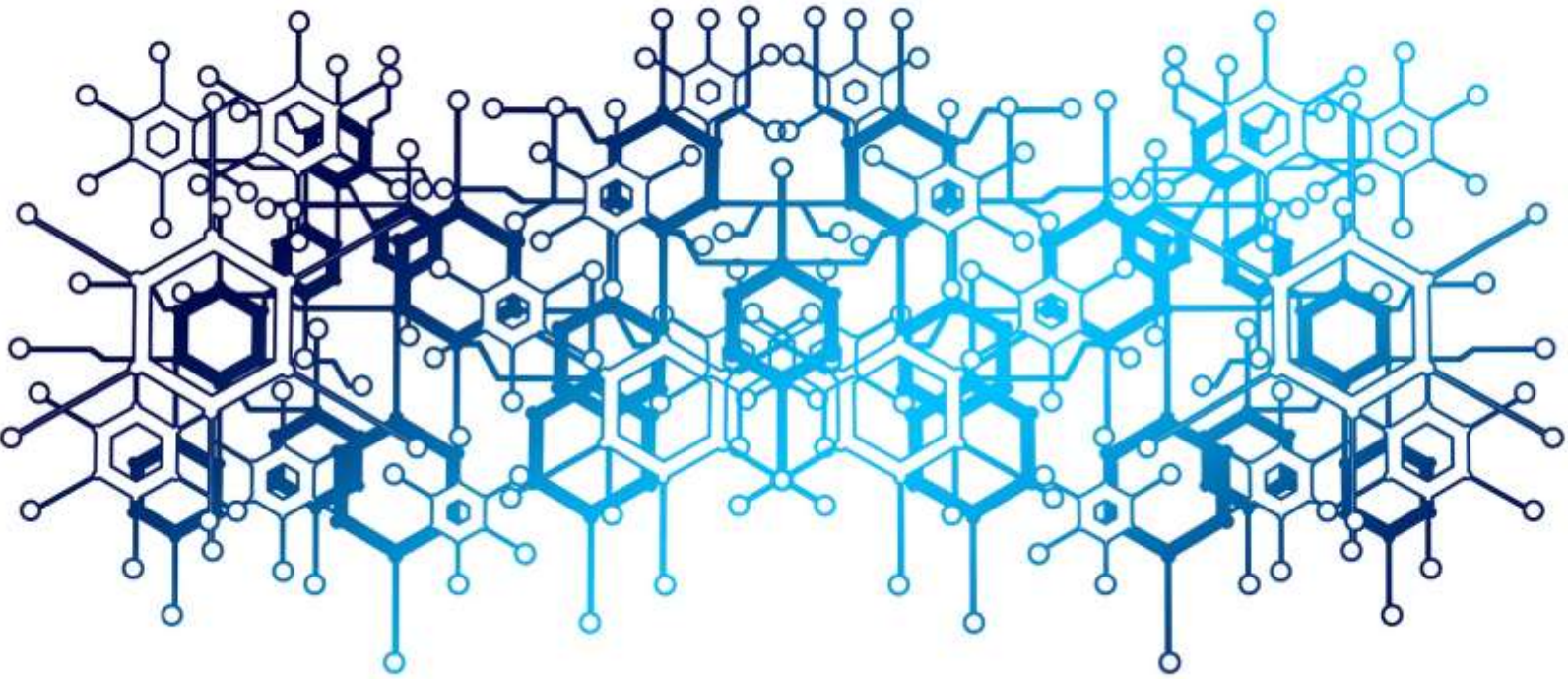

BLOCKCHAIN REFERENCE GUIDE

ADOPTION AND IMPLEMENTATION OF BLOCKCHAIN TECHNOLOGY FOR THE COLOMBIAN STATE

El futuro digital es de todos

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Introduction

During the last few years, the importance of the use of emerging technologies (ET) in society, such as those that seek to improve the quality of life of people and facilitate the management of their daily tasks, has been discussed.

The Fourth Industrial Revolution (4RI), its incorporation into society and the adoption of policies has been configured as necessary for the achievement of the social, economic, and political challenges of the present and future. Its implementation becomes relevant to unleash the processes of social innovation required by our countries.

It is a fact that the use of emerging technologies such as blockchain, fits without friction within the already widespread and accepted policy of open government, whose precepts are those of transparency, collaboration, and participation. In fact, these precepts are strengthened and deployed completely within the characteristics of the mentioned technology.

The fundamental pillar of this is the possibility of solving the problem of understanding how technology, like blockchain, offers effective answers to the solution of social, economic and political problems, in a way that helps to mitigate the existing gaps that systemically trigger problems in these areas of development.

To achieve the implementation of technological projects, it is required the addition of technical capabilities to materialize innovation projects through public-private partnerships between service providers, public entities, industry, academia, and financial institutions, civil society and other actors, so that they put all their willingness to achieve the purposes to generate public value and energize the entrepreneurship ecosystem for the solution of public challenges. Therefore, it is necessary to promote the Govtech approach for the promotion of entrepreneurships that revitalize the use of emerging technologies such as blockchain.

A comprehensive analysis of the environment will therefore help us to consolidate achievable, relevant and useful projects for our institutions and citizens in which the sectors actively participate, improving the social, economic and political dynamics that today need the protection of technology for the consolidation of a country model in line with local reality and needs in harmony worldwide.

This guide presents the guidelines that must be observed by public entities for the development of blockchain projects in public management, to design

and operate them in an organized, staggered and structured way, based on recommendations and good practices, allowing the general improvement of the welfare of citizens and the services provided by the State.

In addition, the guide will explain the fundamental and differentiating characteristics of blockchain technology, as a pillar for development and improvement of processes and interaction with the citizen. For this, it will be necessary to address, among others, the following attributes that characterize this technology:

- Immutability of the records: Given the nature of this technology, the data remain stored in encrypted form (encrypted. It is important to note that blockchain cryptography is optional) and irreversible (cannot be altered or changed), in practical terms it offers to the entity adopting it, and to the beneficiaries of the processes, a feature that promotes transparency in its missionary processes.

- Information Security: If there is a failure in the availability of the information technology infrastructure, data loss is avoided. In addition, the data is stored in encrypted form and the interaction with these is given from the consent of its owner regarding personal data, generating the appropriate traceability of these interactions, being recorded in the block chain.

- -Elimination of intermediaries: institutions and citizens can interact directly, without the need for third parties to validate their transactions, therefore eliminating the friction and delays associated with the intervention of more actors in a process.

- Traceability: one of the most important characteristics of the blockchain technology, given its immutability of the records and storage of the events that happen with an element stored in it, is the possibility of knowing the complete trace of an information element from the first moment it is stored in the blockchain network. This allows, for example, that a property title can be fully identified and that its associated attributes are known, within these, when and who intervened in the transfers, and other legal operations allowed by the law related of properties.

- Decentralized Database: Another of the distinctive characteristics of blockchain compared to other information management technologies, is that databases are decentralized because they are not on a single server or data center, which provides data resilience (data is not lose). This is achieved because they do not depend on a single record as a

source of information. The distributed records allow the immutability of the data and that the reliability of the system to be unique, over conventional databases.

In 2020 there have been important news in the implementation of blockchain projects. One of the most important pilot projects for the World Economic Forum (WEF) is in Colombia[1], where it already mentions the specific projects for the management of the School Feeding Program -PAE, in the framework of the initiative led by the Attorney General's Office, in partnership with the Center for the Fourth Industrial Revolution of Colombia and other actors. This project seeks to mitigate corruption in this program by offering transparency in the processes, thus taking care of public resources and the welfare of the beneficiaries.

Another relevant aspect in the implementation of blockchain projects is to promote projects for the development of the economy and financial inclusion. In September 2020, the Financial Superintendence, through its regulatory Sandbox initiative, has defined the rules for the development of pilots for the legal exchange of cryptocurrencies to make viable its implementations associated with blockchain technology.

The purpose of this guide is to enable public entities to provide inputs and tools that allow them to understand what it is for and how they can implement simple use cases of blockchain, in their management context, which supports the digital transformation required in the State.

In addition, it is intended that public entities develop and implement blockchain projects, so that Colombia can be a pioneer and leader in the region in the implementation of initiatives with the use of emerging technologies.

[1] World Economic Forum (2020) http://www3.weforum.org/docs/WEF_Blockchain_Government_Transparency_Report_Supplementary%20Research.pd

PART I: ABOUT BLOCKCHAIN

Chapter 1. Background

To begin with, it is interesting to explain that the Political Constitution of Colombia defines the essential principles for the development of the administrative function, which, according to Article 209, "is at the service of general interests and is developed based on the principles of equality, morality, efficiency, economy, speed, impartiality and publicity, through decentralization, delegation and decentralion of functions".

In 1991, one of the constitutional purposes achieved in our country was the incidence of decentralization as an essential pillar in the structure of the State. At the same time, moralization as part of the search for transparency in the processes and democratization in the access to services became elements that are part of the guiding principles of public service.

Today, almost 30 years later, decentralization, transparency in digital processes and democratization in access to digital services, become one of the essential elements on which to base technologies such as distribution accounting (Distribute Ledger Technology), which includes blockchain.

For the National Government, it is of most importance to promote the digital transformation of the State and to encourage emerging technologies for the generation of value in the public sector. For this reason, the National Development Plan defines the Digital Transformation as one of the most important axes for generating changes in the State. In its article 147 of the law 1955 of 2019 (defines that entities of the national order must develop digital transformation plans, incorporating components associated with emerging technologies and the Fourth Industrial Revolution, defining that such strategic projects of digital transformation will be guided by the following principles:

1. Use and exploitation of public data infrastructure, with an openness approach by default.

2. Application and use of standards, models, norms, and tools that allow for the adequate management of digital security risks, in order to

generate confidence in the processes of public entities and guarantee the protection of personal data.

3. Full interoperability between public information systems that guarantees the supply and exchange of information in an agile and efficient way through an interoperability platform. The exchange of information in electronic form, according to the standards defined by the Ministry of ICT, between public entities is fully and permanently enabled in real time when required. Giving compliance to the protection of personal data and safeguard of information.

4. Optimizing the management of public resources in Information Technology projects through and, using demand aggregation and prioritization tools for cloud services.

5. Promotion of technologies based on free software or open source, the above, without prejudice to investment in closed technologies. In all cases the technological need must be justified considering cost-benefit analysis.

6. Prioritization of emerging technologies from the Fourth Industrial Revolution that facilitate the provision of State services through new models including, but not limited to, disintermediation technologies, DLT (Distributed Ledger Technology), massive data analysis (Big data), artificial intelligence (AI), Internet of Things (IoT), Robotics and similar.

7. Linking all digital interactions between the State and its users through the Portal Único del Estado Colombiano (Colombian State's Single Portal).

8. Implementation of all new procedures in digital or electronic form without any exception, consequently, the interaction of the Citizen-State will only be in person when it is the only option.

9. Implementation of the policy of rationalization of procedures for all proceedings, elimination of those that are not required, as well as the use of emerging and exponential technologies.

10. Inclusion of programs for the use of technology for citizen participation and open government in the mission processes of public entities.

11. Inclusion and permanent updating of security and trust digital policies.

12. Implementation of public-private strategies that promote the use of electronic means of payment, following the guidelines established in the Program for the Digitalization of the Economy adopted by the national government.

13. Promotion the use of electronic means of payment in the economy, according to the strategy defined by the national government to generate a massive network of acceptance of electronic means for payment by public and private entities.)

To develop the digital transformation, the State has developed several initiatives. For its part, the CONPES 3920 of 2018 approved the National Policy of Data Exploitation, Big Data, whose central purpose is to increase the use of data in Colombia, through the development of conditions for these to be managed as assets generating social and economic value in the country. This policy has enabled the intensive use of data and its usefulness in Colombia.

In 2019, CONPES 3975 was issued, which defines the Digital Transformation and Artificial Intelligence Policy, whose objective is to promote the generation of social and economic value in the country through the strategic use of digital technologies in the public and private sectors, in order to boost productivity and favor the well-being of citizens, as well as to generate the cross-cutting enablers for the sectorial digital transformation, so that Colombia can take advantage of the opportunities and face the challenges related to the Fourth Industrial Revolution (4RI). This policy has become the roadmap for promoting the Fourth Industrial Revolution and fostering the use of emerging technologies in the country.

In 2020, the Digital Transformation Framework for the State was issued, which contains the guidelines to orient public entities in the development of digital transformation plans. The guidelines also contain the digital transformation kit, which consists of a guide to the use of emerging technologies, a guide to robotic process automation, and a guide to the development of digital services, among others.

In coherence with the above, it is of utmost importance for the National Government to continue issuing guidelines to enable the use of emerging technologies for management and public service, under which the development of blockchain should be one of the priorities.

In August 2020 a first version of the blockchain guidelines for the Colombian State was published for comment, called *"Guide for the use and*

implementation of distributed registration technology (DLT/Blockchain) in the public sector", a document in which theoretical bases were developed and some examples implemented in the public sector in countries such as the United Arab Emirates, Estonia, China, the European Union, Canada and the United States were shown. These elements were subject to comments from various stakeholders that have given as a result, that the first published exercise, will results this Reference Guide for the adoption and implementation of projects with blockchain technology in the Colombian State, under which, it seeks to develop capacity for entities to enlarge or promote projects under this technology.

In this way, progress is being made in reducing the barriers identified that slow down or prevent the massive advance of blockchain in the public sector, due to the existence of conceptual, cultural, and technological barriers or gaps.

Additionally, this version of the Guide seeks to transcend theoretical concepts to provide components that aim to generate value for the public in order to promote the digital transformation of entities, through a pragmatic and realistic approach to the national context, in which those aspects of improvement to promote changes through the use of technology must be considered.

Under the exposed, the present guide establishes the form how the blockchain technology should be implemented for the State, developing, from the technical domain, a qualitative approach with systemic focus, tending to generate capacities to impel its digital transformation from the development of blockchain projects.

Today, some public entities in Colombia are developing blockchain initiatives that are worth highlighting. For example,[2], in August 2019 the Attorney General´s Office (PGN) with resources from the Inter-American Development Bank (IDB), began the development of projects using blockchain technology through important public-private partnerships with the Universidad Nacional de Colombia for the technological development. This development took place in the digital laboratory *ViveLab* Bogotá, operated by the research group *InTIColombia*. The cooperation agreements with *Colombia Compra Eficiente*, the Medellín Mayor's Office and the articulating support of the Center for The Fourth Industrial Revolution of San Francisco and Colombia applied

[2] The information of the project can be consulted in the following links: https://www.weforum.org/agenda/2019/05/heres-how-blockchain-stopped-corruptofficials-stealing-school-dinners/ and http://www3.weforum.org/docs/WEF_Blockchain_Government_Transparency_Report.pdf:

blockchain technology in contracting state matters to "contribute to reducing corruption through transparency in the public bidding process and alerting civil society, organizations and citizens directed to the Attorney General's Office, through a pilot using blockchain technology and "intelligent contracts" in order to have unchangeable information records during the public bidding process". The main components of the project developed are summarized in the following table.

Blockchain technology in public tenders *(articulated with FEM)*

Role of C4IR.co-Articulator

WHAT DOES IT CONSIST OF?	To contribute to reducing corruption through transparency in the public bidding process and alerts from civil society, organizations and citizens directed to the PGN, through a pilot using blockchain technology and "intelligent contracts" to be able to have unchangeable information records during the public bidding process, for the presentation of bids and their evaluation.
WHAT DO YOU WANT TO ACHIEVE?	1. To generate evidence on the benefits or not of the use of blockchain and "intelligent contracts" to improve transparency in public bidding. 2. Generate a prototype and public policy recommendations on the use of Blockchain in public tenders. 3. To structure a project according to the observed results that allows to scale up the impact to different government entities or applications.
WITH WHOM?	FEM. Attorney General´s Office, Universidad Nacional, Medellín Mayor's Office Quanstamp, Colombia Compra Eficiente.

Source: STRATEGIC DOCUMENT BLOCKCHAIN, C4RI.

Figure 1- Summary of the Blockchain technology project in public bids

We firmly believe that this success case should serve as an example for other institutions and public entities, so that they can make decisions oriented to implement digital transformation projects with blockchain technology.

Throughout this guide, the principles that should govern projects under blockchain technology are developed, within which, the observance of the Presidio Principles for blockchain of the World Economic Forum, to which Colombia has adhered, is promoted.

Chapter 2.
Blockchain - The block chain

According to the European Union Forum and Observatory for Blockchain[3], blockchain is one of the main technological advances of the last decade. A technology that allows large groups of people and organizations, to reach an agreement and permanently record information without a central authority, enabling the construction of a fair, inclusive, secure, and democratic digital system.

