Land

¹⁰The 1947 Indian Independence Act [1947 c. 30 (10 & 11. Geo. 6.)] is a British Act of Parliament that divided British India into two new independent dominions, India, and Pakistan. The Act obtained Royal Assent on July 18, 1947, and on August 14, 1947, India, and Pakistan, consisting of the West (modern-day Pakistan) and East (modern-day Bangladesh) areas, were formed. (*Kulke and Rothermund, 2016*)

records maintenance is handled by three State Departments/Agencies, namely the **Land Records Department, Survey Department, and Registration Departments in the States** because it involves land-related details, maps plan, and land registration. Since each department operates independently, records modified in one department become obsolete in the other department. Although when land transactions are recorded, ownership titles are still considered. This opens the door to fraudulent activities such as double sales, non-owner sales, *benami* (unidentified buyers), back-dated sales, and so on. Illegal encroachments, title disputes, and other issues account for about 40% of all court cases in India (*“Land Records Modernization - Legal Insights”, 2017*). As described below, land/property can be transferred from one party to another by sale/purchase, land acquisition, inheritance, judicial orders, and bank mortgage. (*Thakur et al. 2020*)

In India, the most common method of updating ownership is through a sale transaction, which is completed through the registration of deeds. Deed registration and title registration are the two main types of registration processes. A documented conveyance deed is executed between the parties and registered at the registrar’s office in ‘Deed Registration.’ (VT_4, p.2, q.6)

This registered deed provides the property's proof of transaction and is used to keep land records up to date. The 1882 Transfer of Property Act grants the possibility to transfer or sell the immovable property via a registered instrument. The transaction can be registered, but the land title is not assured. A registered sale deed and additional documents, such as property tax receipts, survey records, and RoR records, are used to demonstrate ownership. The legal legitimacy of the transaction is evaluated by the Registrar in ‘Title Registration,’ and the rights are only transferred if the grantor has a clear title to transfer. (*Aggarwal, 2018*)

2.3.1 Land’s Public Acquisitions

Land acquisition is another method in which the government acquires agricultural and/or non-agricultural areas for various development purposes such as village/town extension, road building and/or development, reservoirs, military camps, canals, industries, and railways. The Land Acquisition Act of 1894, which is a major act,

governs the process of acquiring land in the public interest. Acquiring land that is privately owned by citizens and non-governmental organizations is a possibility. The Land Acquisition System improves the acquisition of land as well as the resolution of dues and disputes. The title and ownership of the land are updated in the appropriate land registers following the notification and acquisition of the land (known as Khasra and Khatoni in the majority of the States). Because of inheritance or death instances, the Patwari/Talitha, a revenue officer at the village level, updates the ownership rights. The Patwari has the authority to transfer land to the heirs in the period allotted. Court orders can also be used to update ownership rights. Furthermore, when a land/property owner takes out a loan, the lending bank enters the mortgage of the property against which the loan is made in the land records database. Even while the number of transactions generated through land purchase, inheritance, mortgages, and court orders is small, they must be documented to keep the system current and complete. (*Thakur et al. 2020*)

2.4 Existing problems in Indian's Land-Records

Existing land records in the country are illegible, poorly maintained, and frequently do not reflect the reality on the ground. States governments face significant difficulties, including the maintenance and availability of property records information. The fact that these systems are descended from the old 'Zamindari' system is one of the main reasons for their inadequacy (MB_6, p.1, q.5).

Furthermore, India's current legal framework does not provide any assurance of ownership. At the district and village level, many departments update and preserve this information. But the problem arises when data between these Departments are not synchronized on a regular basis, resulting in discrepancies in the records and, in many cases, mismatches between the information on the documents and the ground position. The management of land markets in the country is harmed by poor handling of land transactions and record-keeping systems. (*Aggarwal, 2018*)

According to the World Bank's 2020 Ease of Doing Business Survey, India placed 154th in terms of land/property registration (World Bank, Registering Property 2019). The

quality of land administration, the transparency of the information system, and the time and cost are all factors that penalize India in this ranking. Land registry in developing nations has numerous challenges and uncertainty in land demarcation. *The main issues with the existing system are fundable in the multiple agencies involved in the process of land records, such as Courts, Banks, and registration departments, and their incapacity of coordinating themselves. Other problems could be found in the old and outdated cadastral records and their poor management, which consider an inadequate usage of IT systems and old methods of survey. All this entails fraud and corruption, which spread across the land administration process and that jeopardize the capacity of the administration to guarantee their citizens' property rights. (VT_4, p.1, q.5)*

2.5 The National Land Record Modernization Program (NLRMP) and the case of Andhra Pradesh:

2.5.1 The National Land Record Modernization Program

In August 2008 the Indian Government launched the National Land Record Modernization Programme (*NLRMP*) with the goal of developing a modern, comprehensive, and transparent land records management system that assures that immovable property titles are secured and proven. (<http://dolr.nic.in>). In 2014, the initiative was renamed Digital India-Land Records Modernization Program with the objective to develop a contemporary and effective land records management system (*DILRMP, 2008*), but the system remains vulnerable in terms of privacy, cyber-attacks, and other issues (information and corruption), although was not implemented all over the Indian states but just in some of it, a number of states are still using old archives where they maintain paper documents, those are the once which faces the most of the problems in terms of corruption and tempering.

2.5.2 Andhra Pradesh and its blockchain Land-Registry

The Government of Andhra Pradesh¹¹ since 2019 has undertaken a program to retain land registry records, and authorities have begun the process of deploying Blockchain in several industries. *The state government has teamed with an Indian start-up called Zebi¹² to develop Blockchain-based property register records. Andhra Pradesh was the first state in India to implement blockchain technology at this level, this was possible thanks to the fact that the new capital city, Amaravati, was born to be a Smart-City, and the government of Andhra Pradesh (AP) bought all the land from the farmers who owned it, by doing that all the titles of ownership were cleared, without any dispute still pending it was possible to develop a blockchain from zero, knowing that errors could be very limited (SM_7, p.2). In the territory part of the new capital city, the property deeds will be recorded thanks to a Government Land Registry where the nodes of the blockchain will be the institutions such as banks, investors, and big companies involved in the project. The Land Department would approve the transfer of asset ownership from the seller to the buyer by uploading the information in the blocks added to the chain, the distributed ledger is based on a Private Blockchain working through the Proof of Work (Ibid).*

This experiment is important also to show how other government agencies, such as the State Municipal Department and the Water Department, can be integrated. In India Blockchain is still in its early stages, and the decision of Andhra Pradesh could be an important experiment to see which pros and cons this new technology could have (SM_7, p.2-4). The experiment will be crucial, if this new system works, it might bring other Indian states to implement it, as well as convince the federal government to

¹¹ Andhra Pradesh is a state in the south-eastern coastal region of India. Is the seventh-largest state in India and the tenth for population (49 million), the capital city is Amaravati (103.000) which is still under construction. (CIA.gov 2021)

¹² Zebi is a full-stack core-blockchain company founded by Silicon Valley veterans. Full-stack means that Zebi operates in the entire blockchain ecosystem – infrastructure and products. Core blockchain means that Zebi does not offer any other service apart from the blockchain. (<https://zpb.zebi.io/>)

contribute through direct investments. The system that is taking place in Andhra Pradesh, as already said above, is based on a private blockchain, which will use this technology to create interoperability between different institutions and stakeholders (Banks, Notaries/Courts, Surveys, SRO¹³, and Districts), the stakeholders themselves are the nodes of the blockchain, which will take care of the process of validation of information, the nodes are dispersed across a network and perform the duties that have been allocated to them. (*Thakur et al. 2020*)

2.5.3 The planned Blockchain-based Land-Register System's participants (nodes)

1st Node: Bank (Mortgage/Loan, Buyer, Owner)

Banks are the primary financial lending institutions that facilitate financial transactions between buyers and sellers.

2nd Node: Notaries/Court (Property Deeds/Disputes)

Notaries are private entities that help prepare deed papers for a variety of transactions.

3rd Node: Department of Survey and Settlement

The Survey and Settlement Department in the states are in charge of performing rural surveys and mapping land parcels. They regularly make cadastral maps at a size of 1:4000. This department is also in charge of updating current survey maps in order to conduct inheritance and sale mutations.

4th Node: SRO is the fourth node. Registration of deeds and the issuance of deeds

The SRO office is where the sub-registrar conducts his fundamental functions, such as deed registration and the safekeeping of the deed registries. The SRO and Tehsil office function together in a few states (Haryana and Punjab).

¹³ The Sub-registrar Office **SRO** is immediately subordinate to the District **Registrar**. The chief function of the **sub-registrar** is to **register** documents for which the required stamp duties and **registration** fees are paid. On application from parties, he issues certified copies from preserved records of registered documents. (*Telangana.gov.in*)

5th Node: Tehsil Office (records validation/updating) - The Tehsil office is the central hub of the land records system, where all records are kept and updated. This office also keeps all the essential land records and registrations. This also serves as a front desk for a variety of citizen services. Village Level bureaucrats (Patwaris) keep the land records for each village up to date on a regular basis below the Tehsil Office. (Thakur et al. 2020)

A node can be a communication endpoint or a communication redistribution point that connects to other nodes. Every node on the network is regarded equal, yet they all play various roles in the network's support. Not all nodes, for example, will store a complete copy of Blockchain or validate transactions (Voshmgir, 2020). All the above-mentioned nodes, on the other hand, would have full access to Blockchain.

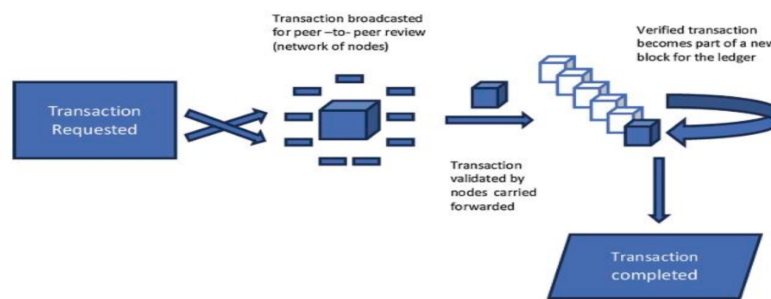


Figure 6 – Process of Transaction through Blockchain. – (Thakur et al. 2020, p.4)

2.5.4 The steps in a Land Recording process made through Blockchain:

- The buyer goes to the State's official "Land Management Information" portal, where he finds and picks one of the officially listed lands/properties that meets his needs.
- The terms and conditions of the transaction are negotiated and agreed upon by both the buyer and the seller. The transaction is made public once it has been launched by the council of administrators (nodes), who each retain an identical copy of the transaction. The transaction is accepted after the involved nodes reach a consensus. A block is added to the ledger as a result of the transaction.

- The buyer now can apply for a property loan from a bank, which is also part of the nodes, following this approach, the bank ensures due diligence. It only authorizes the proposed loan after thorough authentication and sends the customer an approval letter.
- The buyer receives a copy of the offer letter, and the nodes involved validate the transaction. As a result, a new block has been added to the ledger. (Node -1)
- The buyer uses an e-stamp calculator to calculate stamp duty and pays it via the Stockholding Corporation of India Limited's e-Stamping system. The nodes' consensus validates the transaction, and a new block of data is added to the ledger. (Node-2)
- The deed is drafted and electronically signed by the buyer, the seller, and two witnesses. The deed is signed and submitted to the Sub Registrar Office, along with the registration cost, which is paid online.
- The concerned authority posts a copy of the filed deed and a receipt for the registration money on the network, waiting for approval. A block is added to the Blockchain after most nodes have been authorized (Node-4).
- All submitted documentation, including map plans and ID proofs, are verified by the Sub Registrar Office (SRO). After that, the SRO gives the buyer/bank the registered deed. The consensus approves the issued deed, and a block is created for this transaction (Node-4). (*Aggarwal 2018*)

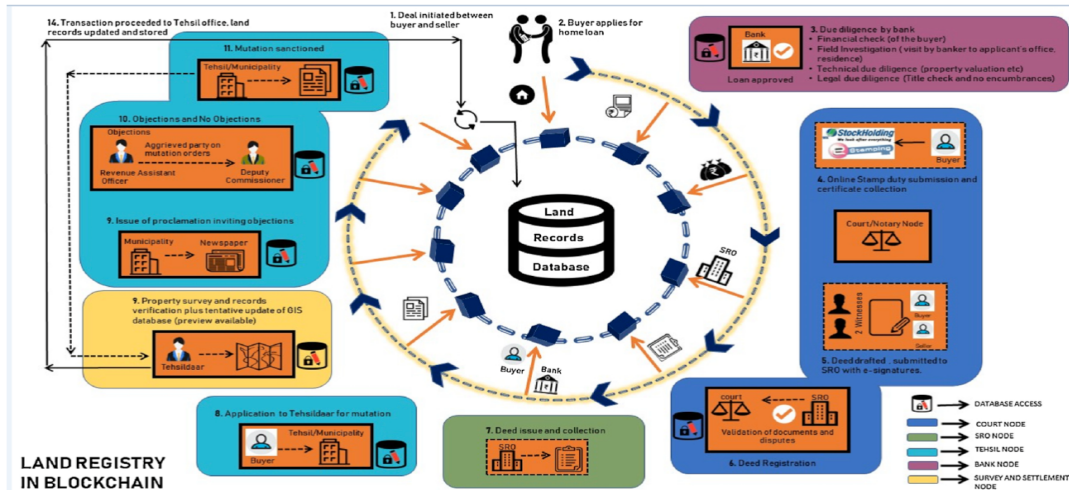


Figure 7 – The passages needed to update land records through Blockchain, (Thakur et al. 2020, p.5)

2.5.5 Design details for the Implementation of Blockchain architecture:

Any property has particular elements to be recognized on the system, this is the account number, the owner’s name, the address, the parcel-ID, the total area of the property, the buyer’s name, and the area which will be bought. When all these elements are gathered and uploaded the system will automatically create a new class, this will take the name of New Property, when the new property is registered for the first time then its records are uploaded into the block with its own hash. When the owner sells his property, the system records the buyer's information, including how much (area) he or she intends to purchase. The current hash and the prior hash both store the same information. If it is changed, it returns false, indicating that the record is no longer valid. The aggregation and association relationships reveal the interactions between the various modules. The attributes and functions for each class (Transfer Property, Land Records, Mutation Inheritance, Court, Land Acquisition, Survey and Settlement, Convert to Block) are listed. (Mishra and Suhag 2017)

2.6 Challenges in implementing blockchain in developing countries

Blockchain allows for a faster, easier, and more convenient method of registering property, as well as the protection of data from tampering and barriers to corruption

episodes. Although, Blockchain, like any other technology, has inherent downsides. In this paragraph, I am going to analyze which are the principal limitations that could stop this technology from being implemented in developing countries (India). The technology is very new, and it started to gain attention only in the last five years. In the subcontinent, there are not yet enough case studies that could be deeply analyzed, and application of this technology remains limited to certain businesses/industries which are testing the technology's capabilities. To what concern the public administration the efforts in developing this new technology have been initiated by some of the State Governments, mainly to track items in the manufacturing sector and in the supply chain sector. (Sinha 2018)

Then few states such as Madhya Pradesh, Punjab, and Haryana understood that there was a serious possibility to use this technology also to implement a new system for land records, and then they started to experiment with it. (Ibid)

2.6.1 Main development problem

A land-record system based on Blockchain request a high degree of certainty, the data uploaded on the blockchain cannot contain wrong information, neither they can contain transactions with disputes still pending, the problem in developing countries such as India, is that data regarding land properties and those regarding purchase and sale transactions present a certain frequency show discrepancy, this problem must be resolved before the blockchain is being implemented, if not the information uploaded will prove to be wrong. This flaw can now be fixed thanks to a start-up born in Singapore which has developed a new technology called: Continuous Operating Reference Station technology¹⁴ (CORST), the geo-localization tool is based on 17 satellites that will be working continuously through an operating reference station which will collect information through the Global Navigation Satellite System (GNSS), and they will process a survey of all the land parcels. It by verifying the veracity of the data of the documents and databases available today, through this innovative method

¹⁴ For a better understanding of this technology:

https://www.fig.net/resources/proceedings/fig_proceedings/fig2019/ppt/ts02e/TS02E_singh_kumar_9921_ppt.pdf

it will be possible to correct the errors funded in the land registers, thus giving the possibility to implement the blockchain-based system in a simpler and more reliable way. (SM_7, p.1, q-3). This method is starting to be used in the State of Andhra Pradesh and has been pushed by the current Chief Minister: YS Jagan Mohan Reddy. By the CORST, the average time to complete control of land parcels around all the state's territory will take around six months to be measure, in the end, clear data will be fully available for all land's parcels in the state, ultimately, this will give the possibility to develop an efficient land-record system. If the CORST technology will work in AP, then it will probably be adopted by other Indian states and then possibly by other countries around the world (Ibid).

2.6.2 Other development problems

Other problems regarding the implementation of this technology are: 1) a lack of experts specialized in the implementation of blockchain's architectures, the experts familiar with the different types (private, public, hybrid) of blockchains were and are still limited. 2) A limited number of governmental and private organizations whit the requested pre-requisites to work and carry-out a successful training for public employees and administrators. 3) The immutable nature of blockchain creates a sense of fear and distrust in the minds of employees and functionaries that will tend to continue to use existing computerized systems. 4) There are still problems deriving from the legislative systems, India and other countries have laws that prohibit the use of digital signatures or that do not take them into consideration for official documents, this can be a serious impediment for the development of blockchain's based systems and would require serious government intervention for the change and creation of new regulations to support and facilitate new innovations, moreover, there is no regulation on how the transactions should be written and which is the minimum set of attributes needed for recording a transaction, rules should be fixed by a regulatory body, but it's still not clear which body should do that (at least in India). 5) The cost of initially set-up a large network for the application of Blockchain is significant, many resources are required, and public investments are crucial. 6) The set-up of a network with enough bandwidth to keep the nodes running is not simple. The availability of networks in India is still quite low. Furthermore, in several states, land records databases are still kept at

the district level. The upkeep of land records data is still done at the district level, where officials of the revenue department (tehsildar) are in charge of the basic registers. *(Singh 2020)*

Latency difficulties may arise in a Blockchain network that comprises large ledger records: For complete knowledge of the transactions and the many entities linked with the transactions, a network, and interactions of the nodes with traditional database servers are required. High-end servers are necessary not just to handle the current demand, but also to handle the additional connections required for replication of transactions to all participating nodes. Furthermore, the layout nodes and their efficient implementations have yet to be studied, making it problematic in the event that implementations are unavailable. To suit business objectives (in the case of a Private Blockchain implementation), several channels can be created to facilitate a group of nodes and separate them from the rest. Multiple smart contracts must be used to integrate the various channels. *(Shuaib et al. 2020)*

2.6.3 Indian Government's Strategy to overcome these Problems

The proper application of business rules and smart contracts is critical for successful Blockchain implementation. To address these difficulties, the Indian government has begun to establish unique technical excellence centers, known as Centers of Excellence (COEs), with the necessary staff and resources. In addition, these centers collaborate with a variety of technical institutes, including the Indian Institutes of Technology (IITs) and the National Institutes of Technologies (NITs). The Indian government has begun supporting Blockchain projects for several start-ups. With the support of industry, the government of India has begun to strengthen the digital infrastructure and public network enhancements, public investments are growing as well and different states as reported above are exploring or already developing the technology in their public administrations meanies in land-records systems. *(Aggarwal 2018)*

2.7 Final Considerations

Maintaining land records and keeping them up to date has proven to be a difficult challenge in India. In most of States, citizens have little faith in the existing systems. Even if they have a valid sale deed, citizens are confused if they legally own a piece of land. Others who wish to acquire land are unsure whether the seller is the legitimate owner. Blockchain Solutions may be used to resolve these challenges and in a circumstance like Kerala, where the flood destroyed paper documents (*Vellaram 2019*), it may be the best solution to protect crucial information, that if not may get lost.

Blockchain technology could allow us to address many of these issues while also providing cascading advantages. The use of Blockchain technology in the land ownership and registration process could increase transparency, minimize fraud, and improve valuation. This will also improve land management and conveyancing, as well as the country's Gross Domestic Product (GDP). The implementation of blockchain technology will also aid in the achievement of the Sustainable Development Goals (*SDGs*). In particular, the SDG goals regarding peace, justice, and strong institutions will be strengthened by accurate and secure land records since institutions will be more effective and accountable (*UNCTAD 2021*). Each transaction, whether it is a property sale, an inheritance, a court order, or a land acquisition, will be captured and permanently recorded by the system. This means we will get near-real-time updated records with accurate traceability and visibility into the state of property records. This will result in a single source of truth for the ownership status and transaction history of a property. Buyers will be certain that the land being purchased is the correct plot and that the seller is clearly the owner, decreasing the risk of forgery and disputes, as well as the expenses and time associated in any given transaction, and paving the way for conclusive Land Titles to be implemented.

2.7.1 Challenges of Implementation

Land records, registration, and surveying information are kept at several levels, such as revenue departments (Tehsils) and Blocks. All of the data is kept in isolation at separate levels and is not available centrally. Furthermore, land parcel boundaries have not been

updated and are not properly demarked for individual users. The ownership of the shares is still divided among the owners. Individual interactions should result in a distinct, identifiable entity or object. As a result, boundary coordinates should be used to clearly identify all parcel boundaries and shares. Business process engineering is essential for each State to have a standard operating procedure because the data is managed by numerous departments. However, because the land is a state subject in India, the states have sole authority over it. The Indian government should provide uniform operating guidelines for the installation of Blockchain-based systems across the country. The current Blockchain system design process is based on a single context. There is no generic or universal Blockchain design available. (Thakur et al. 2020)

2.7.2 Latest Innovations (goLand-Registry)

GoLand-Registry is a cutting-edge blockchain-based software solution that aids the world's governments in ensuring systematic, transparent, and secure online land register management and data verification. It's part of a partnership with UN-Habitat¹⁵ to establish a framework for developing emerging technology tools and digital platforms to improve urban design and planning in the South of Asia. For land registry deeds anchoring and verification, goLand-Registry uses the public hybrid blockchain platform LTO Network (<https://docs.ltonetwork.com/>).

goLand-Registry's mission is to assist the Member States by:

- Enabling land and property survey, mapping, and registration in urban informal settlements
- Using cutting-edge technology to map the property registration process and ensure that the data of land occupancy certificates are stored in a decentralized public blockchain environment.

¹⁵ UN-Habitat works in over 90 countries to promote transformative change in cities and human settlements through knowledge, policy advice, technical assistance, and collaborative action. Source: <https://unhabitat.org/about-us>

- Using an open source blockchain verification tool, property owners can independently show the authenticity of their land titles.

2.8 Limitations and Implications

2.8.1 Limitations that characterized the study

The limitations encountered by this study were many and differs one from the other, first of all, we should take in consideration the hype that these days characterize blockchain technology, this creates very different believes in experts, there is who have great faith on the distributed ledgers, and who is skeptical and does not think the technology could be really “disruptive”. Moreover, until now the blockchain has been used mainly for financial and cryptocurrencies solutions, while there are not yet many examples of other fields where it could be used, land administration is surely one of those.

In this sense the cases where has been put in place are limited, those regards relatively little countries like Georgia and Sweden (*pp. 17-18 chapter 1*), or single cities such Amaravati in Andhra Pradesh (IN), the technology is at its first stage and there are areas which are not well defined, there is still space for experimentation and innovations, which means different views should be taken into consideration and there is not a single idea that should be taken has the only single truth. In this research, information has been an asset and have been validated through literature reviews and experts’ interviews, regarding this the literature available is scarce and still incomplete which means that has to be carefully considered and compared with other studies, the best way to confirm those resources is to contact people directly involved in the development of blockchain projects, this is made possible thanks to a wide spectrum of interviews. This strategy is specifically needed if the study, such as this, wants to investigate how the technology is being implemented in a developing country like India. People working on projects under development are the most reliable source of correct information, they are continuously informed and always updated. On the other hand, one of the main problems with the interviews is that they request a high amount of time, a strict

organization, and some luck to get a positive answer to the interview's requests. Time was a big limitation for this research and even if well managed was a little portion of that needed for a full collection of information and data. The topic, even if very specific, was highly complicated, the first part of the document, which explains how the blockchain works, requested a high amount of time to be understood and synthesized, sometimes information suffered discrepancy dictated by the political orientations of those who have been interviewed, this can result in bias in the qualitative research. In fact, there are substantial differences between people who work or have worked for the government and those who value work done from outside, such as NGOs and other non-governmental experts.