Blockchain, as a chained series of reliable transaction records, has several advantages, as well as a strength in terms of digital and information security, since a blockchain record can be difficult to hack (some even say that it may be impossible, since it is estimated that to alter a blockchain that does not have corrupted source code would require 10 times the existing computing capacity of the planet[4]). However, it is important to keep in mind that this phrase can give a false sense of digital security, so it is important to consider from the design stage all the digital security and information security controls appropriate for the blockchain solution.

Blockchain is based "on Distributed Records technology, which takes information safely through a peer-to-peer network without intermediaries[5]".

Today the use and application of blockchain is much more than the exchange of cryptocurrencies value, for which it was initially designed. Blockchains are used in various types of projects and applications as an element that allows the traceability of records or assets, for example, in real estate, financial, records that require the identity of the person or organization, applications in logistic, supply chain, or any type of thing or title value. The potential impact of blockchain is promising in both public and private projects.

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[3] Blockchain Forum. Information avilable in: https://www.euBlockchainforum.eu/
[4] Calculations based on a panel of experts consulted for this Guide.
[5] SAP. Blockchain explained from a business perspective https://www.sap.com/latinamerica/insights/what-is-blockchain.html

How does Blockchain work?

A blockchain "registers data through a peer-to-peer network. Each participant can see the data and verify or reject it using consensus algorithms. The approved data is entered into the ledger as a collection of "blocks" and stored "chain" in a chronological way that cannot be changed[6]".

This guide refers to Distributed Ledger Technology (DLT), in which blockchain is considered as a type of DLT. This is since there are already multiple DLT use cases globally, for industrial and government sector applications, on which it is relevant that organizations that venture into the use of this technology, have a wide range of references to document their use cases.

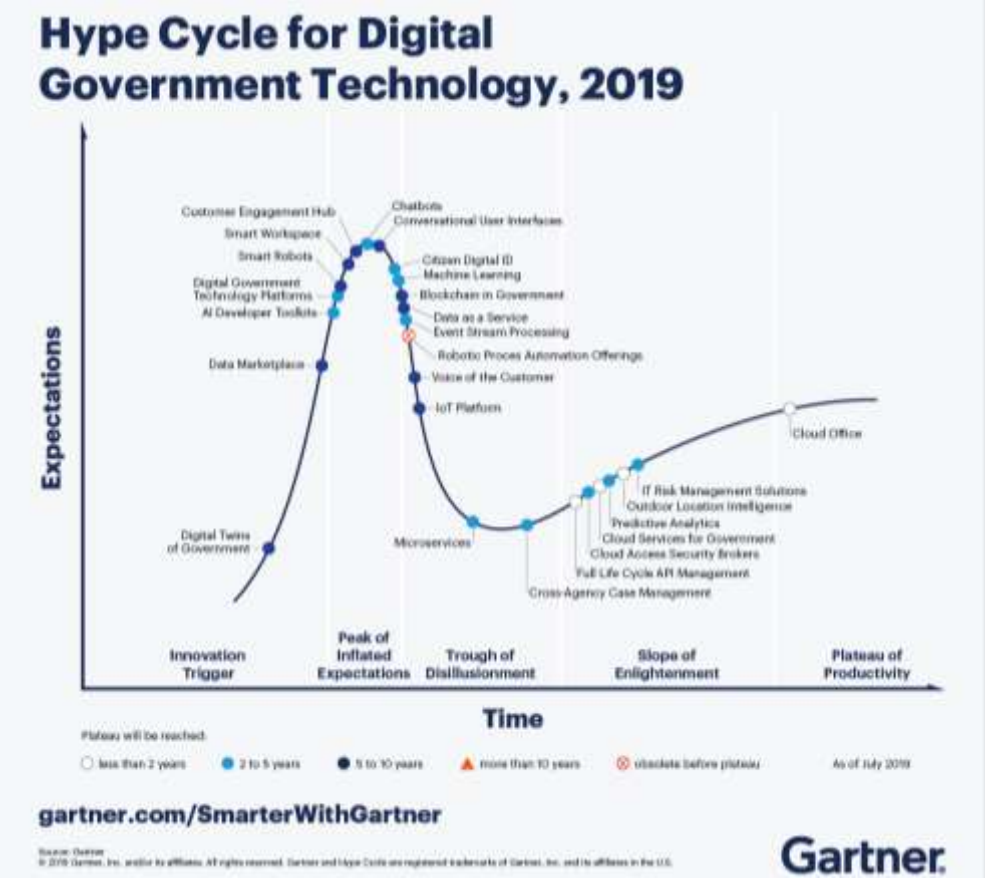
In a few years, blockchain has even evolved to the so-called blockchain 3.0[7] that seeks to generate efficiencies and speed in transactions by generating a horizontal model in which the scalability, performance and speed of transactions depend on strong nodes. This type of evolution will not be discussed in this guide, however, below is a link where can be seen where the technological evolution of blockchain can continue.

What is the status of Blockchain technology?

The following chart, called Gartner Hype Cycle for Blockchain Technologies 2019, presents different states of development and adoption of the blockchain technology according to different use cases. This graph indicates that most of the solutions are 5 and 10 years away from reaching productive stability and a transforming impact, which suggests a low level of maturity of the technology. To date, blockchain has not reached maturity in some enterprise ecosystems, and according to Gartner in 2018, it was indicated that an adequate state in the use and development of the technology could be achieved in 2028 when the block chain becomes fully scalable.

However, in the last two years the development of technology has had a dizzying activity that has put governments, banks, and industry to work together piloting and making blockchain implementations. In this way, blockchain technology is in an experimental stage at a global level, generating great opportunities for Colombia if the generation and adoption of related knowledge is decisively promoted. (C4RI Colombia, 2019).

[6] SAP. Op.cit
[7] For more information, it is suggested to consult the following link: https://www.blockchaines.tech/tutoriales/blockchain-3-0-el-futuro/



Source: Gartner, (2019[4]), *Top Trends From Gartner Hype Cycle for Digital Government Technology, 2019* (https://blogs.gartner.com/smarterwithgartner/top-trends-from-gartner-hype-cycle-for-digital-government-technology-2019)

Figure 2- Digital Technology Cycle in Government 2019

Gartner's 2019 analysis shows a breakthrough in the development of the technology, which is evidence that the time is right to start implementation processes under blockchain.

Blockchain has the potential to transform government services by providing a transparent and authorized recording of government transactions and reducing friction between ecosystems of the public and private sector. It is likely to transform many government functions, such as public records, procurement, and regulatory oversight of supply chain risk.

It can be concluded from these differences between the two charts, that the focus on the development of blockchain applications is about to reach its critical mass, which shows the importance of governments driving blockchain initiatives.

2.1 Why apply emerging technologies such as blockchain?[8]

The Blockchain technology has undoubted benefits for the operations and the management of daily processes in the organizations. Some of its characteristics are unique, and allow to generate digital confidence, as well as efficiency and effectiveness in the development of organizational processes. The following are the differentiating characteristics of blockchain technology:

- Immutable: the records stored in it, cannot be altered since the whole network has a copy of 100% of the records and can be validated by consensus.

- Improved security: since all the nodes of the network have a copy of the records, there is no way to change them and it is not possible to issue a new version of any existing one. No central validation authority is required. Additionally, the stored information may be encrypted or scrambled. - Enhanced security: since all nodes in the network have a copy of the logs, there is no way to change them and it is not possible to issue a new one version of any existing one that meets the validation criteria by the network of nodes. A central validating authority is not required. Additionally, the stored information can be encrypted or encoded.

- Distributed Records: The need for high computing capacity is dramatically reduced, except in the mining of a cryptocurrency.

- Elimination of intermediaries: transactions are between network participants. For example, the authentication of a university degree occurs between the person who consults it and the owner of the degree, or of a user by means of authorization of the holder.

[8] This section has been developed from the author's notes and taking as reference the following article: https://101blockchains.com/es/caracteristicas-tecnologia-blockchain/

- Information transparency and traceability: it is possible to go to the origin of the first transaction carried out on an item or document, from so that the history of the chain of information contained in a block can be clearly known.

- Anonymity: it is possible to enjoy total anonymity depending on the specific need of the application.

- Democratization of access to services: blockchain enables more people and institutions to access the system. As will be shown later, blockchain can serve as a technology to create financial inclusion tools and thus accelerate access to services.

From the previous characteristics, the main assets that arise and should be exploited with this technology, as far as a systemic vision of the State is concerned, are based on the following aspects:

- Trust in the institutions: trust is generated by having transparency in transactions, and in the availability of information to speed up procedures.
- Interoperability: all institutions can use the same information highway to access data, using common and more easily integrated architectures.
- Data sovereignty: Citizens are the owners of their data, their documents and in general of all types of transactions with the State. These digital assets can be exchanged, presented and shared with institutions and citizens.
- Digital identity management is one of the most important elements in the scenario of blockchain implementations in the State. The citizen uses the digital identity, for its interaction with the State giving agility and transparency to the procedures.

The use of technologies such as blockchain can bring the following benefits to form a digital citizenship[9]:

- The control lies with the user: only users and developers are involved in the transaction through blockchain. This avoids the presence of third parties that can access the data, market it or give it to other entities for profit.

[9] This section has been developed from the article by:
https://www.esic.edu/rethink/tecnologia/blockchain-la-guia-definitiva

- Decentralizes information storage: the information is distributed on individual servers around the world. Therefore, if the system would suffer attack or hacking, it would only compromise some of the nodes involved, which would not break the consensus of the network.

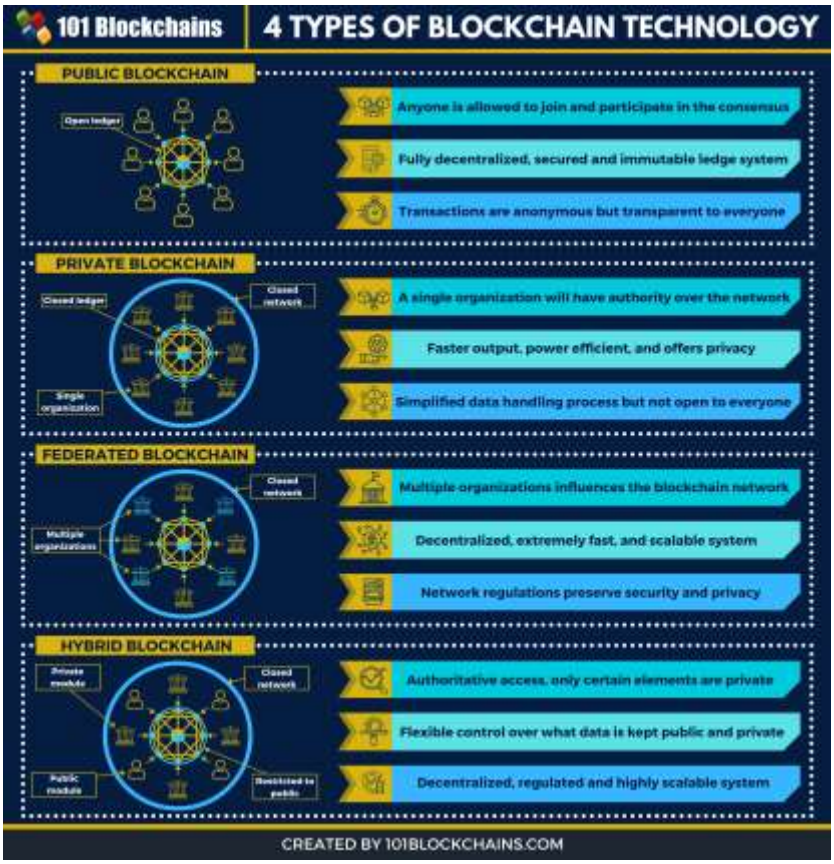
- Technological transparency: blockchain's technology is almost always open source. That means that other users or developers can audit, modify, and improve it with total freedom to create new applications.

  -Reduces transaction costs: operations are completed without need of a third-party mediation. Consequently, the absence of intermediaries can reduce the payment of commissions between individuals and companies.

- Streamlines operations. unlike other operations or transactions that can take days to complete it and where entities are subject to working hours and different time slots depending on their geographical location, blockchain operates 24 hours a day, 365 days a year, at different speeds (minutes or seconds) depending on the type of blockchain being used.

2.2 Identification of Blockchain types

Several types of blockchain have been identified, which are described in the following chart:



Source: developed by MinTIC from 101Blockchains.com

Figure 3- Types of Blockchain

Below are the most common types of blockchain[10]:

Consortium or federated blockchain

In the consortium blockchain, the consensus process is controlled by a pre-selected group, a group of companies or institutions. For example, the right to read the blockchain and send transactions to participants may be public or restricted. Consortium blockchains are considered "authorized blockchains".

Semi-private or hybrid blockchain

Semi-private blockchains are operated by a single company that grants access to any user who meets the pre-established criteria. Although not truly decentralized, this type of authorized Blockchain is attractive for business-to-business (business targeted to companies) use cases and, government applications.

However, it is important to note that hybrids are those that combine private and public networks. They may have operations in private mode that eventually register on the public network.

Private Blockchain

Private blockchains are controlled by a single organization or consortium that determines who can read them, submit transactions to them and participate in the consensus process. Since they are 100% centralized, private blockchains are also useful as testing environments.

Public Blockchain

Anyone can read a public blockchain, send transactions or participate in the consensus process. They are considered "without permission". All transactions are public, and users can remain anonymous in some applications. Bitcoin and Ethereum are prominent examples of public Blockchains.

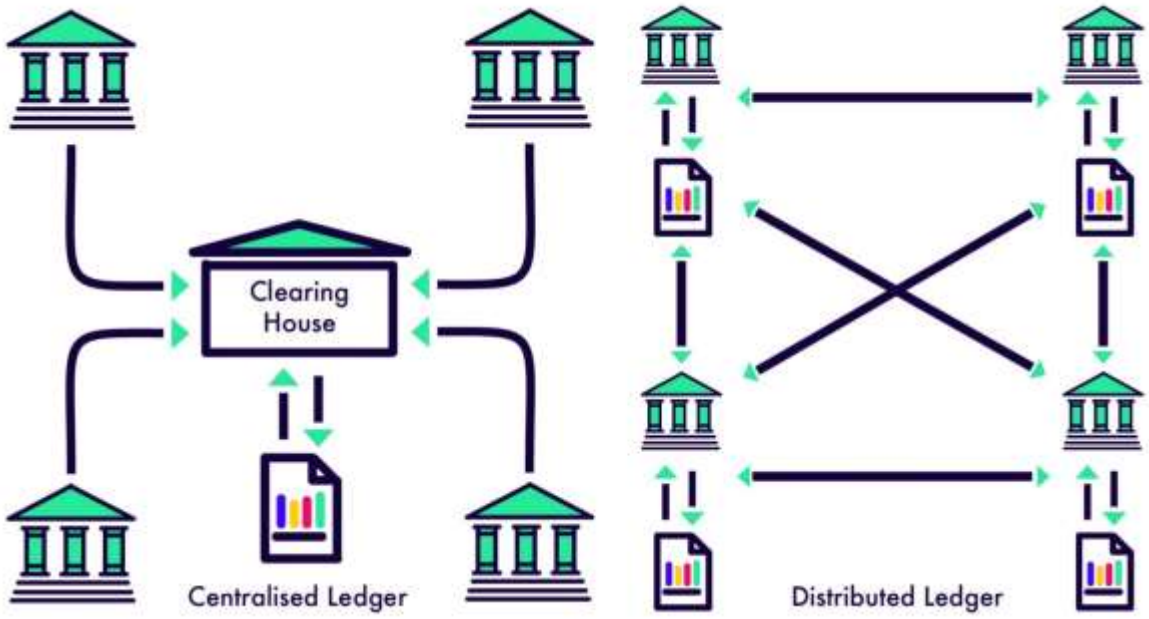
[10] Definitions developed from SAP Op.cit

2.3 Blockchain architecture

Blockchain has different types of architecture that should be considered in the adoption of a solution, there are public, private, federated, permitted architectures, and, the centralized or distributed ones are considered. Next, a brief explanation about the types of blockchain architecture is developed:

2.3.1 Centralized and distributed architecture

There are two other types of architecture that impact the development of current and emerging technologies, centralized and distributed. Each of these is developed below:



Source: developed by MinTIC from Gitcoin

Figure 4 - Centralized and distributed architectures

Centralized data networks and distributed or decentralized data networks are differentiated by the following:

A centralized data network[11] is one that keeps all data on a single computer, and to access the information it must be gain entry to the main computer of the system, known as the "server". In this type of network, scalability can be reduced due to the need for the central server to support all data traffic capacity.

On the other hand, a distributed or decentralized data network "works as a single logical data network, installed in a series of computers (nodes) located in different geographical locations and not connected to a single processing unit, but fully connected to each other to provide integrity and accessibility to information from any point. In this system all the nodes contain information and all the clients of the system are in equal condition[12]". In this type of network, the scalability is greater since distributed nodes can support the traffic load, however, the challenge in each of these is to maintain the storage required to support the progressive and increasing traffic. In turn, this type of network allows services to be provided at a higher speed, since the "bottleneck" effect is less likely to occur because it is possible to support traffic from any of the nodes.

To explain how the differences are evidenced between centralized and distributed architecture in a blockchain project, the following table shows a comparative[13] analysis of the dimensions of security, availability, accessibility and cyber security, data transmission rates, and scalability:

Security	
CENTRALIZED	DISTRIBUTED
If a user has access to the information contained on the server, any data could be added, modified and deleted	All data is distributed among the nodes of the network. If a data is added, edited or deleted on any server in the network, it will be reflected on all other servers in the network. If some legal amendments are accepted, new information will be disseminated to other users throughout the network. Otherwise, the data will be copied to match the other nodes. Therefore, the system is self-sufficient and self-regulating. The databases are protected against deliberate attacks or accidental changes of information
Availability and resiliency	
CENTRALIZED	DISTRIBURED

[11] iCommunity.io, (2019). Centralized VS distributed networks. Medium. https://medium.com/@helloicommunity/redes-centralizadas-vs-distribuidas-2fc50c51f284
[12] iCommunity.io (2019), Op.cit.
[13] Taken from iComunity.io (2019, Op.cit.

If several requests are submitted, the server may be unavailable and may not respond properly.	They can withstand significant pressure on the network. All the nodes in the network have the data and the requests are distributed among the nodes. Therefore, the pressure is not on one computer, but on the entire network. In this case, the total availability of the network is much higher than in the centralized
Accessibility and cyber security	
CENTRALIZED	DISTRIBUTED
If the central storage has problems, your information cannot be obtained unless the problems are resolved. In addition, if users have different access needs, but given the centralization the processes are uniform and homogeneous, it is possible that accessibility problems may arise for certain types of clients..	Because the number of computers in the distributed network is large, denial of service attacks (DDoS) are possible only if their capacity is much greater than that of the network.
Data transfer rates	
CENTRALIZED	DISTRIBUTED
If the nodes are in different countries or continents, the connection to the server can become a problem.	In distributed networks, the client can choose the node and work with all the required information, and in the geographic location point of their preference.
Scalability	
CENTRALIZED	DISTRIBUTED
Centralized networks are difficult to scale as server capacity can be limited and traffic cannot be infinite. In a centralized model, all clients are connected to the server. Therefore, all requests to receive, change, add or delete data pass through the main computer. Consequently, it can carry out its work effectively only for the specific number of participants. If the number of clients is greater, the server load may exceed the availability limit during the time that the increase occurs.	Distributed models do not present scalability problems, since the load is shared among several computers. It can be contemplated to support the management of the electoral process, in which the registering entity has a Blockchain that supports the amount of transactions without compromising security.

Source: IoComunity.io

Table 1- Comparison between centralized and distributed architecture

2.3.2. Public, private, federated, and licensed architectures

In the following table, the main characteristics of four types of architectures are presented, such as public, private, federated, and licensed:

Public	Private
User empowerment Immutability True decentralized structure Larger transparency Offers anonymity	Preserves privacy Faster performance Does not offer anonymity Energy efficient Less volatile network Organizational Empowerment
Federated	Licensed
Saves many costs Energy efficient Offers lower transaction fees Highly scalable Network regulations Extremely fast performance No criminal access Distributed authority	Suitable for organizations Relatively faster Transaction rates are low Environment of trust No native asset required Decentralization variable

Source: 101Blockchain.com

Table 2- types of blockchain and their advantages for specific projects

2.4 Configuring blockchain network permissions

Blockchain networks can have permission settings at various access levels, for example, authorized settings indicate invitation-only, private, or restricted access. Unauthorized settings are completely open with public access. The three main permission settings in the blockchain network are as follows:

- Read access (capacity to view transactions and information)

- Write access (capacity to send transactions and information)

The advantages and disadvantages of the configuration of the blockchain network without permits, based on the construction developed by the World Economic Forum for the use of blockchain applied to public tenders, are set out below: - Access to participation by consensus (capacity to serve as a transaction validation node)

Advantages and disadvantages of the Blockchain network configuration without permissions, applied to public tenders	
Read access: Without permission (with bid confidentiality schemes where applicable.	Read access: Without permission (except participation of authorized providers)
- All transaction and bidding information is public, allowing for permanent public records and real-time scrutiny. Public readability is essential for citizen ownership of the platform. - All public bids are publicly visible from the announcement of the auction. They are never encrypted and must be available for immediate public access. - All supplier bids are public but are encrypted for all parties from the time they are submitted until after the close of the bidding period, when they can be decrypted. Once the bidder concludes each round of bid evaluation, it publishes for the public record all bid information disclosed to it during that round of evaluation. - Bidding decisions and evaluations by the bidder are always visible to the public and remain on permanent record as soon as decisions are made. The public can comment	- Public write access allows citizens and other actors who are monitoring the process to comment within the system and generate alerts about possible suspicious behavior. The public may submit comments and complaints within the system during pre-established public comment periods. - The submission of bids from suppliers is partially "authorized" in the solution. Anyone can submit bids, but only bids from officially pre-registered accounts that register using their own password are reviewed. All these offers are documented and cannot be deleted or "censored" by the bidder. - - A government's ability to conduct a public offering within the blockchain solution is also "authorized," so that participants initiating and conducting auctions in the system must be pre-approved by the institution in charge of the bidding process

Advantages and disadvantages of the Blockchain network configuration without permissions, applied to public tenders	
on decisions and evaluations during pre-established periods in the contracting process.	
Access to participation by consensus (participation in transaction verification): No permission	Disadvantages of a Blockchain setup without permissions:
- The consensus without permissions provides a high degree of network security, measured in terms of the network hash rate for working test networks such as Ethereum. Through various types of decentralized consensus algorithms beyond proof-of-work, network security is generally higher on unlicensed systems because they allow more node participants, which in turn increases the costs and difficulty of a "double-spending" attack, where a malicious or corrupt actor(s) dominates(n) the computational or voting power of the network, either by bribery or collusion with other nodes or by other means, in order to compromise transactions and records. - In general, the increased network security offered by maximized decentralization of the consensus process can only be achieved in consensus Blockchain networks without permission. It is particularly valuable for anti-corruption use cases, as it increases the cost and makes it more difficult for corrupt actors to unduly affect transactions and records in the system. - For institutions organizing a new application or decentralized service, participation by consensus without permission generally has lower configuration and maintenance costs, since it is not necessary for certain participants to configure nodes to operate the network. In contrast, in an authorized consensus network, the pre-designed nodes, or other parties on their behalf, would have to bear the costs of ongoing configuration and maintenance, security, and software upgrades. It can also be difficult to identify suitable and reliable entities to operate the nodes.	- Transaction throughput and scalability: all things being equal, blockchain networks permission-less consensus participation has lower transaction scalability and throughput, as their consensus algorithms have higher transaction approval requirements. Most of the major permission-less blockchain networks have limited transaction throughput today. The current Ethereum core network can process approximately 15 transactions per second for all global participants and is therefore not currently suitable for large-scale deployment. With network congestion, including that which could be caused by the procurement application itself, the transaction speeds of the solution could slow down. - Transaction fees: permissionless consensus blockchain networks require transaction fees, for performing transaction verification, to compensate nodes or miners. Transaction fees are generally sent along with the transactions in the system the use of transaction fees raises several issues: While transaction fees are generally very low on Blockchain networks, they are variable and can increase rapidly in times of congestion or network stress. The use of cryptoassets for transaction fees can be problematic in jurisdictions where their use is illegal or not explicitly permitted. Transaction fees may compromise supplier anonymity during the bidding period, as suppliers may be required to pay a traceable transaction fee when submitting their bid. - It may not be legal for suppliers to pay additional costs (i. e. transaction fees) to use an e-procurement system. - Power consumption: a proof-of-work Blockchain-based system, such as the current Ethereum, requires substantial electricity consumption and cost. Alternative consensus algorithms, such as proof-of-stake, consume significantly less electricity.

Source: World Economic Forum. Transparency Pilot with the Colombian Attorney General's Office

Table 3 – Advantages and Disadvantages of blockchain configuration network without permissions

2.5 How to do a Blockchain integration[14]?

Blockchain, as a distributed network with singular features, is supported by its nodes that are independent, therefore, initially it would not be necessary to bring the blockchain network to cloud services, however, if the nodes of this network are unstable can generate delays in processing services.

In case the scalability of blockchain's services is required, the services arranged in the cloud can provide the required stability, among other criteria, can bring the required scalability, in this way, an integration between cloud and blockchain can be a solution that allows to scale and ensure the availability of the services.

It is important to evaluate the cases in which it makes sense to integrate in the cloud for the operation of blockchain services, so that this type of solution is used for those organizations that require to increase the capacities and avoid possible difficulties with the existing technology.

To perform an integration, entities must focus on the following three aspects: technical, transactional, and organizational integration.

Technical integration.

It is important to understand how integration and operation can be developed with the existing information technologies, and to see how they mesh with blockchain transactions.

Transactional integration.

Decisions must be made as to what type of records are required to be included in the blockchain. In this regard, it is important to refer to the MinTIC's guidelines on Common Exchange Language.

Organizational Integration

The integration of each participant in blockchain transactions must be contemplated.

[14] This section has been developed from Allen, Eddie (2017), The profound impact of blockchain integration, IBM, https://www.ibm.com/blogs/systems/mxes/2017/07/profundo-impacto-la-integracion-blockchain/

2.6 Blockchain for the creation of Smart Contracts[15]

The concept of "Smart Contracts" or Intelligent Contracts, was defined in 1997 by a cryptographer and jurist named Nick Szabo. At that time, it remained pure theory because blockchain technology did not exist. The emergence of the "blockchain", which makes it possible to execute certain actions programmed in a "ledger" that is shared and validated by several participants to guarantee security, is precisely what has made it possible to turn this concept into a reality [16]".

Smart contracts take the clauses and information from contracts arising from legal relationships, so that through the code the transaction is allowed to develop by storing it in the blockchain, even without the need for intermediaries and achieving consistency in the information so that no unauthorized modifications are allowed.

An example of how a Smart Contract operates, “is the case in which a tenant and a property owner can sign the contract digitally, in which the document contains the agreed rules such as the cost of the rental fee, the regularity of payment, the forms of termination of the contract and other details; once the transaction is completed the record is generated and remained in the blockchain, from that moment the chain of blocks cannot be altered, but it allows its consultation in a simple way showing only the relevant information and protecting personal data as the case may be[17]”.

A smart contract system works "under the premise of "If - then", (IF X happens, THEN Y will happen), so any condition that is contemplated, will mean that an action is executed. An example could be an expiration date or a price that has been reached, or any other key event, which will automatically cause what was stipulated to happen to be executed, a

[15] Section based on the article Quick Guide to Smart Contracts or Smart Contracts, available at the following link: https://www.vass.es/blockchain-guia-rapida-de-smartcontracts-o-contratos-inteligentes/
[16] Vass Company, 2017. Blockchain, fast guide of ‘Smart Contracts’ https://www.vass.es/blockchain-guia-rapida-de-smart-contracts-o-contratos-inteligentes/
[17] Ibídem

payment to be debited from the account, the validity of a contract to expire, etc. [18]".

ADVANTAGES OF SMART CONTRACTS[19]

- Autonomy: It is easy to sign a contract or agreement with legal pre-validated general clauses.
- Trust: documents are encrypted and validated by various agents, making it almost impossible to lose or change them.
- Security: It is guaranteed by the encryption and that the same information validated in several blocks at the same time.
- Speed: As they are self-executing, no third-party intervention or manual actions are required, so there is immediacy.
- Savings: no need to pay a "referee" to ensure that what is stated in the contract is fulfilled.
- Accuracy: to know that what is executed is exactly what the contract says, there are no mistakes when avoiding the intervention of people to carry out the actions involved.
- Backup: there is no possibility of losing the information because it is stored in several different blocks.

[18] Ibídem
[19] Ibídem

2.7 How does Blockchain validate the data?

The validation of the information is carried out through a mechanism called *consensus*. This mechanism defines whether a record or information can be registered in a block.

A blockchain network can "agree" on a transaction in many ways, depending on the scope of the application process that is happening[20], then only the most used "consensus" will be developed, however, in the cited references additional relevant information will be made available regarding the technical aspects in validating the data.

2.7.1 Test Work (PoW)[21]

It is one of the most popular consensuses, and especially used in crypto asset. The nodes show their effort (proof-of-work) competing to solve a complicated cryptographic problem that requires many calculations and, therefore, a lot of computing energy.

2.7.2 Proof of participation (PoS)[22]

The participation test is an alternative to the PoW for public Blockchain. In this case, the nodes validate the new blocks of the chain in a kind of lottery, where the tickets would be the token of turn. This type of mechanism is very agile but can have a disadvantage, for exemple, in those who have more crypto actives, more crypto actives win.

2.7.3 Proof of delegated participation (DPoS)[23]

It is a version of PoS in which the owners of the crypto active choose witnesses (hence its delegated name), allowing a large decentralization that can potentially benefit small owners, but can facilitate possible anti-competitive practices that would promote cartelization, which would go against free and healthy competition.

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[20] Blockchain validation and its types of consensus proof were taken as reference to Zamorano, Víctor (2020). Consensus protocols for blockchain; PoW, PoS and plus: http://www.blockchainservices.es/uncategorized/protocolos-de-consenso-parablockchain-pow-pos-y-mas/

[21] Taken from Zamorano, Víctor (2020)

[22] Ibídem

[23] Ibídem

2.7.4 Proof of Leased Share (LPoS)[24]

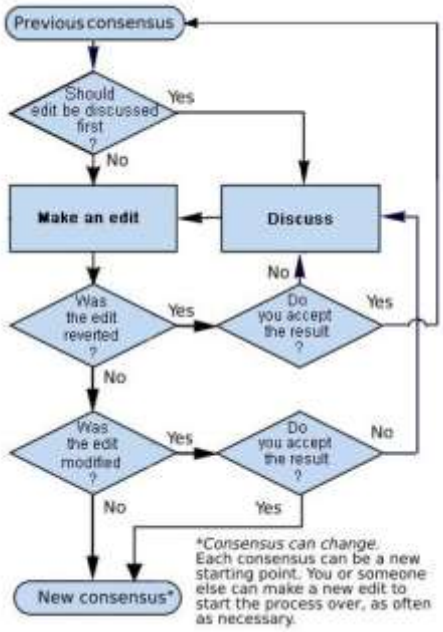
Waves designed this refined protocol to solve centralization problems and vulnerabilities to certain attacks. Small owners "rent" or group their tokens to have more options to generate a new block and earn the reward.

2.7.5 Elapsed Time Test (PoET)[25]

This algorithm, developed by Hyperledger Sawtooth, is suitable for public or private networks; it defines random waiting times to generate new blocks per stochastically chosen nodes. It is very impartial, but it depends on the processing level that the network nodes have.

2.7.6 Practical Byzantine Fault Tolerance (PBFT)[26]

Its name refers to the story of the Byzantine generals. In this case, the generals know and trust each other, simply to produce concepts they generate votes in several rounds. This mode is Ideal for permitted systems (among others used by Hyperledger Fabric, and NEO). The attached figure presents the flow of the consensus process.



Source: Taked from Zamorano, Victor(2020).Blockchainservices.es

Figure 5 - PBFT based consensus process

[24] Ibídem
[25] Ibídem
[26] Ibídem

There are many other distributed algorithms, which can be found in the following attached link:

https://www.verypossible.com/insights/pros-and-cons-of-different-Blockchain-consensus-protocols

3. Open Government and Blockchain

The open government is a new way of acting through which public administrations, by means of action plans, offer information about their management under actions of transparency, accountability, promoting the participation of citizens in the management of public affairs.

This concept is supported by the following three basic pillars: transparency, since the administration must make available to citizens all the information on what they are is doing and how they are doing it, in compliance with the established regulations; collaboration to facilitate joint work between civil society, companies and the administration; and the direct or indirect participation, of citizens, which requires access to information that public administrations must make available to them.

3.1 Transparency[27]

Governments have developed standards on transparency as an essential aspect of promoting open government and guaranteeing people's rights. Through transparency measures, data must be available to the citizen, and in addition, the control of access to this information must be regulated in accordance with the consent of the data owner authorized in accordance with data protection regulations.

Transparency is directly related to the duty of public authorities to make available to citizens the information and data related to their management.