2.8.2 Implications

Even with some problems still to be solved, Blockchain remains a technology of great interest for the development of new systems that can benefit from greater transparency and immutability, those characteristics may be very interesting for both public (governments, NGOs, international institutions) and private institutions (banks, businesses, multinational corporations), blockchain in land-records could be an innovative process to fight and resolve some of the biggest problems at the national and international level, as we could see during the first two chapters, many developing nations have weak cadastral systems, this lowers economic growth, creating insecurity and difficulties as regards the ability to attract investments. Moreover, adequate control of the territory could benefit the maintenance of natural environments, protect biodiversity and food productions, greater reliability on land properties would give more security to farmers, who could thus concentrate their efforts on increasing productivity also through technological investments. Blockchain could be an important ally to achieve the goals set by the SDGs, mainly for those regarding the United Nations Convention to Combat Desertification (UNCCD). In today's world, only 30% of the world's population has legally registered rights to their land and house, with the impoverished and politically marginalized being particularly vulnerable to land tenure insecurity (*World Bank, 2017*). The 2015 United Nations Sustainable Development

Goals (and in particular the number 15¹⁶) will be impossible to accomplish unless these changes will take off. There has been international agreement on the necessity of secure land tenure for development outcomes. The Voluntary Guidelines on the Responsible Governance of Tenure (*FAO, 2012*), which are based at the Food and Agriculture Organization of the United Nations, were accepted as the worldwide norm on this front by the Committee on World Food Security in 2012.

One of these guidelines is particularly important for the topic discussed until now, in this document, it is reported clearly that States should take all appropriate measures to limit the informal tenure that results from overly complex legal and administrative requirements for land use, transactions of properties and development on the land. Development requirements and processes should be clear, simple, and affordable to reduce the burden of compliance and increase property rights (*FAO, 2012, p.17 – Point 10.4*). In this framework the use of Blockchain to improve the transparency, and the efficiency of cadastral systems in developing countries could make the difference in the process to achieve this particular SDG. Although blockchain could serve for other scopes also in developed countries, as we have seen before with the project implemented by Sweden, this project had the aim of fastening transactions between the different stakeholders involved in the sales of properties, in this case, reliable cadastre systems are already present but this does not mean there is no a possibility for improvements, transactions validated and stored on the blockchain are cheaper than traditional ones, and documents benefit from the advantage of blockchain in terms of immutability, verifiability and to be a safe store always updated and with high resilience to disruptive events (natural catastrophes, fires, and wars). Blockchain doesn't benefit only States, it has great possibilities also for businesses, indeed a study made in 2017 by Accenture underlined how investments banks could save up to 12\$ billion by deploying underlying blockchain to secure properties and land transactions in developing countries, the eight banks studied in the research may save an average of

¹⁶ The SDG number 15 is focused on the protection, restoration, and promotion of sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

30% on expenditures because to improved data quality and openness. (*Accenture, 2017*). Systems based on blockchain could improve the general reliability of documents, only this feature could save billions of dollars that are now spent on legal fees by companies and individuals in legal disputes over irregular transactions (*CIARB - Costs of International Arbitrations, Survey 2011*).

3. Work methodology and Interview analysis

3.1 Introduction

This chapter will analyze the methodology that has been followed during the duration of the research, in particular, it will analyze the procedure on how the interviews have been conducted, which were the main groups analyzed, which were the possible bias that should be considered to understand deeper the overall research and its results and innovations, in the analysis of the interviews, to individuate possible bias, a wide range of descriptor have been used, mainly to understand what could be the origin of an idea or vision different from that identified in previous interviews, secondly the descriptor processed by Dedoose® (<https://www.dedoose.com/>) give a clear lecture of what was the category of experts that have been interviewed.

3.2 Research Design and Literature Review

This work has been conducted using an exploratory approach with the collection of data based on a qualitative method, this method was chosen for the relative novelty of the analyzed topic. Exploratory research was able to fill the gap in terms of knowledge on blockchain-related to the field of land administration, and by investigating different perspectives it generated new and emerging insights. Indeed, this methodology has been of great help in filling some gaps that emerged from the literature review, the gaps found were addressed through a process that considered semi-structured experts interviews and extensive desk research, the desk research considered documents gathered thanks to official documents from international institutions such as the World Bank, the United

Nations, and its agencies (FAO, UNCCD, UN-Habitat, UNCTAD, IMF), international and national (Indians) NGOs, as well as YouTube videos (TED Talks) and scientific periodic and newspapers. Both primary and secondary qualitative data were collected as part of the research procedure. Information from the literature and interviews were integrated to answer the study questions. The literature was also reviewed to locate appropriate expert profiles that might provide their perspectives on the research issues. A total of seven interviews were conducted. The interview participants were chosen from a variety of backgrounds, ranging from academia to the corporate sector, in order to establish a broad enough knowledge base.

3.3 Interview Methodology

The interviews were conducted, as mentioned above, using a semi-constructed method, which used predeterminate topics and key questions. This procedure was chosen to best fit the qualitative method used during the research. The interviews were conducted via Zoom call between March 2021 and June 2021. The interviews were recorded, and the transcript was processed thanks to <https://otter.ai/> which made all the processes quicker and more precise than manually. The seven interviews lasted between 30 and 60 minutes, they started with a short introduction to the research goals and a short presentation of the expert interviewed (main field of work, past projects, and studies), then general blockchain-related questions were being conducted, 2) technical implementation, 3) introduction and usage of (blockchain) technology, 4) legislation and then the 5) future possibilities. The first interviews were done with general experts in the field of digitalization, blockchain, and cryptocurrencies so to have a wide report on what was the general thoughts regarding Blockchain in the Scientific Community, the questions were more general and usually, regarding the major aspects of the technology related to society, the political systems and the governance, this was particularly important to cover the first part of the research which is focused mainly on the features of blockchain, its possibility to be a disruptive technology and its relevance in the field of public policies. Then, in the second chapter a deeper analysis was needed, there the questions become more structured, but even then, the questions have often changed depending on the direction of the interviews, the questions have often covered other themes than those foreseen at the beginning, but no less central to the research. In

most of the interviews, this method was very helpful to let the respondents a certain degree of freedom so that they went deeper into the topics considered.

Their sectorial knowledge must be carefully considered, in fact, their speech tended to immediately tune in to the most salient aspects that make up their professional field. In the last three interviews, the semi-structured method proved to be strategic in order to cover various aspects that had not been considered by the literature which, especially as regards the project being implemented in Andhra Pradesh, provides little or nothing. There were several cases in which the interviewees expressed themselves questions asking whether or not some concepts had already been taken into consideration in the research, in a nutshell, it can be said that in some parts, especially regarding the second chapter, they were themselves, proponents of some arguments, this allowed the researchers to broaden its perspectives, analyzing equally important aspects that had not been previously considered.

3.4 Interview Analysis

Thanks to the qualitative analysis software made available by Dedoose®, it was possible to analyze the macro-sectors that were dealt with the most in the various interviews carried out, in particular, to better analyze which were the various topics analyzed, specifically the consideration the experts have about the technology overall and which were their thoughts for future implementation of blockchain in the land-administration field. Moreover, Dedoose® made it possible to create patterns, collect data about descriptors of the single interviews and take into consideration possible bias related to different patterns such gender, studies, work position, relation or not with the government, and capacity or not to use certain tools to program blockchain. This was particularly important to take into consideration what was affirmed during the interviews, for example on a general question when an expert does not have programming experience and he/she say that blockchain is still difficult to program (or use), that information should be evaluated deeper, probably another expert with skills in programming blockchain architecture should be interviewed. This does not mean that

what he/she affirmed must be discarded, but that the analysis must go deeper, considering the information that comes from people more grasped in that field.

3.4.1 Gender Gap in the interviews

Another point that should be taken into consideration is the gender gap still present in this field, indeed there are more men than women working on blockchain and the majority of blockchain experts are male, on seven interviews conducted only two experts were women, and none of them had capacity in programming, while on five men four were able to program blockchain architectures. This fact takes into consideration different variables, indeed, most of the experts interviewed were from India where there is still a problem of the gender gap, the principal matter concerns the fact that there is still a discrepancy between men and women enrolled in scientific subjects in the universities. However, the problem is being to be resolved, according to the study conducted by the Society for Socio-Economic Studies and Services (SSESS), data during the past decade demonstrate that the number of women in most areas of science and engineering has continued to grow over the time. Quantitative surveys however indicate the persistence of gender gaps, both in terms of opportunities, salaries, and career advancements (*MHRD reports, 2011-2016*). One of the main issues is to find women to interview in leading places, such as technological institutions, universities, and other governmental institutions.

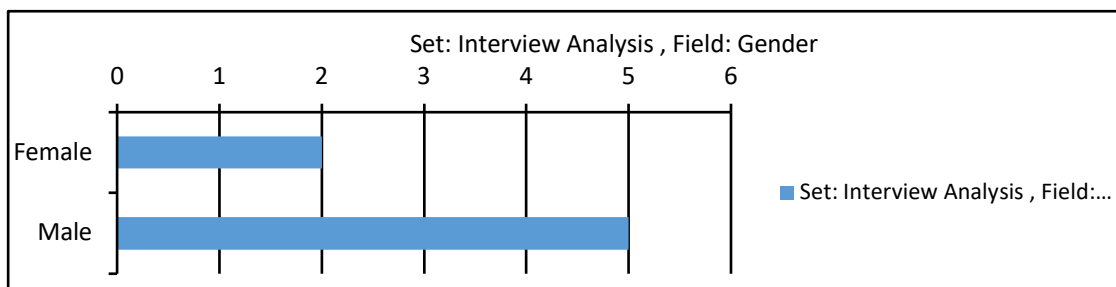


Figure 8 – (Interview analysis – Gender Describer) – Dedoose®

3.4.2 Nationality

Most of the experts interviewed, four out of seven were from India, this is due to the principal aim of the study, which was to study how the blockchain could improve land records in India, and in particular to study the experiment that is taking place in Andhra Pradesh. The other three interviews were conducted by taking into consideration the general thoughts on blockchain from an Italian expert in cryptocurrencies and blockchain architecture (GZ_1) and two researchers from the Institute for future studies and technologies assessments (IZT) in Berlin (CF_2) and the German Development Institute (DEI) with (WR_3). When the discourse from a general perspective on the distributed ledgers passed through a more specific field, the interviews started to focus on specific institutions, mainly in those involved in the development of a blockchain cadastre, in particular the Government of Andhra Pradesh, the National E-Governance Division (part of the Ministry of Electronics and IT), and the Land Records Computerization Division, in the public sphere, and companies such *Zebi* (Blockchain Big Data) and *Bitfury* (Blockchain Technology) in the business sphere, this two, in particular, are having a big role in the implementation of the Blockchain's based land-record system in Amaravati's Smart-City complex (AP).

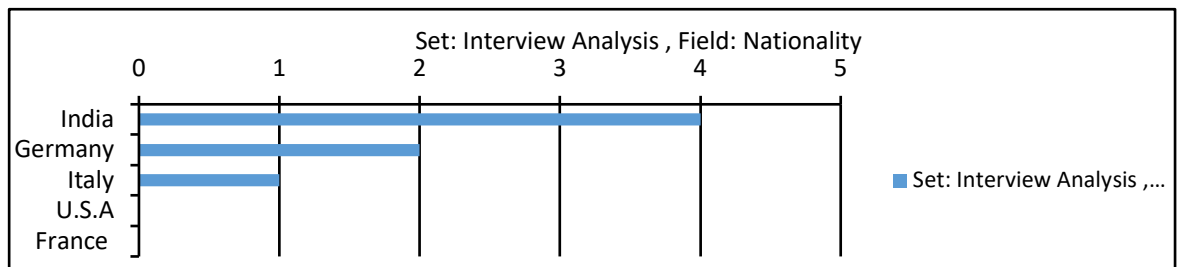


Figure 9 – (Interview analysis – Nationality Describer) – Dedoose®

3.4.3 Limitations of Non-Disclosure of Sensitive Information

For what concern the experts that come from governmental and private companies, limitations on the disclosure of sensitive information related to the systems that are being implemented should be considered, indeed, some information related to sensible data and process was not shared because non-disclosure documents have been signed, this pone a limit to the overall assessment of the research, which, by the way, thanks to

public data and international studies, some of these data, albeit with a lower degree of certainty, have in any case been received and indicated to allow complete use and reliability of the information expressed. These concerns, in particular, the steps concerning the certification of properties between the various institutions, what are the levels of corruption among public administrators, and as regards private companies, the functioning of the CORST technology for geo-localization surveys, which could be used even for non-civil purposes. The analysis in these terms is based above all on the role played by the interviewees, if their position concerns governance roles or relating to positions that are not completely independent, such as those of government or political order, usually the degree of secrecy regarding some information is vastly greater. However, we should not forget that this can also happen in private companies, which indeed for fear of industrial espionage, choose not to disclose some sensible information.