In accordance of this right and principle, Colombia issued Statutory Law 1712 of 2014, which requires public entities and other subjects obliged to have places on their website for access to contents and the disclosure of public information. Likewise, the MinTIC, within the framework of its competences,

[27] Watch link: https://compolitica.com/tecnologia-blockchain-un-nuevo-modelo-de-accion-de-gobierno/

issued Resolution 1519 of 2020, which defines the guidelines applicable to the access and disclosure of public information on the websites and electronic headquarters of the regulated entities.

In order to guarantee transparency, “blockchain technology would allow to have registration systems that facilitate the consultation and follow up of the State's operations, favoring a change in the exercise of the institutional practice that promotes a greater openness to information, allowing the generation of citizen controls and facilitating a greater efficiency in the management of the control entities. Through these registers, a digital identity will be created for each element or operation that will make it possible to know its history and to follow up on it according to the levels of transparency that are established and the granted permits[28]”.

To promote the Open Government, through blockchain, it is necessary to develop the following components:

3.1.1 Traceability

Traceability is the capacity to “verify the history, location, or status of an item through documented identification. The fusion of serialization the assignment of unique identifiers to products ranging from consumer goods to complex medical devices, with intelligent manufacturing and traceability is the first step towards complete end-to-end visibility of supply chains. As products are tracked, the resulting data generates high value and provides a great amount of information that organizations and citizens can use to make better decisions[29]”.

"A case where the use of blockchain in supply chain traceability could have enabled comprehensive tracking and instant identification of all infected romaine lettuces during the 2017[30] coli outbreaks, as reported by the Public Health Agency of Canada. In the specific case, all contaminated lettuces had to be recalled, which demonstrated deficiency of the tracking and tracing process. A more complete, accurate and accountable traceability system

[28] Lucas, Miguel. Blockchain technology. A new model of government action. https://compolitica.com/tecnologia-blockchain-un-nuevo-modelo-de-accion-de-gobierno/
[29] WEF (2019). 5 ways traceability technologies can lead to a safer, more sustainable world https://www.weforum.org/agenda/2019/09/5-ways-traceability-technology-can-lead-to-asafer-more-sustainable-world/
[30] Consult the link: https://www.itbusiness.ca/news/could-blockchain-have-preventedthe-romaine-lettuce-e-coli-outbreak/107481

would have provided substantial visibility of the products and helped make the entire supply chain safer. [31]"

Resource:
To learn more about this use case between the World Economic Forum and the International Trade Center - ITC, please follow the link below:
http://www3.weforum.org/docs/WEF_Accelerating_Digital_Traceability_for_Sustainable_Production_2019.pdf

3.1.2 Data sovereignty

Data sovereignty is "developed from what is known as sovereign identity (SSI)[32], in which decentralization is possible by giving users control, not only of their identifiers, but also of the data associated with them[33]".

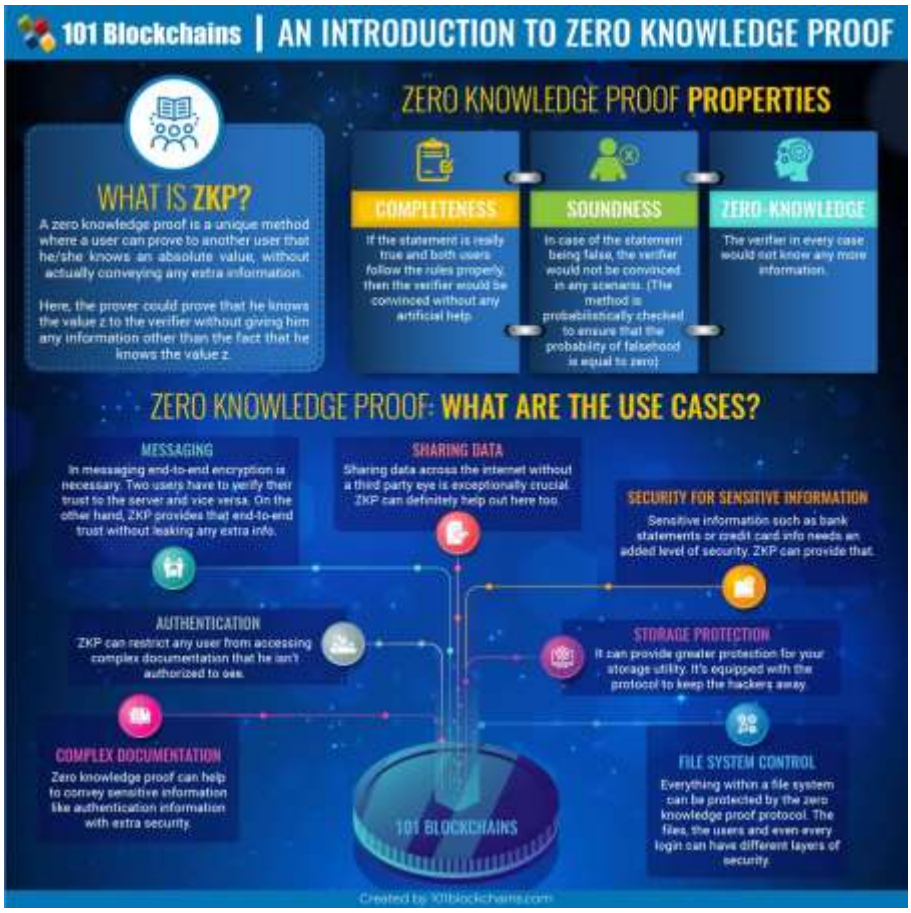
In a SSI approach, you have the possibility to collect all user-related information by having a means to generate, control unique identifiers by providing facilities to store identity data through verifiable credentials, accompanied by storage of transaction history or personal data hosted on a social network, which can even be certified by known individuals.

An SSI approach allows information to be controlled by identifiers, so that identity data is stored through the transaction history of the data associated with the identification of the subject performing the transaction, even allowing users to control how much data they share; it also allows the use of the data to be monetized if this is authorized by the user.

3.1.3 Zero Knowledge Proof-ZKP

Zero Knowledge Proof technology, "a technique that uses cryptographic algorithms to allow several parties to verify the veracity of information without the need to share the data that compose it [34]. The figure below shows the attributes and uses of this information management methodology.

[31] Ibídem
[32] Consult the link:
https://www.euBlockchainforum.eu/sites/default/files/report_identity_v0.9.4.pdf
[33] 3 EU Blockchain (2019), Blockchain and digital identity.
https://www.eublockchainforum.eu/sites/default/files/report_identity_v0.9.4.pdf
[34] Alameda, Teresa, 'Zero Knowledge Proof': How to preserve the privacy in a based data world, BBVA. https://www.bbva.com/es/zero-knowledge-proof-como-preservarla-privacidad-en-un-mundo-basado-en-datos/



Source: 101Blockhains.com

Figure 6- Zero Proof Knowledge Attribute Diagram

A zero-knowledge test must have three different properties to be fully described[35]:

- Integrity: if the statement is true and both users follow the rules correctly, the verifier would be convinced without any artificial help.
- Soundness: if the statement is false, the verifier would not be convinced in any scenario (the method is probabilistically verified to ensure that the probability of falsehood is equal to zero)
- Zero knowledge: The verifier in all cases would not know more information

[35] Anwar, Hazib (2018), What is ZKP? A Complete Guide to Zero Knowledge Proof, 101Blockchains.com https://101blockchains.com/zero-knowledge-proof/#prettyPhoto/1/

3.2 Collaboration

A collaborative government “implies a commitment to provide scenarios of open cooperation between citizens and other agents in the management of public administration. Likewise, this openness to collaboration must also be provided within public entities among their servants, as well as between them and the entities[36]”.

To facilitate collaboration, in blockchain technology is required to promote interoperability. Below are the main elements that make up an interoperable blockchain project:

3.2.1 Interoperability

In the Blockchain technology, the Interoperability is one of the base elements that allows its development and operation. Interoperability is "the capacity of organizations to exchange information and knowledge within the framework of their business processes to interact towards mutually beneficial objectives, with the purpose of facilitating the delivery of digital services to citizens, companies and other entities, through the exchange of data between their ICT systems[37]" .

The crisis caused by the coronavirus Covid-19 has shown the need to increase the exchange of information between entities and organizations, to facilitate the procedures and operation of them. Achieving interoperability is a key aspect so that the uses of blockchain technology can be perceived by users, so that the management and operation of systems interoperate safely and stable.

To achieve interoperability, MinTIC has made available the Interoperability Framework (Figure 10) as a common approach for the provision of information exchange services on an interoperable basis. This framework defines the set of principles, recommendations and guidelines that guide the political and legal, organizational, semantic, and technical efforts of the entities to facilitate the secure and efficient exchange of information.

The attached diagram describes institutionally how the different elements and actors are aligned to ensure the interoperability of systems created by public sector organizations.

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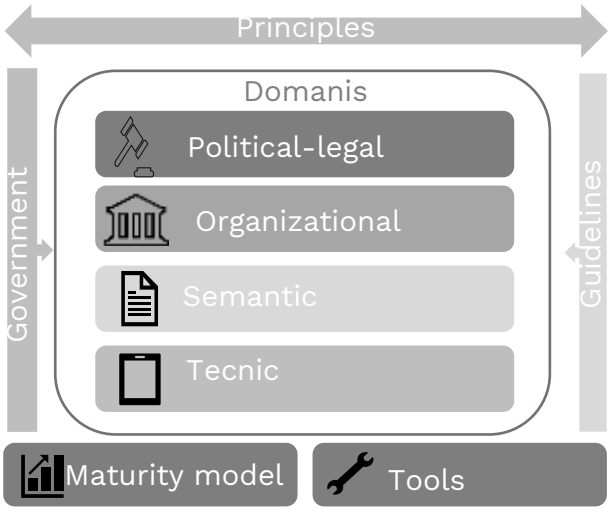
[36] Cordero Valdavia, Magdalena (2019), Blockchain in the public sector, a perspective International, Basque Journal of People Management and Public Organizations https://www.euskadi.eus/t59auUdaWar/t59aMostrarFicheroServlet?R01HNoPortal=true&t59aIdRevista=3&t59aTipoEjemplar=R&t59aSeccion=51&t59aContenido=2&t59aCorrelativo=2&t59aVersion=1&t59aNumEjemplar=16

[37] https://mintic.gov.co/arquitecturati/630/w3-article-9375.html



Source: Interoperability Framework for Digital Government. August 2019. Ministry of Information and Communication Technologies, Vice-Ministry of Digital Economy

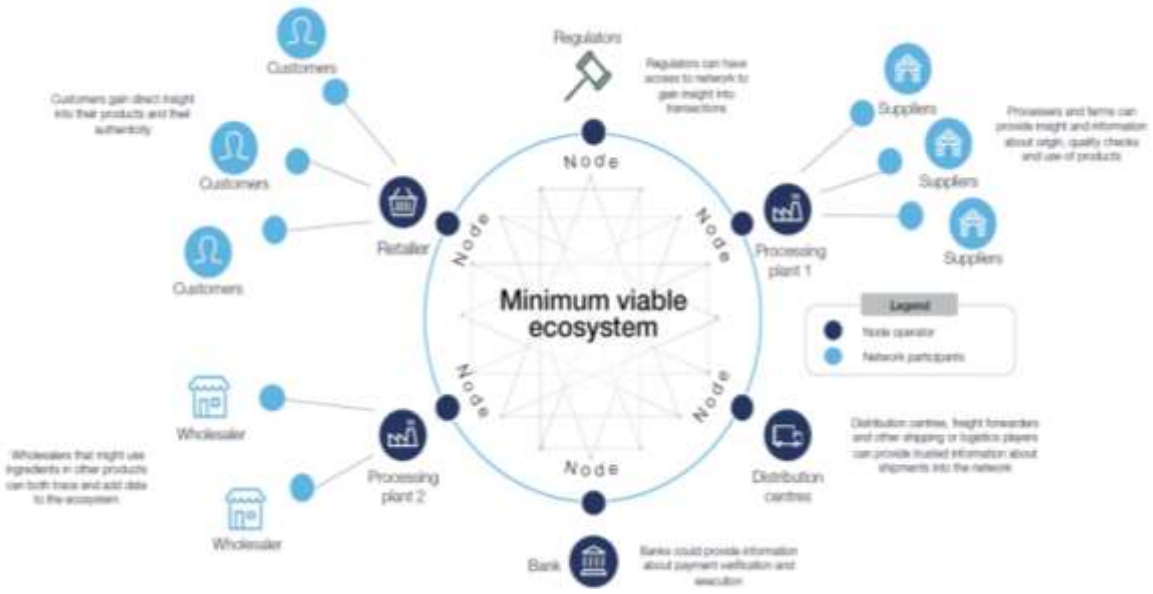
Figure 8- Conceptual model of the Interoperability Framework conceived by the Colombian government

The Interoperability Framework offers a model of maturity, a series of activities that can be used as a reference by entities to share data through information exchange services linked to Digital Citizen Services, with the purpose of facilitating the provision of their procedures and services to citizens, companies and other public entities in the country.

RESOURCE

The complete document of the current Interoperability Framework (August 2019) can be found at this link: https://www.mintic.gov.co/arquitecturati/630/articles-9375_recurso_4.pdf

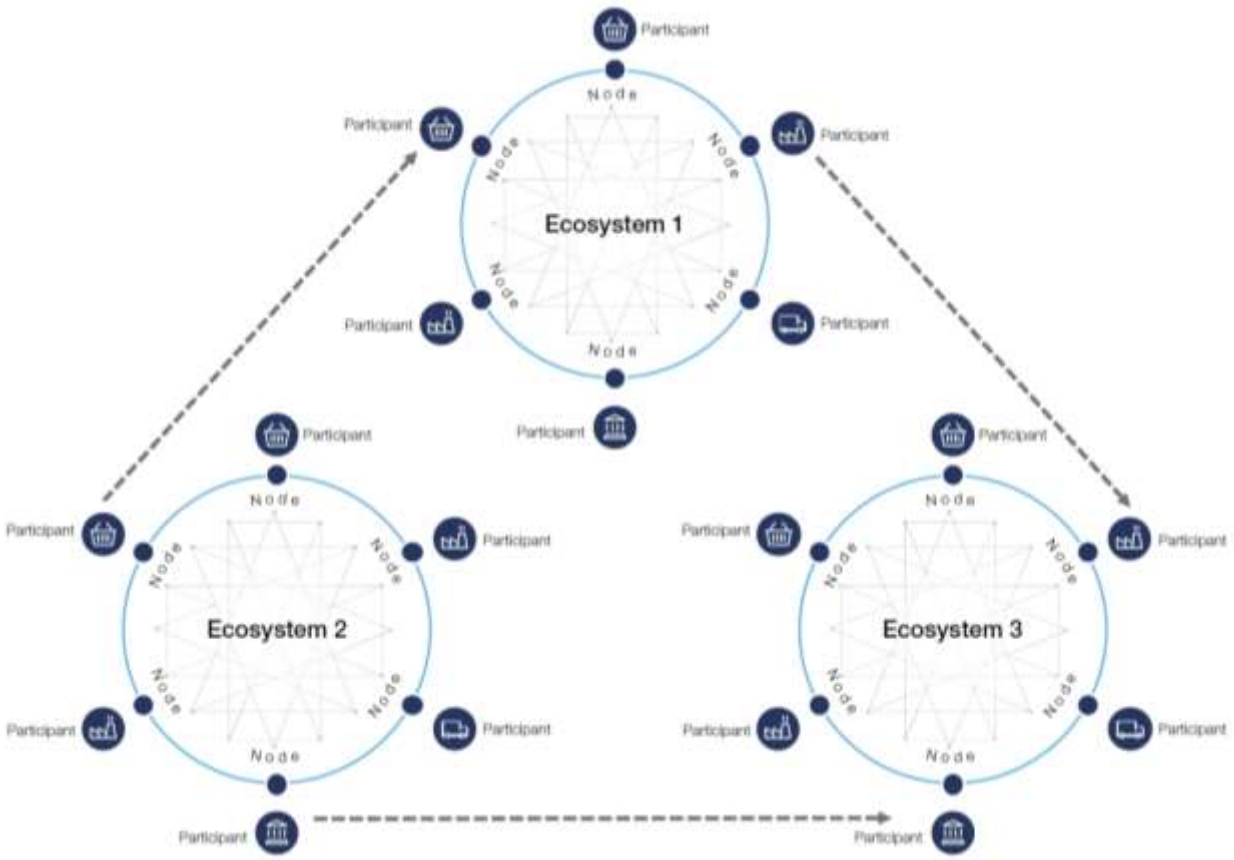
Following the need to implement the interoperability of blockchain services, the World Economic Forum has made available to citizens a detailed toolbox that includes all the edges of a blockchain implementation applied in the context of interoperability, as shown in the figure below.