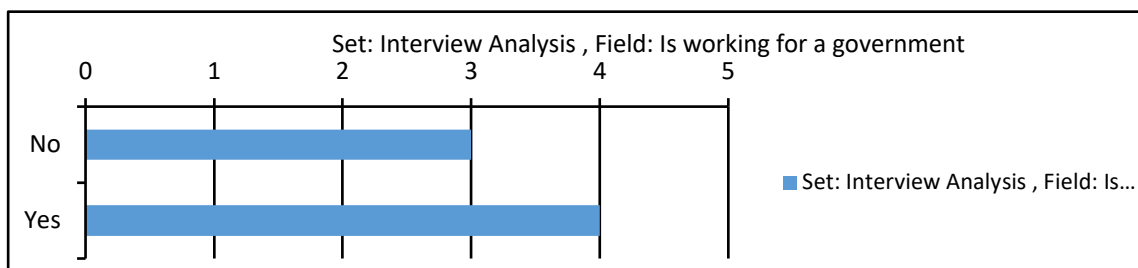


Figure 10 – (Interview analysis –Government Responsibility Describer) – Dedoose®

3.4.5 Work Sector

This pattern should be considered as well in the overall assessment regarding the interviews and their output, a simple example that should clarify the importance of this describer is the difference between an interview done to a researcher or a professor, and another done to an expert that is working on an ongoing development project, the focus of the two interviews will probably be different in some of the most salient parts, indeed the expert that is working on a project at this moment will consider more the present aspect of the technology, which are the failure point, which is the overall function of the system and if the technology is truly making the procedure easier or cheaper, while for what concern a professor and even more a researcher, he/she can have a more

futuristic vision on that technology, perhaps even more utopian as regards future developments, (which then may or may not become reality). This is not always verifiable during the interviews, but it may be a hidden trend that must be considered, the interviews conducted with professors and researchers are usually more positive about the future developments of blockchain in land administration, while the people who work directly in the projects have a more realistic vision and consider more the limits present today, giving them a certain importance. To conclude, both parties consider the limits, but they overall evaluate them in a different way.

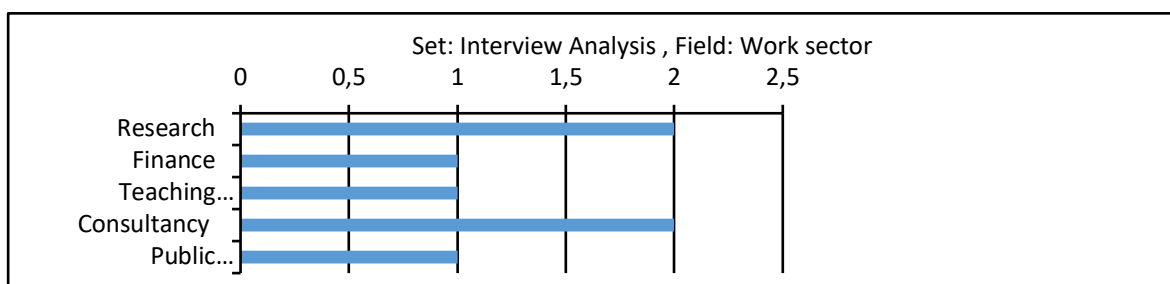


Figure 11 – (Interview analysis – Work Sector Describer) – Dedoose®

3.4.6 Time limitation

One factor that should be deeply considered in the overall assessment of the paper should be time limitation, the possibility to cover a wide range of experts was difficult to achieve both for the issue already reported, both for the fact that unfortunately, some of the experts who received an invitation to answer some questions never answered or they did not have time because involved in their own research and projects. With a larger sample of interviewees, the information would probably have been more varied and would have covered more aspects, time is certainly part of the limitations, but it should not be forgotten that many times it is more appreciable a summary work that gives the possibility to enjoy a clear document, with specific objectives and which goes into an in-depth analysis of a specific sector.

4. Discussion and Conclusion

Different countries have begun efforts to modernize their cadastral systems in order to better fulfill society's current and future demands, property rights, and foster economic growth by fighting corruption and documents' tempering. In recent years, land administration has been particularly interested in blockchain technology. Unlike today's centralized cadastral methods, blockchain allows for the creation of a decentralized and transparent database. However, there has yet to be a detailed examination of the benefits and cons of using blockchain technology to record cadastral information, examples are still limited and those are restricted to small realities (Sweden, Georgia, UAE) or experimental projects. According to the general perspective of the scientific community, a cadastral system is needed to ensure efficient exchange and appropriate use of real property units (*Enemark et al, 2005*). The cadastral systems have to serve as the “*where*” component of the property rights system by providing precise information about land and property units, their location, and related interests. This can be accomplished using a range of different techniques. In most the countries, the land cadastre is based on a centralized database maintained by a public institution. However, new solutions are gaining popularity, blockchain technology and its application are catching most of the attention for future development projects.

4.1 Blockchain in Land Records

During the course of the research, we have seen how Blockchain technology related to land administration is still a technology that needs several innovations and that it requests great reliability in terms of data, only recently some barriers for the adoption of the technology have been resolved (*e.g., CORST, p.35*) but large-scale adoption will largely depend on the successes this technology may have in developing countries.

There are many reasons why the land administration field should not overlook blockchain technology. First of all, similarly to the banking sector, the main role of the land administration authority is to act as a "trusted third party" - exactly the role that blockchains promise to replace. Second, the possibilities (as well as the drawbacks) of a distributed ledger deserve more attention.

Greater transparency and control over one's personal data, central characteristics of a decentralized system, could also be the future for public data. This characteristic shows to be interesting to fight and tackle problems of corruption in such institutions, this may be central for those countries which suffer chronic problems related to land records institutions' transparency and property rights issues.

Indeed, the purpose of using blockchain for land registration is rather easy to justify in a country where the land administration system is not trusted, either due to corruption, bad governance, or just for a lack of quality in terms of land records registries (*Vos, n.d.*), in those cases, there are almost no doubts that blockchain could be the answer to organize the systems more efficiently than how it works today. A question that comes along with the new paradigm is if the technology should be implemented also in those countries where the land records systems are working properly. The answer could be expressed by analyzing the experiment conducted in Sweden with the new cadastre based on blockchain, the results here were pretty positive, transactions between the various institutions involved have become much faster, halving the time required to certify the transfer of a property from one person to another and guaranteeing an adequate level of security and immutability of the documentation (*Paragraph 1.2.5, p.18*).

4.2 Is Blockchain disruptive in Land Administration?

The general consensus among the first interviews (general experts) was that the technology does not give much uniqueness from a technical standpoint; rather, it is more about merging current technologies into one solution. Peer-to-peer networks and decentralized systems, for example, are used in a variety of other approaches, which means that some of the benefits given by blockchain technology might also be implemented using standard database solutions. Combining multiple methodologies, on the other hand, opens up new possibilities that cannot be reached any other way. Indeed, the promise of a decentralized and trustworthy database is likely the most compelling reason for interest in blockchain technology, particularly in governance. Other solutions may be used to create decentralized structures, but blockchain technology and the mathematical procedures it employs allow for the preservation of confidence among all

participants. Because the data stored in a block is incredibly difficult to counterfeit, trust is maintained. Furthermore, blockchain technology can give confidence and transparency in a context where other parties' reliability and the permanence of recorded data are unknown. The potential to maintain data integrity, reliability, and originality in instances when trust between parties is lacking was cited by some interviewees as the most essential aspect of blockchain technology. However, a few experts wished to emphasize that the new characteristics supplied by blockchain technology are very dependent on the application industry. Aside from the simple facts of how and where the technology is used, prior solutions have also established many boundaries: for example, the type of blockchain (as described in the previous section) should be chosen in light of the application sector and existing technical solutions.

Another potential benefit arises from blockchain's 'tracking feature.' As previously said, falsifying or erasing information is more difficult with blockchain, or at the very least, it is possible to track exactly where information has been fudged. A blockchain-based system also has a high tolerance for mistakes due to its decentralized nature, as the maintained database is spread among multiple computers at the same time. This means that in the event of an attack or other malfunction, a single server is not alone in a vital position. Furthermore, some interviewees (*VT_4, GK_5, SM_7*) mentioned the added utility of smart contracts. Smart contracts allow to program and automate specific procedures, allowing to establish extended transaction chains.

4.3 Data protection and Privacy

The openness of data in blockchain opens up many possibilities, but it also raises concerns about data security and privacy, particularly in permissionless and public blockchains. This type of network typically has access to the entire transaction history as well as transaction pathways. Alternative solutions, in which open data is partially buried, are now being developed (*Private and Semi-Private blockchains, p.9, paragraph 1.1.4*). Different encryption methods also try to prevent transactions from being linked to a specific person. Nonetheless, there is evidence that it is not difficult to link transactions to specific accounts on the Bitcoin network (*Public blockchain*) under the existing rules. This issue has previously been addressed, and a stronger encryption

solution has been offered to increase data security and privacy. There is a disadvantage to these kinds of add-ons as well: the feature can be abused and may attract criminal actors.

During the interview's questions were raised as to whether it is possible to construct a blockchain in which some data is open to the general public and others are exclusively accessible to a select group of participants. The experts determined that using encryption technologies, it is technically possible to partially hide information and then designate who has access to what information. This type of feature is particularly important in the case of cadastral registries. Personal information and other partially disguised data might be placed in a blockchain as an identifier, these IDs would then be used to track down the original personal information from external databases.

4.4 Social Matters

The specialists interviewed believe that societal barriers are mostly caused by a lack of understanding and the inability to use blockchain-based technologies. Furthermore, the overall comprehension and adoption of new technologies, such as blockchain technology, has been raised as a social obstacle. A few interviewees also wished to stress that blockchain technology will not instantly solve "deeply ingrained" register-keeping issues. Even if blockchain technology provides a reliable and functional technology system, those in charge of maintaining the information can be paid or blackmailed into making fraudulent entries, of course, the possibilities to be discovered from further controls increase. In addition to the social issues raised in the interviews, it should be emphasizing the need of considering the surrounding society's beliefs and attitudes. While blockchains can assist to increase trust and transparency in some circumstances, the importance of social barriers should not be overlooked. The differences in the cultural and social background should be considered as well as the system in use in the particular state or country, weighted assessments should be done before developing a blockchain's based cadastre. We have seen the example of India where, in some states, improvements in the land-records databases were possible thanks to the DILRMP and now people do not want to adopt other systems, because they are satisfied with the system already in use.

4.5 Conclusion

Blockchain technology allows for the creation of a decentralized, transparent, and trustworthy database. However, how disruptive the technology will be to the land administration's institutions is still unknown. More research on prospective uses and ramifications, as well as problems associated with the implementation of blockchain technology, is required to move forward with this subject. The study had the aim to fill the gap by looking at the new opportunities that blockchain technology offers for land management especially regarding the possibilities it gives in fighting corruption and tampering, as well as improve property rights in developing countries. The strategy of the study was to interview blockchain's specialists with a track record of success, and integrate the latest findings with the existing literature, by doing so it was possible to consider deeply the advantages and disadvantages of the technology regarding the land administration and what could be the future of this technology. The study's main contribution is that it can be used to guide future endeavors. The study has both a practical and a theoretical perspective that integrates basic knowledge of blockchains with professional views on present and future blockchain implementation.

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Figures:

Figure 4: (“Map of Countries by International Property Rights Index, 2020 - Knoema.Com” n.d.) Knoema Data Provider, 2020.

Figure 5: (Percentage of computerization of land records in India) – Mishra and Suhag 2017, p. 47.

Figure 6: (Process of Transaction through Blockchain). – Thakur et al. 2020, p.4.

Figure 7: (The passages needed to update land records through Blockchain), Thakur et al. 2020, p.5.

Figure 8: (Interview analysis – Gender Descriptor) – Dedoose®

Figure 9: (Interview analysis – Nationality Descriptor) – Dedoose®

Figure 10: (Interview analysis –Government Responsibility Descriptor) – Dedoose®

Figure 11: (Interview analysis – Work Sector Descriptor) – Dedoose®

Annex:

In the following pages are reported the transcripts of the whole interviews conducted during the research, those were seven interviews in total, they were collected from different experts in different countries and with different backgrounds, both in terms of studies and professional experiences.