Source: World Economic Forum, Interoperability Framework

Figure 8 - Interoperability framework in limited Blockchain supply ecosystems

A Blockchain implementation will be integrated and interoperated as shown below:



Source: World Economic Forum- Interoperability model

Figure 9 - Intersection of Global Supply Chain Ecosystems

The different scenarios of interoperability, bring with them 3 different layers that are listed below with aspects that compose them:

Layer	Aspect
Business Model	Governance Model
	Data standardization
	Business Model
	Legal framework
Plataform	Consensus Mechanism
	Smart contract
	Authentication and Authorization
Infrastructure	Hybrid Cloud
	Managed Blockchain
	Proprietary components

Source: World Economic Forum- Interoperability model

Table 4 - Blockchain Interoperability - 3 Layer Breakdown

RECURSE

An elaboration on interoperability is detailed in the document prepared by the World Economic Forum, which can be found at this link: http://www3.weforum.org/docs/WEF_A_Framework_for_Blockchain_Interoperability_2020.pdf

3.3 Participation

Blockchain can facilitate citizen participation through a “system of simple and free access to information, under which, citizen participation can be promoted as a key element of this governance model based on the democratization of information[38]”.

The use of the Blockchain will provide innovative models of public information exchange through mechanisms that make it available in open and accessible formats to increase citizen participation.

Citizen participation is an essential element to ensure democracy and to promote active collaboration in governments.

Citizen participation mechanisms "are closely linked to the new technologies that are being implemented to improve democratic channels and joint processes between institutions and society[39]. In this way, the aim is to develop effective and accessible tools for participation by improving communication between both parties. One of the traditional forms of political participation is elections. And it is a challenge for the government to find secure solutions for electronic, digital, or virtual voting. One consequence of open government is the opening of public data to citizens, which implies the publication of public sector information in formats that allow it to be reused by third parties to generate new value. All the information provided -which must be complete, accessible to all, free and unrestricted, i.e., readable, non-discriminatory and free- constitutes the input for innovation, in addition to increasing government transparency and accountability to citizens [40]".

3.3.1 Digital Identity[41]

A digital identity is an online “presence that represents the will and consent of a user in a technological ecosystem. An identity could belong to a legal entity, a financial intermediary or a physical object. Ideally, a digital identity is verified by an element of trust that confirms the legitimacy of a stakeholder, so that those who interact with that stakeholder's digital identity have confidence that the stakeholder is who and what he says he is[42]”.

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[38] Lucas, Miguel. Blockchain Technology. A new modelo of action government. https://compolitica.com/tecnologia-blockchain-un-nuevo-modelo-de-accion-de-gobierno/
[39] (Shermin, 2017)
[40] Cordero Valdavia, Magdalena (2019), Op.cit.
[41] This section has been developed since https://widgets.weforum.org/blockchaintoolkit/digital-identity/, traducido al español
[42] Ibídem

Digital identity requires a sum of identity attributes to ensure that who is represented in the digital ecosystem is the person who expresses his will to carry out a transaction. There are different attributes that must be evaluated when digitally identifying a person:

- Biometric attributes such as face, fingerprint, voice, among others.
- Attributes of user knowledge: passwords, e-mail.
- Behavioral attributes: patterns of use of information systems and platforms, ways of behaving in a space or with a machine, transactions that are carried out, among others.
- Social or civic attributes: such as national ID, passport number, driver's license number, driver's license number, first and last name, date of birth, address, or state, among others.

3.4 Capacity and resource development

To develop blockchain in the framework of an open government requires the development of capabilities and generate resources to implement blockchain projects.

Listed below are some offers available in the country for capacity building in the development of blockchain projects:

3.4.1 Red UxTIC.co

Through the UxTIC.co Network, the universities have joined to form a Blockchain working group, with the purpose of increasing the levels of adoption and knowledge transfer from the academy. Within the activities of this group was the realization of a university tour, in which 12 universities participated, to make the survey of the projects in the academy or in collaboration with the private or public sector; within the results were found more than 20 projects made by researchers and students, several of them in alliance with other universities or companies in Colombia or abroad.

In addition, the network includes communities such as Token Partner[43], who have conducted a survey of companies working in the sector. What Token Partner observes is that companies struggle to recruit talent, and that it is necessary to promote professional training to respond to the needs of the sector nationally and internationally.

For more information about the Tour, refer to the link:
https://uxtic.co/spip/?-Tour-Universitario-Blockchain-2019-

3.4.2 Jorge Tadeo Lozano University

Blockchain technology promises to revolutionize entire sectors of the economy in the years to come. The engineering, law and economic science faculties want to take advantage of the movement by creating courses or modules dedicated to the blockchain theme, intelligent contracts, and crypto actives among others. There is an expectation around the technology and several universities have already shown interest in the topic. Many have already started to give extension courses. The first university to teach a

[43] See the information in: https://www.meetup.com/es/tokenpartner/

blockchain subject in the Systems Engineering career was Universidad Jorge Tadeo Lozano since the second semester of 2018. From this subject, classes open to the public interested in the subject have been held, with the purpose of involving the speakers that are part of the different Blockchain communities, with the academy.

The open class offered by the university, in permanent cycle, can be found in this link: https://www.utadeo.edu.co/es/evento/academicos/clase-abierta-introduccion-la-Blockchain/home/1

3.4.3 SENA Innova

SENA Innova - Productivity for companies is a call that in the 2020 supports the development of applications for companies. Companies can submit two types of projects: to renew the offer of companies through the development of new products or services or the sophistication of existing ones; and to improve administrative, production or marketing processes, in order to bring the product or service to the customer on time, without extra costs and with better quality.

The resources of the call can be used to co-finance materials, technical personnel, technological services and equipment leasing, among other expenses.

More information:
https://www.sena.edu.co/esco/Empresarios/Paginas/SENA%20INNOVA%202020/Nuestro-Proceso.aspx

3.4.4 Área Andina University Foundation

This university institution offers a diplomado called blockchain, the foundations of a disruptive technology.

The objective is to know how this technology works, the legal framework, and the technology in which it is immersed, as well as its application and strategic use.

The link to this diplomado can be found here:
www.areandina.edu.co/en/content/curso-en-Blockchain-fundamentos-de-una-tecnologia-disruptiva

3.4.5 Bogotá Aprende ICT[44]

The Mayor's Office of Bogotá has launched a comprehensive ICT 4.0 capacity building program. This virtual content will easily offer the meaning of blockchain, its advantages and disadvantages, the areas in which it has the greatest strength, the entry into the financial market, the use of Bitcoin and the impacts on the transformation processes in companies in the digital environment.

3.4.6 Bogotá Chamber of Commerce

It offers a webinar that provides a guided approach to these new technologies of the Fourth Industrial Revolution C4RI, its implications, and recommendations for their understanding and use.

3.4.7 National University of Colombia

This university has developed several courses that are listed below:

Blockchain Technology and Economic aspects[45]

The course seeks to generate in the participants understanding and solid knowledge about how blockchain, Bitcoin, Ethereum works. From its economic foundations to its technological bases.

Blockchain – Creation of intelligent contracts[46]

Through master conferences with itinerant participation, workshops and practical activities, an introduction to the development of applications on blockchain is given, evidencing the potential of this technology, and presenting possible applications in different sectors of the economy.

Additionally, there is a TEDx talk that took place in the city of Barranquilla, which talks about how trust improves in government if we use blockchain technology. It gives an overview about the trust of citizens in their governments and what can happen if the trends continue. Examples from that talk are explained in this guide and references to how these pilots were conducted.

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[44] Watch the link of the program: http://www.bogotaaprendetic.gov.co/cur3.html

[45] The information is available in the following link https://bogota.unal.edu.co/noticias/actualidad/curso-tecnologia-Blockchain-y-aspectos-economicos/?tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Baction%5D=detail&cHash=3969354d6c0cbe442d15c8c89730ce44

[46] The information is available in the following link https://ingenieria.bogota.unal.edu.co/uec/?p=9749

For more information, please visit the following link:
https://youtu.be/gDJBQwTkdc4

3.4.8 Javeriana University [47]

The University in virtual mode has this course which is listed below:

Fundamentals of Blockchain Technology
In this course we will explain in detail what is bitcoin and what is blockchain technology, as well as its main applications and the challenges to achieve its adoption. The importance of this course is in the contents that it develops, since besides putting in context the circumstances under which the blockchain technology arises and the way it works, it opens the panorama to the applications and possibilities of this technology in real uses, both current and future.

3.4.9 EAFIT University

The Faculty of Economics and Finance advances the course of Introduction to the blockchain and impact on the financial market.

3.4.10 Andes University

From the Faculty of Economics, it is proposed the following course:

Blockchain: beyond Bitcoin

The technological development of data encryption methods through non-centralized systems, known as blockchain, has allowed the problem of trust to be solved outside traditional institutions.

Blockchain eX Innovation Center

Its mission is to accelerate and facilitate the adoption of technologies, articulating and creating initiatives together with the public and private sectors, academia and society in general through its pillars of Innovation and business transformation, exponential transformation and the so-called Journey 4.0 which is based on the principles of digital mindset, strategic understanding of the fourth industrial revolution - 4RI and how to take action to materialize the iniciatives.

[47] The information is available in the following link
https://educacionvirtual.javeriana.edu.co/fundamentos-de-la-tecnolog%C3%ADa-Blockchain

3.5 Examples in the implementation of blockchain around the world

3.5.1 Around the world

Governments can leverage blockchain technology to deliver cybersecurity, process optimization, integrate services in a 'hyper-connected' way while strengthening trust and accountability. The Distributed Registry format can be leveraged to support a range of applications in the public sector, including digital cash, payments, land registration, identity management, supply chain traceability, healthcare, chamber of commerce registration, tax, voting, and legal entity management.

The following are some international best practices on the use of blockchain in government, implemented between 2017 and 2020[48]:

3.5.1.1 North America

CANADA

- The National Research Council of Canada (NRC) announced that it had built an Ethereum blockchain scanner to experiment with transparent management of government contracts and reliable data sharing with the public.
- The Government of Canada (GC) is using project-based blockchain technology to issue employees with a kind of resume or digital resume, which provides "a permanent, proprietary and secure record of their skills and experiences."

Mexico

- The Mexican government plans to conduct a public recruitment procedure in a blockchain network.

[48] The following cases are taken from Consensys, Zug Digital ID: Blockchain Case Study for Government Issued Identity, https://consensys.net/blockchain-use-cases/government-and-the-public-sector/zug/ https://consensys.net/blog/enterprise-blockchain/which-governments-are-usingblockchain-right-now?_ga=2.43621152.461112524.1598642409-1754052997.1598642409, Which Governments Are Using Blockchain Right Now?,

- The digital government unit of The Secretariat of the Civil Service of Mexico launched HACKMX, a project that takes advantage of blockchain technology to track and validate public contract bids.

United States

- The Defense Advanced Research Projects Agency (DARPA) is creating a blockchain cyber security shield, a blockchain-based platform for transmitting secure messages or processing transactions that can be tracked through numerous channels. The application will be used in a variety of ways to facilitate communication between units and headquarters and for transmiting information between intelligence officers and the Pentagon.

- The U.S. Air Force implemented the Blockchain Approach for Supply Chain Additive Manufacturing Parts (BASECAMP) project to ensure long value chains with distributed accounting technology.

- The U.S. Department of Health and Human Services (HHS) invested $49 million to build Artificial Intelligence and Blockchain solutions to reduce costs and operational backlog.

- The United States Postal Service (USPS) filed a patent for incorporating blockchain technology and digital certificates to authenticate user information and more recently proposed to facilitate the day

- The Food and Drug Administration (FDA) launched a pilot project that explores the utility of blockchain in secure tracking and verification of medical prescriptions.

- In 2014, the U.S. Internal Revenue Service classified digital currency as property.

3.5.1.1.2 South America

Argentina

- In Argentina, a digital identity project for inclusion based on blockchain was announced, with the aim of improving citizens' access to government services.

3.5.1.1.3 Europe

Austria

- The Austrian government inaugurated the new Research Institute of Cryptoeconomics, which will support blockchain's research projects through an 8-million-euro fund.

Estonia

- The Estonian government has already been testing the technology since 2008 and was the first country to use blockchain nationally.
- The e-Estonia program created by the government has 99% of the services offered online, 44% of Estonians use online voting, 98% of tax returns are filed online and 98% of Estonia has a digital ID, with more than 700 million digital signatures. 99% of health data is digitized and stored in a chain of blocks,

Georgia

- The Republic of Georgia launched the first blockchain land registration system with the aim of strengthening the rights of landowners, improving citizens' trust in government, and reinforcing data security. Currently there are more than 1.5 million property titles registered, with an average registration time of 3 minutes.

Germany

- The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH established a 'Blockchain Lab' to harness the potential of blockchain and related technologies in the efforts to achieve the UN Sustainable Development Goals.

Lithuania

- The Central Bank of Lithuania launched a sandbox to develop products and solutions based on Blockchain. More than 21 registrations from several countries of the European continent were registered.

Luxembourg

- The Infrachain project creates a governance framework that enables blockchain applications to become operational in today's regulatory environment.

Malta

- Malta's Registrar of Companies will adopt blockchain technology with the aim of increasing efficiency and modernizing business processes.
- The Maltese government tested a credentials program based on blockchain that instantly verifies academic credentials.

The Netherlands

- The City of Groningen launched a proof of concept to help citizens regain financial control over their debts through a variety of services, including debt assistance, debt prevention and income management. The project stores GKB clients' changing financial status in a private blockchain, along with bills and income payment information from outside partners.

Slovakia

- It has a public bidding portal based on blockchain technology.

Spain

- The Ministry of Energy, Tourism and Digital Agenda co-finances the project TrustForWills, a Smart Contract platform for the management of digital assets using blockchain.
- The government of Cataluña launched an autonomous identity project, called IdentiCAT. The "IdentiCAT" can be privately managed by citizens.

Sweden

- The Swedish Land Registry (Lantmäteriet) is testing real estate transfers and other "multi-party" transactions on Blockchain.

Switzerland

- In partnership with the ConsenSys uPort, the municipality of Zug tested a government-issued sovereign identity on the Ethereum blockchain. The reference to the full use case can be found at this link: https://consensys.net/Blockchain-use-cases/government-and-the-public-sector/zug/

Ukraine

- The Ministry of Finance of Ukraine tested a test auction using blockchain technology.

United Kingdom

- The UK Food Standards Agency (FSA) completed a pilot to track meat distribution in a cattle slaughterhouse using blockchain. This test marked the first time that the blockchain traceability technology has been used as a regulatory tool to ensure compliance in the food industry.

3.5.1.1.4 Africa

Ghana

- The government of Ghana, in partnership with Bitland, launched a pilot project to register land in a blockchain. Over 78% of Ghana's land is unregistered. The project had now been tested in 20 communities in Kumasi by 2018.

Mauritius

- The government of the island of Mauritius has created a Regulatory Sandbox License (RSL), which allows external investors to develop blockchain-based solutions under the supervision of the Mauritius Board of Investment.

Sierra Leone

- The government of Sierra Leone, in cooperation with the non-profit organization Kiva, launched a blockchain platform for credit history.

SouthAfrica

- The South African government has established a crypto asset regulatory working group to investigate concepts related to blockchain.
- The South African National Blockchain Alliance (SANBA) was formed to establish a partnership between government, business, academia and civil society to support the use of blockchain technologies in the South African context.

Tanzania

- The Tanzanian government eliminated 10,000 ghost workers from the public sector by using blockchain technology to audit the public payroll. This step has saved about 4.5 billion Tanzanian shillings (USD 195.4 million), which are paid monthly to the ghost workers.

3.5.1.1.5 Asia

China

- Xiong'an launched a 6,667-hectare forestry project. An online platform based on blockchain, big data and other high-tech traces and manages the life cycle of trees.
- The State Information Center, Union Pay, China Mobile and three other organizations launched Blockchain Services Network (BSN), a nationwide blockchain infrastructure project that was conceived as the "Android or Apple IOS system" for blockchain.

Hong Kong SAR

- Hong Kong's financial department has published new rules for crypto actives exchanges to be licensed. One rule stipulates that encryption exchanges do not need a license from the Securities and Futures Commission (SFC) to operate if they do not trade any product defined as a value.

India

- The Minister of State for Electronics and Information Technology has identified blockchain technology as a key research area in domains such as governance, banking, finance, and cyber security in a draft approach paper. The document also presents a national blockchain framework, which analyzes the potential of distributed accounting technology and the need for a shared infrastructure for different use cases.
- The Government of Maharashtra and the Department of Revenue partnered with an open source hybrid block chain platform to complete a proof of concept for land records in the block chain.