List of Interviewees:

- a. (GZ_1) Bitcoin Entrepreneur**
- b. (KF_2) Institute for future studies and technologies assessments**
- c. (WR_3) German Development Institute**
- d. (VT_4) Indian Ministry of Innovation**
- e. (GK_5) Indian National Informatic Centre**
- f. (MB_6) ORF - Observer Research Foundation (Think Thanks)**
- g. (SM_7) KPMG, and Centre for Innovations in Public Systems (CIPS)**

A table with more details on the experts interviewed can be viewed at this Google Drive address: (<https://drive.google.com/file/d/1LOwG9A8n8zi573Yh4ESu08xzbB-hennf/view?usp=sharing>)

a. (GZ_1) – Entrepreneur based in Milan (Italy), creators of various startups working on Blockchain architecture, mainly in the cryptocurrencies and mining field. Interview conducted on the 03/24/2021.

1. What are the goals you intend to achieve in your career and which ones do you feel you have already achieved, how much has the Blockchain contributed to the results you have achieved and how much will it contribute to determining future ones?

Contribute more actively to the coding of the blockchain concerning the tools available on Bitcoin, code development to develop the business of start-ups already operational and created by me aimed at this sector. The results achieved are an important network concerning innovation in the field of cryptocurrencies and in particular with regard to Bitcoin, in-depth knowledge of the subject both in the technological and in the political and socio-economic fields.

2. What comes to your mind when thinking about the Blockchain?

Initially, the term Blockchain was never mentioned by Satoshi Nakamoto, who called the technology used as the basis for bitcoin transactions as a time-chain and not as a chain of blocks, the word was born and developed after the birth of Bitcoin, it was adopted to define a technology that then generated doubts and perplexities to explain a new and innovative phenomenon such as that of crypto-currencies, in short, the blockchain as a speaker is used today to clarify some aspects of the technology and make it "usable" even to newbies who require simple and easy to interpret concepts to understand and interpret the system that allows crypto-currency transactions, it could be said that this word is used to "tame" the technology.

3. Do you think this open-source and distributed ledger technology could be a tool for social change?

Yes, the blockchain could become a tool for social change, support for a decentralized and digital version capable of creating a new system where the decentralized nature of public blockchains permit peer-validation to replace third-party middlemen could reduce transaction costs and perhaps transaction time. Another important tool given by blockchain is the possibility to create a new financial system based on “hard money” (this is how a currency with a value based on physical resources is defined, e.g. Gold and Silver), a system abandoned in the 70s with the birth of a new experiment, the FIAT coins, this has determined during the last decades’ several hyperinflationary crises, including the latest in Venezuela, Ukraine and Turkey and no one excludes that this may also happen in the most advanced countries and manipulation of interest rates by central banks. Bitcoin is an experiment to try to recover an economic system set on a Sound Money, innovating it and making it compatible with today's digital society, something that physical gold is no longer able to do.

4. How do you evaluate disintermediation, do you think that this can lead to greater responsibility and willingness of citizens to participate in public decisions, ensuring that democracy itself benefits?

Different types of components make the blockchain an innovative technology, including financial inclusion (everyone can use cryptocurrencies, it is not the same with banks) and privacy (which blockchain allows obtaining through its own distributed ledgers and encrypted transactions), the social impact of this technology could be even greater than what the internet has had up to now. The Blockchain could lead to disintermediation in a positive sense, it could benefit from it in a broad sense an enlarged concept of democracy, not so much as a collective majority decision on some issues, but in the sense of decentralization of the decision-making process, in practice an idea of direct democracy taken to the extreme, in the sense that with disintermediation and decentralization it is more difficult for central entities (governments, institutions, companies) to control decisions and include the choices of a large number of people in

the same type of constrained process. For this reason, through disintermediation, it is possible to return to a situation in which decisions are made locally, therefore more responsible, followed by actors (citizens or communities) who are truly involved in local life and therefore in the decisions themselves. They are therefore more responsible and more incentivized to make decisions for the common good, they are more aware of the information and process it in a more analytical way (because they are close to the problems, they perceive the causes and also the possible solutions), on the other hand, the information itself they are never global but always local. Therefore, not democracy as a process of control by the majority but democracy understood as a strong decentralization of the decision-making process, capillary in reaching the needs of minorities and less influential groups in the normal centralized decision-making process. Another aspect to consider is financial disintermediation, which could itself contribute to greater economic freedom, greater awareness, and decision-making capacity. Bitcoin is crucial as an example of financial decentralization in this sense.

5. Do you think that the role that governments have is important in determining the correct use and implementation of this technology or do you see the various governments as increasingly distant and less important entities to play a central role in technological progress?

Governments seen as increasingly less important and distant entities in carrying out the fundamental tasks for society, have an increasingly marginal role in technological progress and institutions, rather than exploiting digitization to get closer to the citizen, seem increasingly distant from the life of society, the role that governments have for now is negative and does not foresee a real organization regarding the development of technologies, but this is not immutable and could change in the future. Governments nowadays create various problems regarding the social and economic freedom of citizens by imposing rules that limit the possibilities of people, many times the blocks imposed at the base exclude people from the economic-financial sphere, moreover, the weaknesses of the economic system and the cyclical crises like that of the Subprime in 2008/9, and the recent sovereign debt crises are all generated by control and manipulation of the monetary base that governments have through central banks (even

if independent institutions are influenced by policymakers), not to mention, this time in a negative sense, the possibility that new technologies (if used incorrectly) have in creating despotic systems (China, Russia, etc.) in which people are controlled in all areas of their existence. As for economic control, people try to escape the destruction of savings that cyclically, in the form of financial crises, hit the globalized economy. Precisely for this reason, governments, in the opposite sense, encourage the development of tools and technologies that make it possible for citizens to defend their savings (investment funds, bonds, shares, etc.) but are always subject to heavy taxation. Therefore, although unable to manage economic-social and technological phenomena, governments are an attacker that generates defense mechanisms. This mechanism, albeit limited, itself involves an innovation process.

6. Do you think that the Blockchain could be a fundamental element for the fight against corruption and the control of expenses in the business environment?

I do not think that the Blockchain can be a fundamental element for the fight against Corruption and the control of expenses both in the private sphere and in the public administration, it is possible to use public key cryptography or use time for some transparency and notarization activities but nothing fundamental that is not already possible to do with centralized digital tools, the Blockchain allows time-stamping but this is already possible to do with a digital notary, there is nothing really innovative in decentralization, in this sense there is nothing really distributive, on the other hand the type of financial privacy that the technologies deriving from bitcoin allow and of decentralized cryptography in general, can also lead to a reduction of tracks in the opposite direction reliability of corruption phenomena, a reduction of control with positive sides in terms of personal freedom and security by possible attackers (despotic governments - Hackers) and with its negative sides in terms of loss of verifiability or datability in a global sense. There will be both phenomena both that of traceability and that of privacy but that the second will be much more important/relevant than the first as effects.

7. Do you have a more positive or negative view of the world 50 years from now? - Do you think we will be able to control this technological revolution and guarantee its benefits to the largest possible number of individuals?

The vision regarding the future is more positive than negative at least for the long term, but in the medium term things change and the perspective becomes more dangerous, the feeling is that the technological process will have to go through a period where technology will see a use wrong, devoted to a massive control of the activities of the population, proliferation of cyber-attacks and a pessimistic vision in terms of despotic control of identities, information and data by governments, this step is a precursor of a conscious and free use that will take place after passing the intermediate step. On the other hand, already today a part of the world is moving towards a despotic direction, democracies are in a difficult period (retreat), and where authoritarian regimes acquire a renewed economic, social and technological power, most of the world population lives in countries where democratic regimes have little or nothing, only 6% of the population lives in complete democracies, these regimes are increasingly using the technologies at their disposal to maintain the Status Quo by legitimizing their power.

b. (KF_2), Institute for future studies and technologies assessments in Berlin. (<https://www.izt.de/en/>) Interview conducted on the 04/06/2021

1. Can you briefly describe your field and career path until now?

I'm a political scientist with studies and background in media analysis, I started working on sustainability as a junior researcher in a think-tank focused on this topic and then I become Junior project manager and after six years working there, I moved to the German Research Institute in Poznan working on Sustainability Studies and Science management, than last year I accepted to work as head of the research department on digitalization at the Institute for future studies and technologies assessments in Berlin.

2. What goals do you wish to achieve in your career, which one do you already achieved? Hereby, how much has the Blockchain contributed to these achievements and how much will it contribute to future ones?

I never thought of specific goals, I was really interested in this field, and I went through it by continuing to work on the sustainability topic and I achieved different goals. I was lucky enough to work in areas that were of my interest. My aim is to work in an area where I can really have an impact and have visibility in the research field and throughout the community itself. I can say that our work was pretty successful since the social interest in this topic is growing in Germany.

3. How do you think the future will be influenced by technological development and digitalization?

I have a generally positive vision regarding the future, I think that in the coming years we will see several technological revolutions and we are already experiencing some of them. Some technologies that are now still in a state of experimentation such as AI, blockchain, and the internet of things will see enormous development in various sectors, this may in some cases lead to critical issues and problems that it is up to us and governments to solve and address to create the best conditions, in which human rights, environmental sustainability, and technology can have a holistic relationship and thus create a cluster, more equal and sustainable society. This will involve revolutionary decisions, which will redefine our ideals, our choices, and our lives.

4. What comes to your mind when you think about the Blockchain?

Blockchain hasn't played such a big role in my field. I know it can be used by financial firms to improve their ledgers, store data, and improve trust and security in economic processes, but I never felt that Blockchain will be a disruptive technology, I think AI right now is one of the most important which will change our society. Blockchain doesn't play a big role in my field and a debate is still open in the UN and other

institutions on how the blockchain processes, if used, are processed. The crypto community is an interesting movement, but many problems still remain unresolved.

5. Do you think this open-source and distributed ledger technology could be a tool for social change? (If so, then how?)

I think that if all the problems regarding the blockchain and its usability will be resolved then it could certainly play an important role in what concern the disintermediation and decentralization of the institutions, here as well the point it's always the same, how humans will improve and develop this technology, will we be able to improve the tools and in which fields we will use it or not, many problems regarding this question remain resolute and new rules and legislation is needed internationally. Still, it could be an interesting technology to create mutual trust and permit secure online platforms which will be able to make the vote easier and more trustworthy.

6. How do you assess disintermediation? Do you think that this can lead to greater responsibility and willingness of citizens to participate in public decisions, making democracy itself benefit from it?

Disintermediation as said before can be a great improvement for many businesses, for financial institutions and for other firms, it could create new kind of businesses as well and improve the public decision, but the development of the technology itself isn't already achieved on all its shapes, we should continue to invest resources and force to analyze all the aspect involved, the subjects and how this impact on our society. - For what concerns the responsibility, I think disintermediation it's a great tool and it will improve the participation of the citizens, in this are it may be problematic the participation of elder and not digitize people who may not understand the new benefits coming from the technology, and here again, we see how important is the role of governments and politics, the school programs should give the best preparation to the young generations but also to the old ones, it will be increasingly important to permit the people to study and inform themselves, even when the school time is finished.

7. Do you think that the role that governments have is important in determining the correct use and implementation of this technology or do you see the various governments as increasingly distant and less important entities to play a central role in technological progress? (What role do you think that non-governmental institutions and non-profit foundations play in this technology?)

Technology itself it's disruptive and it can create disparities and problems in society. I think the governments are important institutions and powerful enough to organize technological development and give rules, standards and legislations to be respected. In today's world where technologies move quickly and in almost any sector, we need someone that controls human rights, the environment, and sustainability is respected, sometimes we may consider governments and politicians in a negative way or at least as someone not able to decide and to modify the current trends. But the democratic institutions are the most important things to evaluate which direction we should take.

8. Do you think that the Blockchain could be a fundamental element for the fight against corruption (e.g., the Colombian experiment on the public food supply) and the control of expenses in the business environment? (If so, which elements or features of blockchain technology (e.g., such as immutability of certificates and global accessibility) could enable the fight of corruption?)

I think that blockchain as it stands now it's not the best technology to fight corruption problems, the privacy of the transactions and the fact that those are encrypted doesn't permit to evaluate where the resources coming from, how money is spent, and who made the transactions, maybe another kind of blockchain can be developed but if we change the paradigm we may lose some of the improvements part of the blockchain itself, example: if we want to make a private blockchain we may lose the possibility to operate in an open-source environment. But this is only one of the possible problems we can encounter. In the future, we may see improvements in this area, but this is not clear yet.

9. Do you have a more positive or negative view of the world 50 years from now? - Do you think we will be able to control this technological revolution and guarantee its benefits to the largest possible number of individuals?

I have a positive vision of the future, I recognize the problems we may have to face but not for this I will lose my positive expectation for a more sustainable and fair society, technology if well used and administrate could become an important resource for all the human-kind and help us overcome many of our problems, the important thing is not to see it as a mere simplification of our life but to go deep and think more widely on the effect it can have on our society, on the planet on how we do a certain activity and ultimately on how we behave. - Humanity has a great possibility, we never been in this position in all human history, our impact on the environment could be highly disruptive but we have also the possibility to change completely our perceptions on how things should be done, we are able to collect much more data and analyze it with the help of supercomputers, we can decide which energy we prefer and how to make our economy working better and more efficiently, and all depends from us and our aim to change the world.

c. (WF_3) German Development Institute (<https://www.die-gdi.de/en/about-us/mission-statement/>). Interview conducted on the 12/04/2021

1. Can you briefly describe your field and career path until now?

I work as the head of the Managing Global Governance program at the German Development Institute, which is a network of over 100 institutions including governments of emerging economies, academies, public administrations, business circles and civil societies. The leading research institute was founded in 2007 and is still in development, while I joined the network and accepted my current job position in 2018. Before that I did my PhD in political science and I was assistant professor at the Turkish-German University, here I studied global governance, analyzing issues related to international relations. Today I am working and analyzing various issues within the Managing Global Governance (MGG) program network a large part of my work focuses

on analyzing the 2030 sustainability agenda, digitization and the ability to develop training programs as one. of my main activities.

2. What goals do you wish to achieve in your career, which one do you already achieved? Hereby, how much has the Blockchain contributed to these achievements and how much will it contribute to future ones?

As for the objectives of the institute it is quite easy to answer because we have goals and objectives indicated in our mandate, in fact the entire program is funded by the Federal Ministry for Economic Cooperation and Development, and we have agreed under specific terms what the project is about. trying to do, we work with a system of impact and evaluation never seen up to this point and the activities translate into desirable results from a political point of view (information that allows the implementation of policies concerning digital innovation), in particular for what concerns sustainability and digital transformation in the most important countries (USA, Europe and China). From my point of view, I think I have found a job that I am passionate about and generates a lot of interest and curiosity, relations with politics give us the opportunity to be in a position to engage in high-level policy consultancy and political dialogue. They are very interested in the processes of transformation towards the common good and this position seems to me the best for positively influencing society and people with real, tangible results.

3. How do you think the future will be influenced by technological development and digitalization?

As for the future, I think it will inevitably be shaped by technological advances, technology is already affecting all areas of our life and I think this is something that everyone should accept and embrace. Although some aspects of the future are still difficult to imagine, we are already facing many changes in our lives and in the technology itself, the model or models we want to pursue are in our hands (still), but the next technological advancements could bring about a change in this appearance too. Surely one thing is clear, we can no longer do without technology, now the main

problem is how to direct its development, because the risk in 20 or 30 years is that AI can take over and no longer need the knowledge and capacities of man to progress. To answer more precisely, I can say that the technological process still depends on us and on our choices, but that attention must always be higher, and knowledge must go hand in hand, thus giving us the opportunity to adopt concrete and positive solutions.

4. What comes to your mind when you think about the Blockchain?

A great potential for change in the economic, social and financial world, and in many other technological fields. Starting from what concerns the risks, they are quite similar to all the other technological processes already seen previously, from energy consumption, to control and therefore governance and results for humanity and society. No doubt this "new" technology has the potential to generate many positive results that could shape our world in the future and rethink the way we do certain things. Perhaps it will bring with it many other changes also for democracy and the decentralization of decision-making, it could finally solve some problems regarding the privacy and verifiability of some information of central importance for the development of this type of platforms, other aspects concern international trade. and the simplification of some activities. On the other hand, there are concerns that may relate to the criminal side of Blockchain, the possibility of hiding data, transactions and accounts of illegal activities or related to people who are part of criminal organizations.

5. Do you think this open-source and distributed ledger technology could be a tool for social change? (If so, then how?)

When it comes to social change and open-source technologies, I think blockchain will play a central role if communities and developers are able to make it more user-friendly, accessible and secure in some respects. The distributed ledger technology can be used in many different fields and in the future, it will be possible to use services that today need many documents and validations in a much simpler and more immediate way, without all those steps of third parties and institutions that today need several days. The blockchain could make our transactions and the saving of our documents 100% secure,

some already adopt these technologies, many invest in cryptocurrencies and adopt virtual wallets where they "store" their crypto, all this is protected by encrypted information, the market of cryptocurrencies is wide and full of different crypto each with a specific tool. If this new technology takes root like the Internet in the 1990s, then it will profoundly change our society.

6. How do you assess disintermediation? Do you think that this can lead to greater responsibility and willingness of citizens to participate in public decisions, making democracy itself benefit from it?

This question opens up several discussions, disintermediation, a greater level of democracy and even greater responsibility for people will certainly have a positive step in making decisions more democratic. Decisions could be more focused on the community and territories, people could feel more involved in the political process and the awareness of being part of a community will increase, maybe we will observe a growth in trust for institutions. On the other hand, the importance of digital literacy and the ability to understand and be able to use technology correctly are issues of great importance to generate an environment that can give everyone the opportunity to be part of new governance systems, democracy works if everyone has the same voting opportunities. In this case there could be a generation gap between those who are able to use the connected devices and those who are not. Another issue is the security related to possible e-learning platforms, we should protect them from cyber-attacks and protect the privacy of voters. Surely the blockchain could become a new tool to solve some of the problems previously highlighted, certainly many of those related to disintermediation.

7. Do you think that the role that governments have is important in determining the correct use and implementation of this technology or do you see the various governments as increasingly distant and less important entities to play a central role in technological progress? (What role do you think that non-governmental institutions and non-profit foundations play in this technology?)

Certainly, for what concerns e-governance, other tools for decision-making, for what concern more social and philosophical matters and for the development itself the role of the governments will be central. Governments are asked to regulate and create a sure framework, the discussions in the parliaments and in the governments are central to the decision on which decisions are better, which technology it's better or how a technology should be developed. Today the biggest problem of the governments it's that most of the people working in the various institutions part of states are not very knowledgeable about technology tools, the literacy it's very different between the private and the public sector. It's very important to digitalize the government but today there is a lack of information that leads to mistakes in the long term. The public sector doesn't have the money to deal with the capacity needed to cover certain fields of technological studies, many times it has serious problems in the adoption and implementation of certain technologies in the institutions themselves.

8. Do you think that the Blockchain could be a fundamental element for the fight against corruption (e.g., such the Colombian experiment on the public food supply) and the control of expenses in the business environment? (If so, which elements or features of blockchain technology (e.g., such as immutability of certificates and global accessibility) could enable the fight of corruption?)

At this time, it is difficult to answer this question, but there are several experiments such as the one related to land ownership certifications in India which is having different results in ascertaining the correspondence between land ownership and owner (India suffers from a problem endemic to corruption in land registry documentation), the experiment is working quite well in some parts of the country. Other experiments are underway in different countries, the blockchain can solve various problems regarding the certification of documents and their immutability over time, the settings of the block of chains can also be different, the networks can be set up on a scaffold more private, others on a more public one and a mix that allows the use of different security steps and work protocols. I think that with the implementation of some settings, the blockchain can become part of the tools capable of combating corruption and controlling expenses both in the private sphere and in the public administration. In fact, it is already possible

to use public key cryptography or time stamping for transparency and notary authentication activities, on the other hand the type of financial privacy that blockchain technology (and many other cryptocurrencies) allowed by decentralized cryptography in general, can also lead to a reduction in traceability in the opposite direction, and therefore a possible increase in corruption phenomena, given by a reduction in the possibilities for security agencies to control transactions completed thanks to cryptocurrencies. In fact, it is very difficult to find out who the money comes from because all the names are encrypted; all the information is not visible in plain text but in the form of codes, numbers and letters that have an apparent causal order.

9. Do you have a more positive or negative view of the world 50 years from now? - Do you think we will be able to control this technological revolution and guarantee its benefits to the largest possible number of individuals?

I think that humanity at some point will no longer be able to understand / control technological development, the automation of software that is already present on some platforms such as Facebook and other social networks is already difficult to understand, but this gap between human and artificial knowledge I think it will increase in the future with the development of Artificial Intelligence, the greatest fear, what makes many scientists doubt whether or not to create an autonomous artificial intelligence is what we will no longer know how it will do the machine to find the answer to our questions, how are we going to trust those decisions. It is now possible for humanity to create a machine capable of thinking and capable of inventing something for us, this could lead to results beyond our thinking capacity, we do not know what the horizons are, and this is at the same time fascinating and scary.

d. (VT_4) Indian Ministry of Innovation (Electronics and IT). Interview conducted on the 05/24/2021

1. Can you briefly describe your field and career path until now? - Which is your main field of research and in which stage of your role you use blockchain and its tools?

Before I entered the Indian Ministry of Electronics and IT, I was a Professor in computer engineering at the Delhi College of Engineering, then after 20 years of teaching, with the election of Narendra Modi in 2014 the new minister, Mr. Harsh Vardhan called me to take the position as the head of the E-Governance Division at the Indian Ministry of Innovation, since then I and my collaborator are trying to create a reliable system based on the blockchain to develop a better and more trusted Indian Cadastre.

2. Which are your thoughts about a cadastre based on blockchain in India, is there any interest from the government, do you see any possibility of implementing that? - Which are the main institutions involved in this process?

I think a cadastre system based on Blockchain will be the best system to resolve the main problems of land administration in India, it will be able to resolve the issues related to corruption and enable people to better control their documents and the process of buying and selling their properties. - The government is truly interested in the possibilities this technology can have and is already working on it. I've been working on this technology since 2014 and I have already seen many achievements in the development of a new kind of cadastre. Of course, problems still remain, India has many different states, and it is difficult to implement a system that fits all. But we are creating a system that will be able to process different languages and not just English, this will make access easier for a large part of the population.

3. Which type of blockchain do you think will be the best to fit the Indian situation? - A private type based on the Proof of Work or a Public one based on proof of stake or a mix of them?

We are working on a Private blockchain based on the Proof of Work, this fits the request of both stakeholders, government, and states, such a system will be able to process and work properly for the whole community. The information will be public, protected by encryption, and immutable.

4. How do you think Blockchain will shape land administration? - Do you consider that a real possibility, or do you think it is too early to think of a cadastre system based on it?

As I already say, the federal government of India is really pointing resources in terms of investments in this direction, and also the state governments want to implement it, they believe the benefits for the overall land-administration will be great by the adoption of this technology, I think in few years you will read about how blockchain has been adopted by all the states in India, we are probably one of the most advanced countries in the creation of a Cadastre totally based on Blockchain, this will resolve many of the secular problems of corruption and waste of resources in this sector.

5. Do you think a big and populated country such as India will be able to develop a cadastre based on blockchain? - Which are the main problems that prevent a system such as this to be implemented?

Surely India has a big population and has different problems related to it, but that is why the government since 2014 is considering developing a cadastre based on blockchain, so as to make it quicker and more reliable, secure and effective and try to resolve the problems of Corruption. Of course, problems still remain, the fact that a large part of the Indian population does not have access to the internet is certainly a problem that must be resolved, and we are doing it, there is a program from the Federal Government that has disposed of millions of hotspots for the internet connection in rural areas and villages. Broadband for All, Rural and Broadband for All and Urban, and National Information Infrastructure (NII) are the three sub-components covered. Under the National Optical Fiber Network (NOFN), the Broadband for All Program has already reached nearly 2,50,000 village (Panchayats). The Department of Telecommunications (DoT) has served as the project's nodal agency. Another issue that still remains is the lack of devices such as computers and tablets, but last-generation smartphones are going to resolve this problem, and the android smartphones are reliable, cheap, and work properly for our aim.

5- Do you think this technology would be the main driver of social change and new opportunities in the next future, how do you think will change the social and labor structure if adopted?

It will change the life and the security of millions of people; it will generate willingness in the Indian government and there will be more trust in the governmental institutions. What people want is reliable and trustful bureaucratic services, cheap and that works properly without losing the time of citizens, and this is one of the many goals that could be achieved through Blockchain, that is why the government, and many researchers are focusing so much attention on this topic.

6- How do you assess disintermediation? Do you think that this can lead to greater responsibility and willingness of citizens to participate in public decisions, making democracy itself benefit from it?

If you can enable institutions to work properly, as I said, citizens will feel more involved, with a cadastre based on the blockchain every citizen will be able to control the information's related to a property he/she would like to purchase, and he/she will be able to investigate the history of the land or the house is going to buy, this we surely create more sense of institutions and a presence of the states that dispose of services that makes life easier for the majority of the citizens.