Malaysia

- The Malaysian Digital Economy Corporation (MDEC) announced that it is piloting a work visa program for technology freelancers to work in Malaysia on a short-term basis to meet the demand for talent with artificial intelligence, blockchain and cyber security capabilities.

South Korea

- The South Korean Customs Service launched a blockchain-based clearing system for the management of import and export shipments.

Thailand

- The State Railway of Thailand and the Thailand Post Office will develop and apply Internet of Things (IoT) technology to track train arrivals and departures and blockchain technology to track high-value parcels.

Australia

- The Commonwealth Bank of Australia issued a cryptographic bond for the Queensland Treasury Corporation.

- The Australian Securities and Investment Commission (AISC) published a regulatory information sheet INFO 219 for companies considering operating market infrastructure or providing financial or consumer credit services using distributed accounting technology.

The European Commission's EU Blockchain Forum and Observatory has a very interesting map of public initiatives that can be check online. Leave the link for an interactive map here: https://www.euBlockchainforum.eu/initiative-map

Source– EUBlockchain

Figure 10 - Governance initiatives supported by the European Commission's EUblockchain Forum and Observatory

3.5.2 In Colombia

3.5.2.1 Fighting corruption using Blockchain[49]

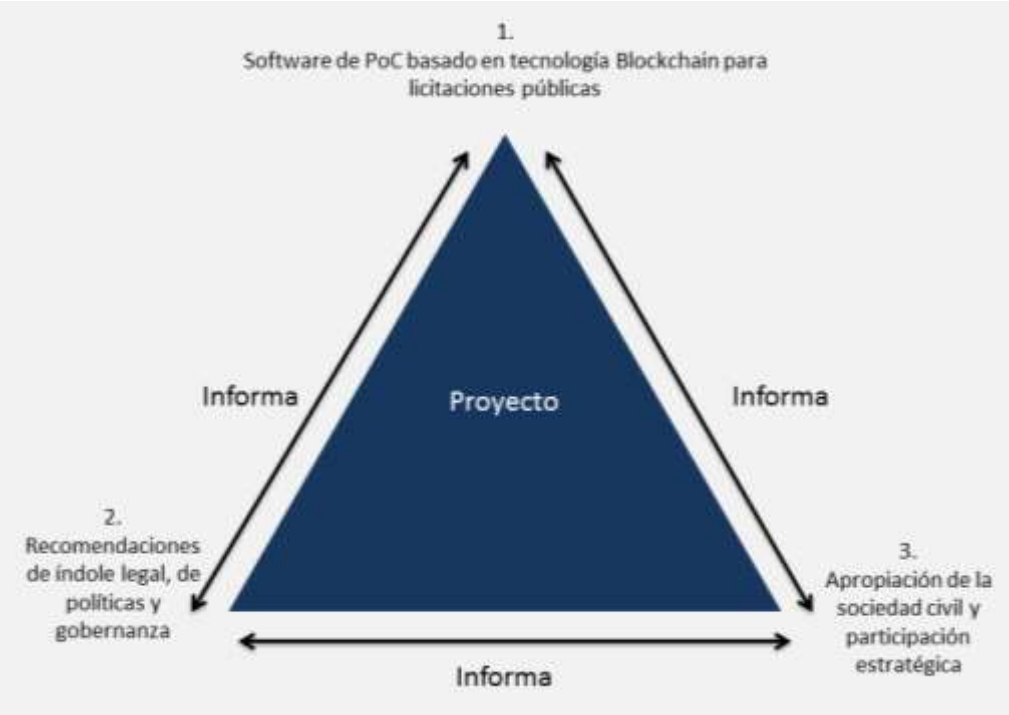
In Colombia, a pilot project has been carried out that brought together various international and global actors and is a success story in the framework of the World Economic Forum - WEF, where the blockchain technology is proposed as an effective solution against corruption. 50 in the bidding processes in a joint work with the Attorney General's Office.

In partnership with the Inter-American Development Bank (IDB) the Office of the Attorney General's Office (Procuraduría General de Colombia), and WEF has led a multi-stakeholder team to investigate, design and test the use of blockchain technology for government processes susceptible to corruption, establishing itself in the case of the use of public procurement[50]. The project, led by the Blockchain and Digital Currency team located within the World Economic Forum Center for the Fourth Industrial Revolution, is called unblocking government transparency with the blockchain technology.

The attached figure shows the approach of the project, with 3 fundamental components:

- PoC (Proof of Concept) software based on blockchain technology for public bids
- Legal, policy and governance recommendations
- Civil society ownership and strategic participation

[49] This section has been developed from; http://www3.weforum.org/docs/WEF_Blockchain_Government_Transparency_Report.pdf
[50] It is suggested to consult the following link: https://www.weforum.org/reports/exploringBlockchain-technology-for-government-transparency-to-reduce-corruption



Source: World Economic Forum – WEF_Blockchain Transparency Report

Figure 11 – Project Approach

The PoC software was developed during the second half of 2019 by a team of engineers from blockchain within the InTIColombia Research Group of the National University of Colombia. It was developed to reflect technical, policy and civic engagement specifications and guidelines that were carefully designed jointly by the project's diverse, multi-stakeholder global expert community. At the same time, the technical development of the PoC itself raised several questions regarding policy and community engagement. Thus, while each of the three elements of the project's approach is a distinct aspect, the three informed each other critically.

3.5.2.1.1 Project description and scope

The Transparency Project has its roots in the development of a proof of concept (PoC) software for the procurement of the PAE public school meal program in Colombia. Background information on the PAE is provided in the Supplemental Research Report. Being rooted in a software PoC, the project adopts a bottom-up approach to investigate and discover the technology and governance trade-offs, possibilities and limitations involved with a blockchain-based public procurement system whose main objectives are to increase transparency and accountability and, thus, to reduce instances of corruption

3.5.2.1.2 Potential vulnerabilities to be considered

PoC (Proof of Concept) software seeks to improve the bidding and supplier selection phase of public procurement through specific channels:

1. Permanent and tamper-proof record keeping
2. Transparency and auditability of procedures in real time
3. Automated functionalities with "intelligent contracts
4. Less dependence on discretionary decision making by centralized entities and authorities
5. Greater citizen participation

The project hypothesizes that by combining these five capabilities into one software solution and matching them with complementary policies and governance systems, governments can implement a more transparent and accountable e-procurement system that will help stop widespread corruption.

3.5.2.1.3 Governance considerations and guidance

A clear legal framework based on international best practices and effective participation and oversight from stakeholder is required. While country specifics feature and industry context make detailed policy proposals impossible, this section highlights policy solutions that can complement and magnify the anti-corruption capability of an e-procurement system, whether blockchain-based or not. Below are some policy proposals reflecting best practices advocated by the Open Contracting Partnership (OCP), the Open Data Charter, the OECD, the United Nations, and the WTO.

These policy proposals are intended to identify some concrete ideas and initiatives that would capitalize on the information dissemination capacity of blockchain-based procurement to increase responsibility, accountability,

transparency, corruption prevention, and equity throughout the procurement process. The purpose of the project is to build a comprehensive e-procurement center to achieve the following objectives:

i. Remove legal barriers: Laws that effectively limit the use of electronic procurement platforms, such as those that require in-person interactions between bidder and supplier, or require paper-based bidding, should be reviewed.

ii. Require the use of the hub: the use of a new electronic procurement platform should be widely promoted, which is feasible to force behavioral change away from in-person procurement processes and consolidate all transactions into a single database or registration system.

iii. Make the hub comprehensive: the e-procurement system itself or an affiliated website should contain all relevant information about the procurement process, including procurement policies, procurement officer codes of conduct and special interest disclosure requirements, notices about upcoming auctions, bidding documents, bidding suppliers, award and rejection criteria, award notices, contract details, and supplier "blacklists" and "whitelists". In addition to the initial procurement auction, all post-award contract renegotiations must be documented on the blockchain platform.

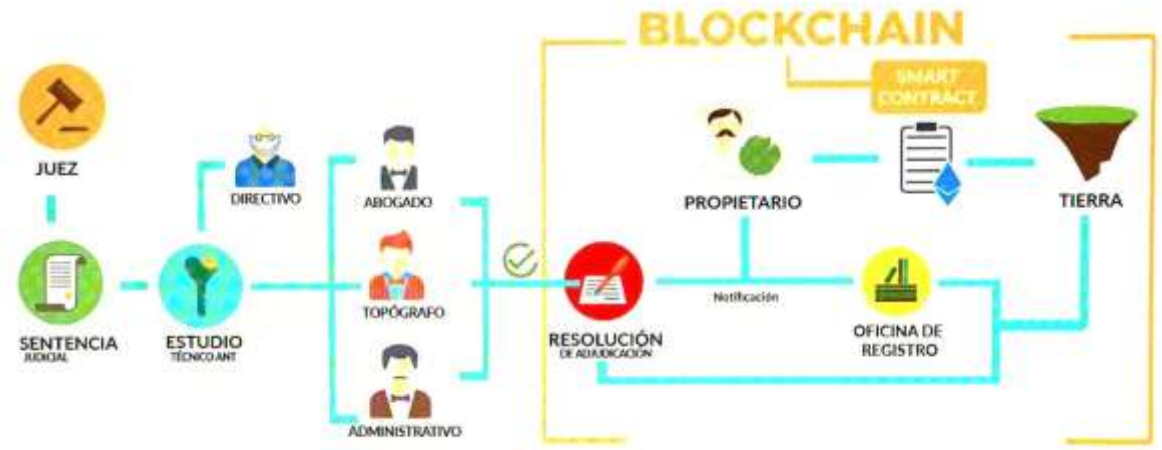
iv. Making information accessible: all this information must be free and accessible to the public, both structurally and cognitively. There should be no access costs or registration walls, and the content of the site should be searchable and downloadable. Existing e-procurement websites, such as Open Public Contracts in Slovakia and Tender Monitor in Georgia, provide plans for such a platform. Both websites, developed by Transparency International's national chapters, exemplify the power of publicly available, concentrated procurement data by allowing users to search for key signs of corruption, such as repeated bid winners, single bidder auctions, and procurement contract details. Even if the public does not regularly visit such a resource, the accessibility of high-quality reporting data drives citizen oversight activities.

3.5.2.2 Blockchain Lands

This project was carried out between April and August 2018, led by the National University of Colombia with the support of Colciencias, the Ministry of Information Technology and Communications, and the National Land Agency (ANT).

The project developed a prototype that allows the encrypted storage of documentation and supports of the restitution land adjudication process, mitigating risks of manipulation, non-consensual adjustments or omission of resolutions after their issuance by the Agency, becoming the first State entity to use blockchain technology in public policy.

The following diagram presents the governance behind the process, shows the flow of the selected procedure and where the prototype has an impact. This starts with the generation of the Adjudication Resolution by the ANT and ends with the notification of beneficiaries and consultation by the Public Instruments Registry Office (ORIP):



Source: elaborado por el proyecto, 2018.

Figure 1 – Process flow and associated governance

In the attached link, you will find the application's MockUp (simulator):

https://www.agenciadetierras.gov.co/wp-content/uploads/2018/09/Mockup-Block-Chain-Tierras.pdf

In its conclusions, it is specified that, regarding digital identity, the prototype established some first tests that allow to connect the facial recognition, through an ID stored in blockchain, with the roles and

permissions of lawyers, administrators and owners to register or access the information of each

award resolution. It is effectively an additional security layer that allows officials and citizens to identify themselves in a reliable, traceable and secure way in relation to the procedure that is the object of the prototype. This means that, with very well-defined roles, for each scope of a given process (which is programmed in the Smart contract) friction is reduced and the efficiency of the interaction grows exponentially, reducing costs and thus expanding the resources available to have better coverage of the services.

The complete executive report can be found in the attached link:

https://www.agenciadetierras.gov.co/wp-content/uploads/2018/09/Informe-Ejecutivo-Block-Chain-Tierras.pdf

3.5.2.3 RITA

The possible applications of this new technology are wide and diverse. Below are a series of projects developed on the infrastructure of RITA, the Advanced Technology Research Network of the Universidad Distrital Francisco José de Caldas. One of the projects was sponsored by MinTIC.

Blockchain projects supported by RITA

- Integrity of Diplomas with blockchain: Project developed with the support of UNDP and MinTIC that allowed establishing the possible uses of Blockchain to improve security in administrative acts before the state, increasing security factors in terms of document integrity, authenticity of people and traceability of operations.
- Monitoring system for the school feeding program secured with blockchain: Hackathon winning prototype to establish control mechanisms, monitoring and transparency around the PAE using open data and blockchain.
- Notarial System over Blockchain: Prototype design of Colombian Notarial System over blockchain to speed up notarial procedures through the internet maintaining high security standards and transparency using this technology.
- IoT with Blockchain: Support to produce research articles on the interaction of blockchain with intelligent cities and IoT devices, based on developments on the infrastructure of RITA at the Universidad Distrital.

- Blockchain Laboratory: Creation of a network of blockchain nodes for research accessible from the different sites of the Universidad Distrital.

- Support to undergraduate, masters and doctorate students: Orientation, advice and training in blockchain technologies to the academic community of the Universidad Distrital, strengthening the development of degree projects in the different levels of training.

3.5.2.4 Bank of the Republic

The company specialized in Distributed Records Technology (DLT), R3 made[51] an alliance with Banco de la República Colombia, for the development of the blockchain Corda platform, focused on its use for the exchange of values.

The company established the need for this alliance with the public entity, confirming the potential of blockchain technology for financial services in Latin America, which is based on a collaborative model of public-private work is crucial to accelerate the implementation of DLT business platforms, such as Corda.

Corda has generated the interest of the central entity to employ it in payment services.

3.5.2.5 XM ISA Group

EcoRegistry

EcoRegistry is a self-funded private initiative and registration platform for emission reduction projects. Users of the platform register the project and go through the validation, verification, and certification processes. This enables the issuance of credits that can be transferred and withdraw as carbon offsets. End users can withdraw these credits for voluntary GHG offsets, carbon tax or any other reason. EcoRegistry is based on a distributed ledger technology (DLT) that enables transparency for carbon offset accounting and supports security and traceability in the management of information associated with CO2 emission reduction projects.

The platform was sought to add transparency, security, traceability, and robust implementation of rules to provide the accountability and

[51] The Bank of the Republic of Colombia will explore exchange of values with Blockchain, october 2019 https://www.colombiafintech.co/novedades/banco-republica-de-colombia-exploraraintercambio-de-valores-con-corda-de-r3

transactional efficiency required by regulators, investors and carbon credit market participants.

The way EcoRegistry implements DLT is through a permissioned or private network that has been implemented under Microsoft Azure's Blockchain-Multichain ecosystem. The system has different uses for this technology. First, from the documentation supporting each validation, verification and certification step, the hash is obtained and stored as proof that the documentation is not modified during the lifecycle of the record. Second, the hash is supplemented with a Blockchain-based digital signature of the validator, verifier, and certifier according to each step. When the certification process is finished, an independent number of tokens is generated according to the emission reduction. The tokens reach the wallet of the project owner, where they can be transferred to another person. Finally, during the retirement process, the tokens are sent to a Burn Address where they cannot be recalled. The private key of this address is unknown, but the balance can be requested at any time for a detailed accounting process. The whole process achieves redundancy and validation of the information associated with the projects.

EcoGox

EcoGox is a system for certification, registration, monitoring, tracking, transfer and redemption of renewable energy certificates, which can describe the type of energy source consumed by an end customer. The recognition of generation attributes for the issuance of renewable energy certificates represents an opportunity for the end customer to make a conscious choice of the type of source from which they wish to consume their electricity.

Through the following points, EcoGox participants recognize the guiding principles that bring clarity and reliability to the ecosystem:

- Accuracy
- Uniqueness
- Immutability
- Traceability
- Transparency
- Technological Implementation

A platform was sought that would allow the traceability of each attribute of generation by renewable energy sources, guaranteeing transparency and

reliability in the system, thus meeting the requirements of the renewable energy certificate market.

EcoGox implements DLT technologies through a private or permissioned network with similar behavior to the blockchain solution found in EcoRegistry. It uses a Multichain-based network supported by Microsoft Azure. Initially every company registered on the platform receives a wallet that will allow them to transact with Renewable Energy Certificates (RECs). These companies have different user roles that allow them to perform different procedures such as transfer, generate or redeem. A generator can enter a new project by attaching the necessary information and documentation that will then go to verification to assign an identity in the blockchain network to the project, once this is done the generation of that project can be entered month by month, this process is verified and subsequently tokens equivalent to the amount of energy generated in that month in KWH are created. These new tokens or serials can be transferred to other users of the platform or can be redeemed to end customers who wish to certify the origin of their electricity consumption. Once a number of CERs are redeemed, they are sent to a Burn Address from which they cannot be retrieved, but their balance can be accessed for accounting and auditing purposes.