7- Do you think a system such as this could be a threat to the security and the privacy of the documents of millions of people, do you think we should rely 100% on blockchain for this matter?

Well in a cadastre the information is public, but yes, for what concerns the private information of the property owner, those will be maintained private thanks to encryption, that doesn't mean we completely forgot about privacy, we are taking care of it and blockchain it already enables a very good level of privacy which makes everything easier.

Which will be the opportunities of a distributed ledger cadastre after the pandemic? - Do you think the government will focus a part of its attention on it or do you think they will focus on other issues, forgetting about this?

Well, it is difficult to answer what will come in the future, but I think the Indian government knows perfectly the advantage in terms of developing this kind of system, is already investing a lot of money and has plans to implement it until every state will have a cadastre completely based on blockchain.

**e. (GK_5), Indian National Informatic Centre
- Conducted on the 05/27/2021**

1- Can you briefly describe your field and career path until now? - Which is your main field of research and in which stage of your role you use blockchain and its tools?

Civil Engineer, Minister of Technology / Cadastral Mapping

Research- Geoinformatics / Blockchain Implementations for eGovernance Applications

Role- Consulting and Research

2- What are your thoughts about a cadastre based on blockchain in India, is there any interest from the government, do you see any possibility of implementing that? Which are the main institutions involved in this process?

1. Blockchain is at the Beginning Stage
2. Governments are exploring its potential and pros and cons
3. There is a Pilot Implementations, some states such Andra Pradesh are creating new cadastre based on Blockchain.
4. State and Central Government

**3- Which type of blockchain do you think will be the best to fit the Indian situation?
- A private type based on the Proof of Work or a Public one based on proof of stake
or a mix of them?**

A mixed one : Frequent high value / low Transaction's systems - in a public
Secured Transaction in private type and isolated channels for specific region
Few States on Private Like where special articles are there related to geography and
caste

Few States only Public:

Few States only Private: Northeastern state only private land ownership

**4- How do you think Blockchain will shape the land administration? - Do you
consider that a real possibility, or do you think it is too early to think of a cadastre
system based on it?**

With the acceptance of cryptocurrency, it will gain importance

It will be a reality because of the number and to fasten the complexity of the court cases.

**5- Do you think a big and populated country such India will be able to develop a
cadastre based on blockchain? - Which are the main problems that prevent a
system such as this to be implemented?**

Yes

Current Rules and Regulations

Low penetration of Internet

Data Protection and Privacy Rules

CA - Certifying Authority and its integration into blockchain

**6- Do you think this technology would be the main driver of social change and new
opportunities in the next future, how do you think it will change the social and
labour structure if adopted?**

IT is for masses

It will be an additional level of IT Support layer and service at National level.

It will bring clarity of the transactions

Encourage usage of cross border transactions

digital division may increase initially but will become a practice in due course of time

7- How do you assess disintermediation? Do you think that this can lead to greater responsibility and willingness of citizens to participate in public decisions, making democracy itself benefit from it?

Visibility of Transaction will reduce court cases and the stakeholder will be able to perform the activities confidently and will leverage eGovernance and boost democratic values through conclusive tiles.

8- Do you think a system such as this could be a threat for the security and the privacy of the documents of millions of people, do you think we should rely 100% on blockchain for this matter?

Cross border transactions need to be controlled

Data privacy act is under process and crypto regulations are under debate

The existing Acts are salient on Blockchain

9- What will be the opportunities of a distributed ledger cadastre after the pandemic? - Do you think the government will focus a part of its attention on it or do you think they will focus on other issues, forgetting about this?

Different departments have different mandates. The department related to cadastral mapping will continue enhancements through their respective IT support agencies and will identify the best suitable features (isolated channels in Hyperledger/consortium-based systems) to enhance the transparency of the transaction with increased immutability of the transactions through the multipurpose land revenue system.

**f. (MB_6) - ORF - Observer Research Foundation (Think Thanks) - New Delhi.
Interview conducted on the 05/31/2021**

1. Hello Mrs. Bal, welcome to our meeting. I will kindly ask you some questions about how blockchain is shaping the landscape of land-administration in India, and I will ask you what your thoughts on this topic are. I will start from a general question on your career. Can you briefly describe your field and career path until now, which is your main field of research, and for where you worked in the last few years, thank you?

Okay, so when I finished law school at the University of Delhi in 2016. My first job was for a law firm for about a year. And then I joined the Observer Research Foundation, which is a think tank in India. And I did a lot of research on blockchain and found around intellectual property and other elements in the economy, things such as the gig economy. And then I joined consensus, and I worked with them for a year. And I had them set up their offices in India and I did some business development for them. And then I joined Disney, where I've been for the last two years. And I am still doing research on the site, but with a lot of intellectual property focused research, things around surveillance, around competition in the gig economy, around emerging technologies, and of course some amount of blockchain.

2. Thank you very much. What are your thoughts about cadastre based on the blockchain technology in India, is there any interest from the government? Do you see any possibility of implementing that? Which are the main institutions involved?

So , there's been different pilot projects over the last few years. And I had the privilege of witnessing one governmental institution trying to implement a project of cadastre based on blockchain in the Union territory of Chandigarh and it varies from state to state, which institutions are involved in land administration, because land is a state subject. But revenues are a central subject, sometimes this creates confusion in the process of development of the system and makes up for discrepancies between the

federal government and the state governments. This creates a lot of problems in India that make it very difficult for such a system to be a useful solution here. And I'll give you insights on an experience I had in a particular project. I'm not sure if I can divulge the particular systems, I think I had a confidentiality agreement in the contract, but basically what happens in the state of Chandigarh, for instance, what people do is they transfer properties to each other under general power attorney documents. So, I will make a quick example, I have a son, and I find a GP in his favor. And then he says the property is on my behalf on the basis of that GP, things like that, you don't really know what the provenance of the title from many properties is, it is incredibly difficult to find the right information. The Chandigarh state administration has done a lot to try to clarify titles, same in Andhra Pradesh, and in Telangana. Which are two states in the south of India. But I mean, the biggest problem in India is that the government does not guarantee crucial information and documents such as the once of the cadastre. Records of proprieties' documents tend to be a mess. So, for this to be implemented, you would need basically a lot of groundwork to be done by the state, to clear up and understand which are the right information and which are not, but this process, even in a small segment of land could take a long time. The state of Rajasthan came up with the law, attempting to do that where they said that after carrying out a survey, they would give provisional land title certificates. But that hasn't been done yet.

3. So, there is a problem with the collection of information. And how they will use that information to implement the new system based on blockchain. Right?

Yeah. What was really ridiculous was that this particular body wanted to still consider going ahead with a pilot, even though they knew that there was this problem of illegal property transfer to general powers of attorney, they said that it was still possible, and they would continue to develop it. What they would do would be to take care to upload on the blocks just the information regarding new properties. So, like newly made apartments and things like that, where the title is clear, and will basically identify an area and see how it would work. In the end they just wanted to pilot it. But basically, it was just to show that they are doing something with technology rather than really fixing the problem.

4. And which type of blockchain do you think will be the best to fit the India situation? - A Private Blockchain or a Public one? - Based on the Proof of Work or on the Proof of Stake?

I think it should be a permission one, in fact in a public blockchain anyone can enter your system and become a node in your system. So, it doesn't make sense. And in fact, there's a paper that's been written on this, about how public blockchains are infeasible for property transactions. But the other problem with putting everything on the blockchain is that digital signatures, which are an integral component of blockchain technology, cannot be used in any transactions related to immovable property under the Information Technology Act of India. This Act does not permit such digital signatures, and this could be another big problem on the road to the implementation of a blockchain cadastre in India.

5. So, a part in the regulation from the government is needed?

Yeah, they would have to change this particular segment. They're looking to overhaul that act. Completely, because it's a 21-year-old act that governs the entire technology sector in India. But they have not done it yet.

6. And do you more likely use a blockchain based on proof of work or proof of stake?

I think it would have to be a scalable solution. Because if you're going to do something, even at the state level, that it's not scalable, then there's a risk of your system essentially shutting down. So, it would have to be something like, I don't even know how valuable proof of stake is to them saying it is more interesting, but proof of stake reduces the trust element of the technology, because then you are basically relying on the institution. I mean, not that you're not relying on the institutions anyway, with the permission blockchain. I think it could possibly be something like Polygon that could be used. I don't know if you're familiar with Polygon, because they've come up with a bunch of scalabilities for this thing, something using basically that as a business base building.

But like I said, the knee, they work that rounding it is very messy. So, unless that is changed, I don't see the point of forcing such technology just for the sake of doing it when it's not even legal to do that.

7. And do you consider it a real possibility for India to develop that in the next few years? Of course, if those problems are resolved - Do you think that the government is really thinking to do that?

I don't think so, it's been a bit of a non-starter, the federal government tried to introduce it, they've spoken about it in great length, but such initiative to work needs to be undertaken by every state. So that is why I don't know if it's going to happen.

8. Okay. Maybe if it will work in a single state. Maybe the other will follow?

Probably. I don't know, maybe. Yeah, I mean, I think it would work in a state where they have really done a lot of good work with gathering data around it. But the problem is that I just don't see. The problem is that the approach is very much technology centric, so they want to, you know, basically take a technology and put it into a system rather than fix that system. Because there's this assumption that technology will lead the scene in the future.

9. Well, I think, for what concerns digitalization, India did pretty well in the past. It was able to gather an incredible amount of data to digitize the public administration. Not many states from developing countries are able to put in place such a complex system and it is interesting how India is focusing its attention on such distributive technology.

Definitely, because the state is a capacity constraint. Technology has definitely the potential for mediation and problem solving. But I would say the problem is with the approach and if you dig a little deeper, you see that actually India is not all what it's cracked up to be. It's not as much of a success as it's made out to be. There's a lot of problems on the ground.

10. Are the problems both related to the government and to the people? - Is the lack of devices and a reliable internet connection still serious issues in developing a project such as one of the cadastres based on Blockchain?

Surely, connectivity is still a problem, even though they say there's 1 billion mobile phone connections, that doesn't really tell you the truth. You could have people with like three or four SIM cards. But that does not mean each of those subscriptions works. The quality of services is very poor telecommunications, if you just look at quality of service and telecommunications, when you Google its telecommunications in India, you see that the Telecom Regulatory Authority has been basically doggedly after the telecom companies to up their quality of service. This is a very complicated problem, and it will take me a long time to explain it. But there's a lot of problems, I would say. I would say that it is remarkable what India has done in terms of the widespread of digitalization, but I would also say that a lot of it has not been done by the government, the most important decision the government took, was to liberalize the telecom market, this enabled competition among different providers, which positively affected the prices, cost of data went as well as the costs of other services.

11. And do you think a system such as this, if implemented, would be a threat for security and privacy of information of millions of people?

Yeah, I think permission blockchains are, in any case, more unsafe than non-permission ones. There's one unknowability that the government has a pretty poor track record on issues regarding security. If you go to any government website in India, you see that they still don't have security certificates.

Also, if someone wants all their data to be deleted from the blockchain, you can't do it. That is another big problem of a blockchain based system. Our privacy legislation has not already come out with a solution for it. There's a lot of pressure to resolve these problems, but nothing has been done yet.

12. Do you think there is the possibility for people to be more involved in the democratic process and overall, in the institutions' decisions?

I don't know if blockchain will be useful in this direction. I mean, that sounds a bit like social media. Surely it could improve the participation of the people in the public decision but that's a completely different topic than the one of land-administration. I guess, the major problem there, is that their algorithms look more like social media companies, they are tailored to kind of compel you to engage with what your interests are and creates equity. Certainly, it's good for the exposure to different points of view. I think that technology does have a great promise for democratization. But the problem is that it leans more heavily into politicians, both in the corporate sector use cases and in the manifestation of functions. So, I think that it would have to be, I don't think that the state should be. Well, it's a tricky one. It's a really tricky one, because, again, it depends. It depends on the state that is doing it, it depends on which corporation's intentions are, if it is trying to democratize a platform for, again, innovate the platform or if it is trying to democratize the processes. There is a lot to discuss around this topic.

13. Now, of course, it depends on which one will be the ones developing it. If it's an authoritarian state, such as China, probably we will see more control over people and it's already like this, but I am thinking about India, a democratic country. And so maybe it will be different. The purpose of the government, and also the will of people to be more part of the solutions, feel more part of the government and be more involved. But this is just my idea.

Did you mean like a voting system on the blockchain?

14. Not really. It's not liked a vote, but more like a discussion, a community to discuss different decisions, of course, maybe on that platform, you can vote but that vote it's not such a real one, but it will give politicians a clear vision on which is the direction people prefer or which are the most important policies that should be putted in place.