CumbiApp (Prototype)

CumbIApp is a cashless platform based on the Ethereum blockchain, which seeks to implement the payment of government aid and programs in a reliable, secure and transparent way. This platform for purchases and payments through tokens with its own characteristics will allow companies or government entities to optimize and control purchases made through resources allocated by economic aid programs such as food aid, housing, medicines, among others for the case of the government or own tokenization systems in the case of companies or private entities. CumbIApp uses artificial intelligence and analytics to improve the allocation of resources, purchase recommendations in the application, among others.

The App allows that the resources or government aid delivered to citizens are allocated in a transparent and secure manner, in addition to maintaining traceability on the use of these, to prevent them from being used incorrectly or maliciously.

CumbIApp uses the Ethereum blockchain to implement smart contracts that guarantee the properties of each token issued on the platform. Each user registered in CumbIApp receives a wallet where he stores his tokens,

which are divided into merchant categories (transportation, food, medicine, housing, among others). Each category has an associated whitelist of users and token-enabled establishments. These whitelists are supported by Smart Contracts in Ethereum that guarantee that the tokens can only be used in a certain group of products and territories for which they were designed in their issuance. The Ethereum ERC1155 standard is used for the issuance of the tokens, this standard allows the issuance of fungible and non-fungible tokens, as well as optimizing the cost of transactions and enabling the issuance of multiple tokens in the same Smart Contract.

4. Possible Cases of Use in blockchain applicable in Colombia

4.1 Government services

The applications for government of blockchain technology are diverse and very promising. If we consider that the government can be conceived as a great information manager in the society, we can identify some of the sub-sectors in which blockchain has a preponderant position in the game. The following are just some examples of the many in which this technology can bring great benefits:

4.1.1 Health

The cases of use in health are very diverse, one of the most significant is that of clinical history to the protection of the supply chain of medicines by protecting them against counterfeiting.

On the other hand, there are projects to directly connect patients with doctors, through management systems based on blockchain that handle the appointments of specialists, the PQRS (with the help of artificial intelligence) and the patient database to make health management more efficient, increasing the employability of doctors and reducing time to users.

4.1.2 Voting systems

A blockchain-based system will offer unique transparency that limits possible illegal practices and behaviors during election times. Blockchain can help improve democracy, through the development of applications that enable electoral transparency and digital voting.

The ubiquity that blockchain provides to interact with an information system that requires the highest degree of authentication, is the perfect ingredient for the fusion of technological standards and practices to be established and the good exercise of democracy.

A practical example carried out in Bogota in 2018, supported and awarded by MinTIC, was carried out with the election of *personeros* in two educational institutions, in which the existing electoral process was developed under blockchain technology.

The High District Council of ICT and the District Secretary of Education, through ViveLab Bogotá, developed an experimental process for the development of digital elections of student representatives, using blockchain.

The infographic below, shows the summary of the process.

Source: Premios Índigo a la Innovación Pública Digital

Figure 13 – Resumen proceso de elección de personeros

4.1.3 Education

In the educational field, we can mention the existing problems with the certificates and degrees of the universities, as far as the falsification of these is concerned. Blockchain puts a definitive end to this practice.

The same can happen with the students' transcripts, which, once put in the system by the teachers, should not be susceptible to further changes

4.1.4 Property registration systems

In Colombia, a first pilot was carried out with the National Land Agency. As evidenced in the section on international use cases, blockchain technology is

beginning to be used in many countries around the world to secure land titling.

4.1.5 Using Digital Identity with Blockchain applications[52]

Public administrations are not only the source of key identity information for citizens (from birth to death certificates), but also need to identify them unambiguously to offer them services. This also applies to companies or associations and increasingly to machines and other agents.

The now so popular procedures of Customer Recognition or KYC (Know Your Customer) would be unnecessary for the procedures before the state because the sovereign and protected digital identity on the blockchain becomes the unique reference point for all types of procedures between the citizen and the public sector.

4.1.6 Blockchain for the orange economy

In the framework of the orange economy, good use can be made of blockchain technology to support the protection of our artists' musical creations. For the same reason that the technology allows the elimination of intermediaries.

The examples in this case come from private enterprise, in a disruption as portable digital music players were to the industry of physical media producers to listen to it.

Warner Music has joined an $11.2 million investment in a new blockchain network called Flow, created by Apple's global head of music initiative strategy and Warner Music's[53] former senior vice president of business development, who says, “The main goal is to create new ways for fans of our artists to explore their fandom and engage with artists in new and different ways that they haven't done before[54]”.

[52] Case taken from Cordero Valdavia, Magdalena (2019), Op.cit.
[53] It is sugest to consult this link: https://www.forbes.com/sites/michaeldelcastillo/2019/09/12/exclusive-from-cryptokitties-tocardi-b-warner-music-joins-11-million-investment-in-ethereum-replacement/#661b757b2b21
[54] Madeira, Antonio (2020), Blockchain disrupts the music industry and causes it to change tone https://es.cointelegraph.com/news/blockchain-to-disrupt-music-industry-and-make-itchange-tune

Source: Own elaboration

Figure 14 – Example of a simple Blockchain ecosystem

PART II:

IMPLEMENTING BLOCKCHAIN

5. How to implement a Blockchain project?

The goal of this guide is for interested institutions to start implementations and pilot processes that will transform their management in a positive way. As any project, some essential components are required to achieve this goal. Based on the project management of agile systems that produce results relatively quickly[55].

It is necessary to emphasize that conventional project management, which applies to infrastructure projects, for example, is not enough to encompass the concepts and the way in which the digital transformation is carried out. When implementing blockchain, you should consider what resources exist to develop them, and identify possible barriers and limitations to implementation.

In this section we will address both aspects in a general way, and it will be described in detail each of the implementation stages for the blockchain cycle life development project.

Before starting each of the stages, some preliminary steps to implement a blockchain project will be developed below.

First, for the blockchain PoC framework to be successful, the specific problem to be addressed must be stated. It is relevant, develop the ideas starting from those benefits that would be obtained by the user, and putting the user and the citizen at the center of the design.

In this regard, ask yourself What should be the steps for a successful blockchain implementation? Observe the following steps[56]

[55] Roselló Villán, Vanessa (2019) The more used methodologist and its advantages in the enterprises. https://www.iebschool.com/blog/que-son-metodologias-agilesagilescrum/#~:text=Por%20definici%C3%B3n%2C%20las%20metodolog%C3%ADas%20%C3%A1giles,las%20circunstancias%20espec%C3%ADficas%20del%20entorno.

[56] Taken from https://101blockchains.com/blockchain-proof-of-concept/, translate to spanish

Take small steps, avoid scope changes

An important aspect to contemplate, which companies and public institutions are faced with, is the need for the solution to be incremental in scope. When choosing what features, it may need for blockchain proof-of-concept, many choose to embrace a lot from the start.

However, making a flashier entry into the market will not mean 100% success. The key is to have a project management office that seeks to keep the scope within the stipulated boundaries of the project, for which, it is important to keep an eye on:

- Get the features you can deliver, not the ones you can't.
- Don't try to do everything at once. Take small steps. In fact, taking small steps help avoid any risk factors.

Connect all ideas and control them

It is required to have a team that supports the idea and helps to find a compact solution, however, it may happen that not all people in the team share the same idea, however, it is necessary to also contemplate the opinion of those who have different ideas and visions regarding blockchain development.

That is why, instead of focusing only on your own vision, try to see the point of view of others as well. You must bridge those ideas and create a solid model of what you want to achieve.

Build a Complete Plan

Another obstacle in the way of an adequate proof of concept is the misinterpretation of the implementation challenges of blockchain. The implementation of blockchain is not an easy task, and it is important to consider that it could have many failures that would end in possible failure scenarios.

Before presenting an idea to the stakeholders, it is necessary to go deeper into the roots and discover the possible weak points. Also, do a brainstorm with the team along each step to find the flaws in the plan and find the solutions.

In addition, limitations must be analyzed and how they can be overcome to make this blockchain proof of concept project a success.

Review the team's strengths and figure out how to mitigate impacts on weaknesses to try to overcome them.

Test, test, and test

After completing the design, you should move on to the testing phase. However, the problem is that many seem to release the MVP (Minimum Viable Product) before testing it properly, which ends up failing. Therefore, test the MVP for a long time before making it available to end users.

This will not only eliminate the possibility of a risk factor, but also help you understand if the MVP is ready to be implemented. In addition, it can never really be predicted how much transactional load the network would have to bear.

Therefore, in the case of MVP in blockchain proof of concept, testing should be performed until they are confident that they have no coding issues.

Collaborating with others

Collaboration with other institutions, companies, nations could help reduce the overall cost of blockchain proof of concept. Also, if it is a new institution, and of not so large coverage or medium size, collaborating with other parties could help you with the cost of production.

It will depend solely on the function or type of blockchain PoC framework you want to work on. Also, the more complex functions you add, the more costly it will be.

For institutions with simple processes, the cost may be excessive. Therefore, the best solution to this problem would be to collaborate with other institutions that are also willing to start a blockchain implementation. This greatly helps the uniformity of the broad scheme of digital transformation as a country guideline, and will support the growth of interoperability between applications, institutions, the private sector, and other nations.

The right equipment for the task

Set up the team with the necessary roles for the development of the proof of concept, verifying which are the strengths required, as well as verifying if the right team for its development is comformed.

It is important, that the best talent is hired, for which it is suggested to find good partnership and find out what kind of initiatives are being handled at the training level in universities, Mintic, SENA, RutaN, Center for the 4th Industrial Revolution, Entrepreneurship Clusters, training academies with demonstrable experience, in any case, institutions should make sure to hire staff accordingly or train their internal teams.

These are the tips to make a blockchain proof-of-concept scheme a great success. Make sure you follow them accordingly because these tips are some of the major issues you might face. Besides, every little detail count and you want to get it right.

Preferably choose open source technologies

Preferably, choose open source technologies that allow the public entity to quickly scale the solution, in a cost-efficient manner, to avoid closed or lock-in solutions. Having outlined the preliminary aspects, each of the stages that should be considered in the design and implementation of a blockchain project are developed below:

5.1 Learn about the principles and best practices applicable to blockchain

5.1.1 Know the Presidio Principles for blockchain and be prepared to apply them.

In the technological context, besides the advantages there are risks associated with the protection of those who consume the services of an institution with blockchain implementations. It is therefore necessary to establish the rules of coexistence of all actors in the digital ecosystem that is created and that each plays a relevant role in the value chain.
The World Economic Forum has published the Presidio Principles[57], adopted by the Government of Colombia, under which it seeks to govern the development of applications under blockchain technology.

What is at stake?
Organizations face some of the following challenges when developing technologies like Blockchain:

- Risks for users: one of the aspects that must be considered is the protection of users' rights, especially the protection of their personal data. The properties of Blockchain as a fundamental technology make these considerations particularly important, given the damage and subsequent effects that can come from the verification of possible risks in the implementation of the project.
- Expansion of existing gaps: Transformation is more likely to occur in places that can make a leap, such as high-growth economies. Although the potential of financial inclusion is discussed, if it is not carefully designed, blockchain can lead to greater exclusion and exploitation of vulnerable populations.

What can be done?
As with any technology, the promises and ultimate dangers of blockchain technology will be reduced to the individual decisions made in its strategy, development and implementation. It is impossible to control all these design options, but there is still room for alignment among the key players on what the minimum standards for the technology should be.

[57] Consult the following link : https://www.weforum.org/communities/presidioprinciples, Presidio Principles: Foundational Values for a Decentralized Future, WEF 2020

The World Economic Forum's Global Blockchain Council has created a "Blockchain Bill of Rights: Design Principles for a Decentralized Future", which aims to align private sector leaders, policy makers, and consumers on a fundamental vision of how users can and should be protected as blockchain technology develops, particularly around the following pillars:

- Agency and Interoperability: the right to own and manage data
- Privacy and security: the right to data protection.
- Transparency and accessibility: the right to information about the system.
- Accountability and governance: the right to understand the resources available.

The 16 principles[58]

Applications created on blockchain-based systems must retain the following participant rights. A participant must have access to information that it allows:

i. Understand how a service is operated, including the potential risks of the service, the availability of the source code, and the rules and standards on which it is based.
ii. Understand the potential risks and benefits of using a service using blockchain technology.
iii. Understand the performance expectations of the system and where the responsibility lies for the provision of the given service.
iv. To understand the rights and obligations of the different participants of the system.

A participant must be able to

v. Create, manage, and store cryptographic keys independently.
vi. Manage the consent of data stored in third party systems.
vii. Transfer data between interoperable systems or parts of a system.
viii. Revoke consent for future data collection.
ix. Access enough information to facilitate system interoperability.
x. Assess whether their data is at risk through appropriate disclosure procedures, which may include, but are not limited to, review of audit results, certifications, or source code.
xi. Have your data protected in accordance with internationally recognized technical security standards.
xii. Limit data collection to what is necessary and the use of data for the purpose for which it was provided.
xiii. Verify, through third party tools or tools created by yourself that operations have been completed and confirmed according to the rules of the system.

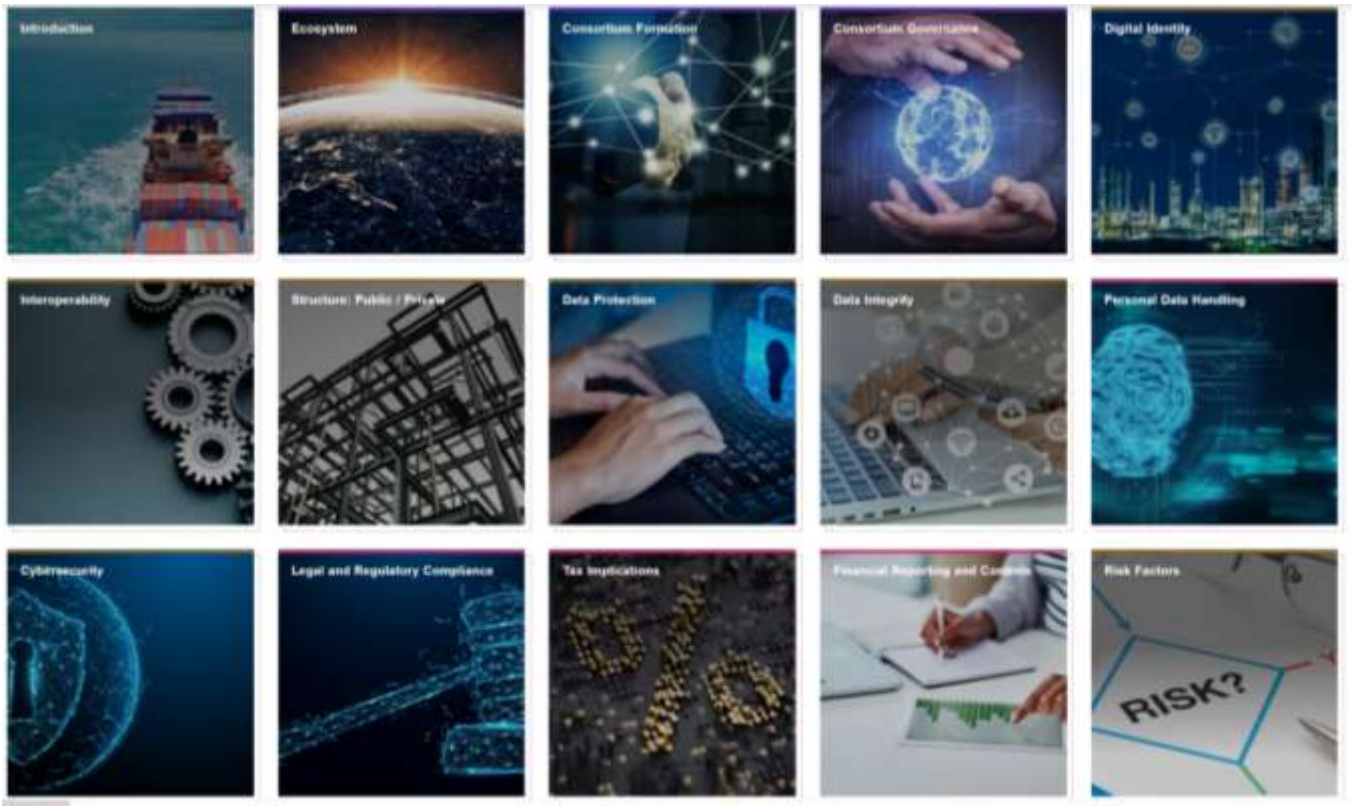
[58]: https://www.weforum.org/communities/presidio- principles, Presidio Principles: Foundational Values for a Decentralized Future, WEF 2020

xiv. Access the information needed to: (a) understand the governance and rules of the system and (b) seek effective recourse mechanisms.

xv. Disable the use of applications that do not treat data according to internationally recognized data protection and governance standards.

xvi. Rectify data that proves to be false, inaccurate, or incomplete when necessary.