I don't know if you noticed this on Twitter, but Twitter trends are basically driven by political agendas. So, you will see that Twitter takes most of the rhetoric being pushed out by the various political parties in my country, that is what is trending on Twitter, because they've got armies to induce people following the major trends and not what really interests them, creating bots to push this stuff out all the time. And I don't think that if a blockchain was placed in there that would be interrupted in the way that it is, unless there's the linkage to the identity (which is possible thanks to Blockchain), but this opens up another discussion if it's good or not to create such digital identity, where will be the limit for privacy, there will be one or everything will be control, if so, who will be the controller? So, I think from that perspective, I guess platforms that lead to people's voices are important. But like I said, it is extremely difficult to create a system which is able to work properly in an environment that still has many problems that should be resolved.

15. Okay, I think I finished my questions. Thank you very much for your time. And I don't know, maybe I will ask something else to you. But the paper you wrote for ORF is very interesting and of high quality for the analysis of the blockchain cadastre in India. It was very interesting to me. And for my thesis, I'm trying to collect as much information as possible, and try to do as many interviews as possible. The topic is very new, and I need the thoughts of experts to investigate deeper the possibilities and the projects that are taking place.

I would say just dive into the paper and confirm the constitutional status of land governments, the record system and confirm that both the state and the center are involved in the process and at which level.

g. (SM_7) - KPMG, and Centre for Innovations in Public Systems (CIPS) - Working at Amaravati project of Blockchain-based land-records system in Andhra Pradesh since 2019. Interview conducted on the 06/18/2021

1. Hi, I'm Luca and I'm doing my thesis on blockchain and how it could improve the land administration and land records in developing countries, in particular,

I'm focusing my research on the Andhra Pradesh experiment. I would like to start by asking you if you can briefly describe your field and career path until now, which is your main field of research and at which stage of your role you use blockchain? -

Yes. So, look, basically, I was working on an engagement model called enterprise architecture. By this program, we bring the latest technology into the government. So, in that context, we started doing the digital transformation across all the departments and the AP state government. This happened to be, in the year 2019, personal training went to 2021 and probably will continue until 2022. The project started in 2019. And then, you know, we got a couple of engagements to penetrate the blockchain into the departments. I started to work on the development of a blockchain project in the Amaravati Smart City, which I've extensively worked on to experiment with blockchain in land administration as a pilot project into the Smart City zone, one of the biggest advantages is that all the land portions part of the new Smart City has clear titles. Initially, we have taken Amaravati as a pilot project to implement this blockchain model, but later on, we have planned this for across the state, but since the titles in the other provinces of the state are not trustful, we stopped implementing it outside Amaravati and we concentrated only on the Smart City territory, where the government did have the chance to implement the blockchain, principally because of the reliable data to do that. The biggest problem here is that when the land titles are fixed in the blockchain, the information uploaded on the blockchain is immutable, that's why the information must be correct. That is why we uploaded on the blockchain only the land which was the property of the government, and which had clear titles. Okay, so, so there is a land pooling, exercise land pooling in the sense, they have fixed the length and breadth of the camera with the smart city. To build its new capital city the government of Andhra Pradesh has purchased the land it needed from the farmers, that's how the land pooling exercise happened for about 100 villagers in that particular zone. The government decided to implement from zero a system of land records based on a private blockchain where the first node was the Company owning the rights on the land plots for that particular land boundary. I participated in the process that saw those parcels of land being uploaded on the blockchain.

2. That makes sense. Is the blockchain you are using based on the Proof of Work or on the Proof of Stake?

We are using a private blockchain based on the Proof of Work. It's a private blockchain. Yeah. But otherwise, you know, whoever the landowners, after the Smart City will be fully developed, the government has told that some portion of this particular city would be given back to those farmers who have invested in this particular initiative, while the other part of the land, which in this project account for a 75% has been divided into various hubs, for example, the health hub, the entertainment hub, the government hub, legal hub. So, these are the pockets that were developed in that particular Smart City area. These areas saw investments coming from private entrepreneurs and investors who come and invested in the growth of those particular Smart City areas. So, they have been given a title that is secured with the blockchain. And the rest 25% of the areas in the other corner of the city have been allocated for these farmers, and they also received a blockchain secured parcel. They have received a certificate from the government, which has a QR code on that and the hash of the other blockchain is actually mentioned in that. So, they have all the documents on by opening that QR code and they can do whatever they want, like controlling the property history and so on.

3. Now a more general question, how do you see the situation evolving in India, like in other states, is the reasoning to develop something similar? Or there is a purpose from the federal government to improve this new system in the other states?

Absolutely. But there are different problems in the achievement of blockchain land records in any state, the biggest one, as said before, is that if we have poor quality data, the blockchain implementation will be nearly impossible without clarifying the information contained in the documents. It is also true that some states did pretty well in improving the digitalization of land records. In India, we have a big problem for what concern the land disputes regarding land titles that are going on since independence, these disputes need to be clarified and to perform a clear result. The hope is in a recent

innovation coming from a start-up in Singapore called Continuous Operating Reference Station technology (CORST), this geo-localization technology is based on 17 satellites that will be working continuously through an operating reference station, and then they will process a survey of all the land parcels. So, they will improve the land titles controller and they will control each piece of land, and with those new data, they will probably get enough clear information to improve blockchain. In the beginning, the citizens of Andhra Pradesh were reluctant to accept this new technology, and there is a lot of it is political sensibility on this matter, initially the government of AP has taken a step back on doing research regarding this. But, the current chief minister, (this is my assumption), is taking advantage of the COVID crisis to push for the embracement of the new technology, to digitalize and innovate the state's public administration. So, I think they are going to start the procedure with the support of the Singapore start-up and their CORST Technology. The average time to complete control of the land parcels around all the state territory will take around six months to be measure, but in the end, we will have clear data regarding all the parcels of land in the state and given that develop an efficient land-record system.

4. Apologize me for interrupting, will this technology be used only by the government of Andhra Pradesh, or this project will be adopted also from the federal government? And another thing, do you think will be possible for those states which didn't process a digitalization program for land titles to pass directly, jumping the steps, to a system completely based on blockchain?

In India, every five years, we have this finance commission, which will come up with a new plan to push innovation on a federal stage. In 2008 the financial commission has come up with a plan called DLRMP which stay for Digitization Land Records Modernization Program. This program was a federal government plan which was first experimented in some states and thus in phase two and three, was taken as an advantage by all the states in modernizing their land parcels. What is happening today is a bit different, is not the federal government but single states that are innovating in this direction, if successful I am pretty sure this system will be adopted by other states. It will be interesting to see how those states more advanced in terms of digitalization of

land records will react if the land record system based on blockchain will become the most effective. The biggest question is. They will change their system passing to the new one or they will keep their current system? - Those states that have a clear land title for all their parcels experimented with a high degree of trust from the citizens who are satisfied with the system. To conclude it's probably easier that this technology will be adopted from the states that have a lower level of digitalization and problems with land titles, like Kashmir and other less developed states. There is one company in particular that has come up to India from Russia. It's called Bit-fury. So, bit-fury has come up to implement these land parcels in AP state, for the entire state. So, at that point in time, we had a feasibility study, to where we can exactly implement this blockchain in the framework of the public administration. But unfortunately, the data is not up to the quality to get into the blockchain and that is why the area covered by the blockchain system is still the one under the administration of the Amaravati smart city project.

5. Which is the land-records system used by India? - Is it similar to those of the U.S and Anglo-Saxon countries or it has its own system?

There are big differences between the Indian land property system and the others from the rest of the world. Indeed, there are two different types of land property systems, the used in Australia, UK, U.S, and Canada, is based on the Common Law while in India the land ownership is Presumed: The Transfer of Property Act of 1882 states that only a registered document can transfer or sell the right (or title) to immovable property or land. The registration of such papers is governed by the Registration Act of 1908. As a result, land or property registration in India relates to the transaction rather than the land title. A registered sale document does not offer government assurance of land title. This means that even lawful property transfers may not always ensure ownership because a previous property transfer may be contested. Whereas in other countries such as Pakistan, Bangladesh, and Indonesia, the government secures the history of the land parcel, the property of the land is given through a precise document which contains all the information, in this case, there is an institution keeping all the documents regarding land records while in India the government doesn't do that, when a new property (or piece of land) has been purchased then the buyer and the seller should go to a notary to

have all the documents done (documents of the transaction), the notary than will secure those documents on the site of the government. So, that's the challenge. While in Australia for example the land record works differently, when the transactions between the seller and the buyer are done then the history that preceded it's not stored, the property is completely on the new owner's name, so once the title is changed onto your name, the historic collapse. In that kind of transaction, I could see a good penetration of blockchain. While if you are supposed to maintain the history then clear data are an asset, a high degree of security and reliability is needed, this is the only way to implement a system based on Blockchain in this case. The approach we used in the city of Amaravati Smart City was based on a clear title. It was relatively easy to implement a land-record system based on blockchain where there was just one landowner (the State of Andhra Pradesh), but otherwise, the blockchain roadmap for the entire state of AP was like, once the re-survey is done, and the disputes are settled, only after having done the re-survey we thought we could implement this process to the other part of the state. The problem of disputes on lands transactions it's also a problem relative to the judiciary system that has to process all those disputes, and that's why will take time and resources to close up all those disputes

6. Do you think those disputes could be resolved or an act from the Federal Government it's needed?

I think quite frankly, that's a never-ending process, there are new transactions on a daily basis, so there are new disputes every day in a country like India. And though you clear the backlogs, again, new transactions would come up. So, I think they should establish a governance structure, which would dissolve all these disputes. And then when those disputes will be resolved then we can get a good quality of data for the land parcels.

7. Do you also have problems with the federal government in terms of regulation of blockchain and how should be working?

There are some problems, but generally, the land-related domain is not under the federal government's jurisdiction. Unlike in other countries, it is completely vested with the

state. The state has the ownership of the entire parcel, so if the state is very confident about a new model or to implement a new technology to take care of the land records, they are free to do that until it respects the general rights imposed by the Indian Constitution. In the project of AP, the federal government is one of the biggest stakeholders, and it's an observing institution

8. Do you see problems regarding privacy, like cyber-attacks? Do you think blockchain has a high degree of security or you see some problem that needs to be fixed?

Sincerely, I don't see many problems in terms of privacy failure, because all the data are uploaded on a private blockchain which will guarantee a high degree of security, and the PoW and the hash system of encryption will effectively protect the data.

9. So, is it open source, if you want to know, which is the history behind a property in Amaravati I can control it on the Blockchain?

There was an initiative from the state government of AP, but now that got completely stopped with the new government. What they wanted to do was to upload information every week, so citizens could have the possibility to maintain under control the data.

10. What was your role, the implementation of this technology with the Government of Andhra Pradesh?

I'm an enterprise architect. You know, I was supposed to strategize how this blockchain or new technologies would actually work. So, I did consult for the government. So, I did the feasibility study for them. And evaluated what were the pros and cons, from the cultural aspect as well as the financial point of view and from various other dimensions, and finally, I come up with a report in the terms of budget, how much it would cost, and financial feasibility

If you would like a good connection on this topic, I can suggest you get in touch with someone who works in Zebby, Zebby is an Indian company that is working in tight contact with the AP Government. Let me check if I have contact with Mr. Furny on my LinkedIn. Yes, I can see he's still working there, he is one of the directors in that company and he can explain to you more deeply how they are implementing that with the Government of Andhra Pradesh. I worked in strict contact with the PMU while they were implementing this land parcel excise. So, I used to monitor how they are performing and as far as I know, they are processing only a private blockchain, which has a single node, there is only one node because the corporation called Amaravati Smart City Corporation is owned by that particular corporation. They are the only owners of that land. So, they are the only node of the Blockchain. Then, when they started dispersing the land to other stakeholders, they have created multiple nodes, when I was working there, there were just two or three nodes, it was really the beginning. Not all the owners of land could be nodes and only to great institutions such bank and investor is given these tools, the others they can just view their ownership. So, they have been given a feature to view the hash. A private blockchain, such that implemented by the AP government is not needed the presence of many nodes. There is not any sort of community behind the blockchain, is it just a private one.

11. It's just a blockchain you completely created from zero, right? - It has nothing to do with solidity by Ethereum?

Yes, all the Blockchain was built up from zero with the help of the Zebby chain, which contributed to bringing all the land parcels and storing them into the new blockchain.

Completed on the 30th of July 2021,

Luca Mario Comincioli