5.1.2 Get to know the World Economic Forum's blockchain toolkit[59]



Blockchain has the potential to revolutionize the way companies compete and stakeholders collaborate in the world of supply chains. As technology is incipient, the World Economic Forum has published this toolkit to provide guidance for the development and implementation of new blockchain solutions.

[59] WEF. Blockchain Toolkit. http://widgets.weforum.org/Blockchain-toolkit/modules

The figure above, shows the constituent elements of this toolkit, designed for an organization that wants to integrate a solution of the characteristics of blockchain.

It is not the purpose of this guideline to delve into the aspects and details of each of the modules in the kit developed by the World Economic Forum, however, the rationale for each is presented in summary form.

It is not the purpose of this guideline guide to go in depth into the aspects and details of each of the modules of the kit developed by the World Economic Forum, however, the justification of each of them is presented in a summarized form. It is recommended to consult each module to have a better understanding of all the concepts.

5.1.2.1 Ecosystem

Blockchain is most effective when used to automate workflows between organizations which allows to drive business processes and data sharing. However, doing so effectively requires an ecosystem with an agreed governance structure that defines the roles and behaviors of participants, how and what information will be shared between participants, data ownership, entry and exit criteria and funding as well.

A Distributed Registry has some notable advantages, including decentralization, increased flexibility, greater transparency, audit trail, independence and more. But, like any new technology implemented in the daily operation of an organization, blockchain also involves additional considerations, such as managing what information is appropriate to put on the network and who can write that information on the shared chain.

More information, please visit: http://widgets. weforum. org/Blockchain-toolkit/ecosystem/

5.1.2.2 Forming Alliances

One of the aspects that can be key in exploring and adopting blockchain is to form a multi-stakeholder alliance with the intention of creating, implementing, accelerating and scaling blockchain solutions for a specific sector. The alliance model allows participants to leverage blockchain technology by balancing benefits, which often include allowing competitors to collaborate to create decentralized networked solutions to solve shared

problems, while protecting their individual competitive advantage while maintaining the confidentiality of sensitive data.

As this technology continues to emerge, the consortium approach can take research and development (R&D) to the next level beyond what one company can achieve on its own to develop new blockchain solutions that address specific supply chain use cases. This alliance can evolve as solutions are implemented to encourage adoption, create standards, and interoperate with other business organizations and additional alliances. For example, a proof of concept (PoC) may begin internally in a single company or with a small group of participants within an industry, then grow over time in terms of vertical and horizontal participation, technical sophistication, or both, where government involvement may be important in learning more about this technology and its advantages.

More Information, please visit: http://widgets.weforum.org/Blockchain-toolkit/consortium-formation

5.1.2.3 Partnership governance

Good governance is a key indicator of a well-functioning partnership. Creating the framework for entities to work together effectively is as important as building the related technology solution. Inevitably, the members of an alliance will have different priorities and interests that must be reconciled. Therefore, before forming an alliance, it is important to plan how decisions will be made and how differences of opinion will be resolved. While there is no one-size-fits-all solution to accommodate all disparate interests, establishing rules of the road from the outset can go a long way towards smoothing out disagreements, or even preventing them altogether.

Deciding on a governance model is important in the very formation of an alliance, as the governance model is key to all other decision-making. Important initial decisions include who will finance the operations, who will be responsible for the development of new technology and who will own this technology. However, keep in mind that it is also possible, and even likely, that the governance model of a partnership will change over time as the blockchain solution becomes more sophisticated, adding new players and functionality.

More information, please visit: http://widgets. weforum. org/Blockchain-toolkit/consortium-governance

5.1.2.4 Digital identity in supply chains

With the increasing complexity of supply chains, reliable identities of peers in the supply network are critical to efficient operations. A trusted identity can encompass different contexts, both physical and digital. This Toolkit module focuses on the ultimate form of identity: an online presence that represents and acts on behalf of an external actor.
This module covers considerations and questions to guide the design of a responsible digital identity system as it relates to blockchain for the supply chain. The information in this module assumes that blockchain is the key capability that enables transformation in a supply chain use case.

This module should be used by designers, owners and operators of the blockchain network to focus on digital identity as one of the key components of the blockchain capability. It contains general considerations on the design of a digital identity system, including who the players are, technology decisions, business models, identity data protection, processes and governance. It also includes a specific focus area designed to inform the design of a decentralized identity system.

More information, please visit: http://widgets. weforum. org/Blockchain-toolkit/digital-identity

5.1.2.5 Interoperability

One of the most frequently mentioned aspects throughout this guide has been interoperability. It is undoubtedly the holy grail for the development of intra-governmental, inter-institutional and even international blockchain infrastructures.

Blockchain technology, by its very nature, is based on peer-to-peer interactions around distributed records that are shared. This makes the transformation from an isolated and fragmented approach to end-to-end value chain integration more achievable, but it also means that the importance of interoperability is imperative.

In the simplest terms, successful interoperability allows the user to be confident that "I know what I see is what you see". This toolkit module provides tools to analyze the challenge of making blockchain solutions work seamlessly in that regard and to choose the right interoperability approach.

More information, please visit: http://widgets. weforum. org/Blockchain-toolkit/interoperability

5.1.2.6 Structure: Public / Private

For supply chain organizations launching new blockchain projects, one of the most complicated considerations is often whether to use a blockchain, and with what permission models. A public blockchain like Bitcoin's allows anyone on the Internet to read or write in the Shared Registry, while a blockchain managed by a consortium or alliance could restrict access to partner organizations, for example.

Ultimately, the "public versus private" decision will affect functionality, security, compatibility with other partners' systems and, perhaps most importantly, the competitive positioning of organizations in their supply chain projects. There is certainly no single "correct" answer. It is vital to first understand the unique benefits and drawbacks of each type of chain and then choose the one that best suits the requirements of your project.

More information, please visit: http://widgets.weforum.org/Blockchain-toolkit/structure-public-private

5.1.2.7 Data Protection

The perceived loss of control over data is one of the biggest obstacles to the adoption of blockchain that many supply chain organizations face. However, with good project planning and communication, this problem can be greatly mitigated.

Blockchain technology never requires an organization to disclose more data than it is comfortable with. Chain data can also be encrypted so that only authorized parties can use it. Therefore, in the course of selecting and implementing a blockchain solution, a supply chain organization has real flexibility to ensure that it addresses both its data protection and privacy concerns and those of other supply chain partners.

More information, please visit: http://widgets.weforum.org/Blockchain-toolkit/data-protection

5.1.2.8 Data integrity

Data integrity is the property of the data used in a solution is correct, reliable and useful to all participants. The term "data integrity" is used here in the broadest and most ubiquitous sense in the supply chain world, referring not only to resistance to unintentional data modification, but also to the integrity, timeliness and accuracy of data throughout its lifetime.

This module covers typical considerations to ensure that the data used in a blockchain solution is correct, reliable, timely for all participants and is

preserved from the point of data creation to the point of use in blockchain. This module emphasizes that the blockchain technology does not necessarily guarantee the accuracy of the data entered in the chain. It stresses that there are in fact multiple stages and steps where data integrity may be compromised.

More information, please visit: http://widgets.weforum.org/Blockchain-toolkit/data-integrity

5.1.2.9 Processing of personal data

The treatment of personal data is an aspect that should lead to the analysis of the current regulations of each country.
For example, the European Union's General Data Protection Regulation, imposes obligations on what it calls data controllers and processors; however, when there is no centralized service provider as in a blockchain network, who is responsible for monitoring the processing of personal data or paying penalties when obligations are breached? And if a blockchain records data immutably, what does it mean for erasure obligations if that data cannot be deleted? While these considerations need not be prohibitive starting a new blockchain project, they must be addressed at the outset, even, in some circumstances, by supply chain organizations that are not in the jurisdiction where blockchain is applied.

In addition, all aspects related to the processing of personal data must be resolved considering good international practices but ensuring compliance with the regulations in Colombia.

More information, please visit: http://widgets.weforum.org/Blockchain-toolkit/personal-data-handling

5.1.2.10 Cybersecurity

Any implementation of new technology must include adequate safeguards against these digital or information security incident scenarios.

Although the blockchain technology is rapidly evolving, there are some fundamental security concepts that can be applied to the blockchain space effectively. After covering these focus areas, this module of the Kit provides a risk management framework and a 10-step safe implementation plan that should be useful in a wide range of supply chain projects.

More information, please visit: http://widgets. weforum. org/Blockchain-toolkit/cybersecurity

5.1.2.11 Legal and Regulatory Compliance

There are some common considerations that blockchain projects must address from a legal and regulatory standpoint. The kit module outlines, some recommendations for projects to consider jurisdiction and industry specific laws and regulations.

For more information, please visit: http://widgets.weforum.org/Blockchain-toolkit/legal-and-regulatory-compliance

For Colombia, some circulars have been issued regarding the use of crypto assets, especially Circular 52 of 2017 on potential risks associated with operations related to "electronic currencies, cryptocurrencies or virtual currencies". You can directly download the Superfinanciera's communiqué at the following link:

https://www.superfinanciera.gov.co/descargas?com=institucional&name=pubFile1025022&downloadname=cc52_17.doc

In addition, it is important to consider that the Banco de la República has conceptualized in the sense that crypto currencies do not obey any regulation since they are not any type of financial instrument officially recognized for the realization of transactions. The pronouncement can be found under reference JDS-23920.

5.1.2.12 Tax implications

While tax implications are rarely included with early design and development, this toolkit encourages a broad-based approach so that no part of the business is an afterthought. Tax implications should be considered from the initial scope and strategy phase of a blockchain implementation.

The purpose of this module of the Kit is to educate implementation managers and companies, identify details and address features to properly apply the various tax implications of the use of blockchain.

For specific tax liability calculations and compliance reporting requirements, the guide applicator should consult with local tax specialists in the jurisdiction, as tax laws may vary depending on specific facts and jurisdictions. Proper planning and tax investigation can reduce tax uncertainty, meet regulatory requirements, generate efficiencies regarding operations and reduce the overall tax burden.

More information, please visit: http://widgets.weforum.org/Blockchain-toolkit/tax-implications

5.1.2.13 Financial reporting and controls

Any blockchain solution designed and implemented for a supply chain must consider the financial reporting requirements of the participants, internal controls and their stakeholders, so that any case is addressed successfully. When combined with more traditional forms of business accounting, blockchain information can help businesses support the preparation of timely and reliable financial statements.

It is important to address the many challenges that can exist when an organization relies on information from a chain of blocks and the underlying technology as part of its financial reporting process and system of internal control. Not all relevant controls operate within the legal structure of the company or in a verifiable and reliable environment; these challenges are amplified as most business professionals have limited experience in the use of block chains and may not recognize the potential implications for financial reporting activities.

It is important to address the many challenges that can exist when an organization relies on information obtained from a blockchain and the underlying technology as part of its financial reporting process and internal control system.

More information, please visit: http://widgets. weforum. org/Blockchain-toolkit/financial-reporting-and

5.1.2.14 Risk factors

New technologies have potential drawbacks that need to be identified and managed. This is especially true when that technology is not simply an overlay application, but rather a central part of the organization's underlying IT infrastructure, as is often the case with Blockchain.

The checklist included in this module of the Kit covers some possible risks and common errors associated with the deployment of blockchain technologies. However, it should be noted that this list is not intended to be exhaustive. With this in mind, project managers should view the information as a generic guide and work with relevant internal stakeholders, such as the cyber security, internal audit, finance, compliance, legal, operations, and information technology teams to identify and prioritize risks that are

important to their deployment and develop mechanisms to proactively manage the risks.

More information, please visit: http://widgets.weforum.org/Blockchain-toolkit/risk-factors

5.2 Preliminary questionnaire

First, it is necessary to establish what is the need and the objective to be addressed in the blockchain project. The following is a questionnaire developed by the Inter-American Development Bank[60] that seeks to answer whether it is advisable to use blockchain to solve the identified problem?
This is a test aimed at public officials who want to know if blockchain can be useful to them. Before starting, they are asked to put aside for a moment the technological discussion and focus on the problem they want to solve.

The questions were developed to help you understand whether blockchain can contribute to solving the problem in question.

1. Do you need all involved to keep record of information?
A / Yes, all the users of the entities involved will generate information that needs to be registered.
B / Yes, but only some users of some entities will generate information that needs to be registered.
C / No, only a small group of a single entity will generate information that needs to be registered.

2. Do you need all the involved parties to access this registry?
A / Yes, all users from many entities will access the registry.
B / Yes, but only some users from several entities will access the registry.
C / No, only a small group of a single entity needs to access the registry.

3. Does anyone involved have an incentive to try to falsify the registry information for their own interests?
A / Yes.
B / No.

4. Do you need to validate the registration of new information in real time or near real time?
A / No, I can wait more than 10 minutes to validate a registration.
B / No, but I can only wait up to 10 minutes to validate a registration.
C / Yes, I need the validation to be immediate.

[60] BID (2019). Blockchain on the public administration, too much sound and les blocks? https://publications.iadb.org/publications/spanish/document/Blockchain_en_la_administraci%C 3%B3n_p%C3%BAblica_Mucho_ruido_y_pocos_bloques_es.pdf

5. What do you think about the existence of a central entity that validates/verifies all the information to confirm that it is legitimate and reliable?
A / I don't want it.
B / Ideally, I don't want it, but I don't mind having it.
C / I need and want such an entity.

6. Do you need to have a reliable historical record of the information to audit or track it?
A / Yes.
B / No.

7. Do you need to follow any validation process or get any permission to access the registered information?
A / No.
B / Yes.

The following are the rules on how to interpret the answers to the questionnaire.

If you answered (a) in all the questions, a solution about a public blockchain not permitted can be the alternative. If the answers are between (a) and (b), then another type of blockchain may be appropriate. If there was a (c) in any question, it is likely that a blockchain will not be very useful compared to other options.

5.3 Plan the blockchain project

5.3.1. Establish the strategy

The first step to develop blockchain projects is to define the strategy in which the objectives to be achieved using this technology applied to the processes, procedures, services or procedures of the entity are defined.

It is relevant that the strategy of use of blockchain, is completely aligned with the Digital Transformation Framework, and the initiatives, processes and areas of the organization prioritized, as well as the Strategic Plan of Information Technology and Communications[61].

5.3.2. Identify cases of use of emerging technologies

Identify and prioritize the processes, procedures, services, or procedures in which the use of blockchain is feasible. For this purpose, first, it is suggested to design the digital service according to the Digital Services Design Guide that can be found in the Digital Transformation Kit for the State.

5.3.3 Check the feasibility

The viability of a blockchain project depends on several factors, including the legal, technical and application of blockchain principles.

Law 1955 of 2019, National Development Plan, defines the general enabling guidelines for the use of emerging technologies in digital transformation projects and fourth industrial revolution, for this purpose, The use of emerging technologies from the Fourth Industrial Revolution is prioritized to facilitate the provision of State services through new models including, but not limited to, disintermediation technologies, DLT (Distributed Ledger Technology / Blockchain), massive data analysis (Big data), artificial intelligence (AI), Internet of Things (IoT), Robotics and similar.

Furthermore, it is relevant to verify the needs of interoperability, the existence of the users' consent to treat their personal data through blockchain applications, and finally, to establish the proper treatment of the data according to specific terms and conditions for the project.

5.3.4 Establish the prerequisites

The prerequisites for the implementation of blockchain applications start from the project definition, identifying the necessary prerequisites before contracting a technological solution. For this purpose, it is suggested to review the Scheme for contracting projects for the development of

[61] The documents referred to here can be found at gobiernodigital.mintic.gov.co

information systems of the MinTIC, which contemplates diverse mechanisms to evaluate the project to be developed

5.3.5 Establish the governance framework

Define the governance framework of the blockchain project, especially it is important to define who are the design decision makers. For this purpose, involve those responsible for the following activities:

- Digital Security
- Information Security
- Personal Data Protection Compliance
- Documentary management
- Information and communication technologies
- Responsible for the process, procedure, procedure, or service.

5.3.6. Define ownership strategy[62]

One of the blind spots of the projects of digital transformation with emerging technologies such as Blockchain, orbits around all the intangible and the human factor in the process of relating to their work and associated tasks.

The projects that really work in the long term, thus overcoming the pilot phase, are those that are appropriate by the institutions.

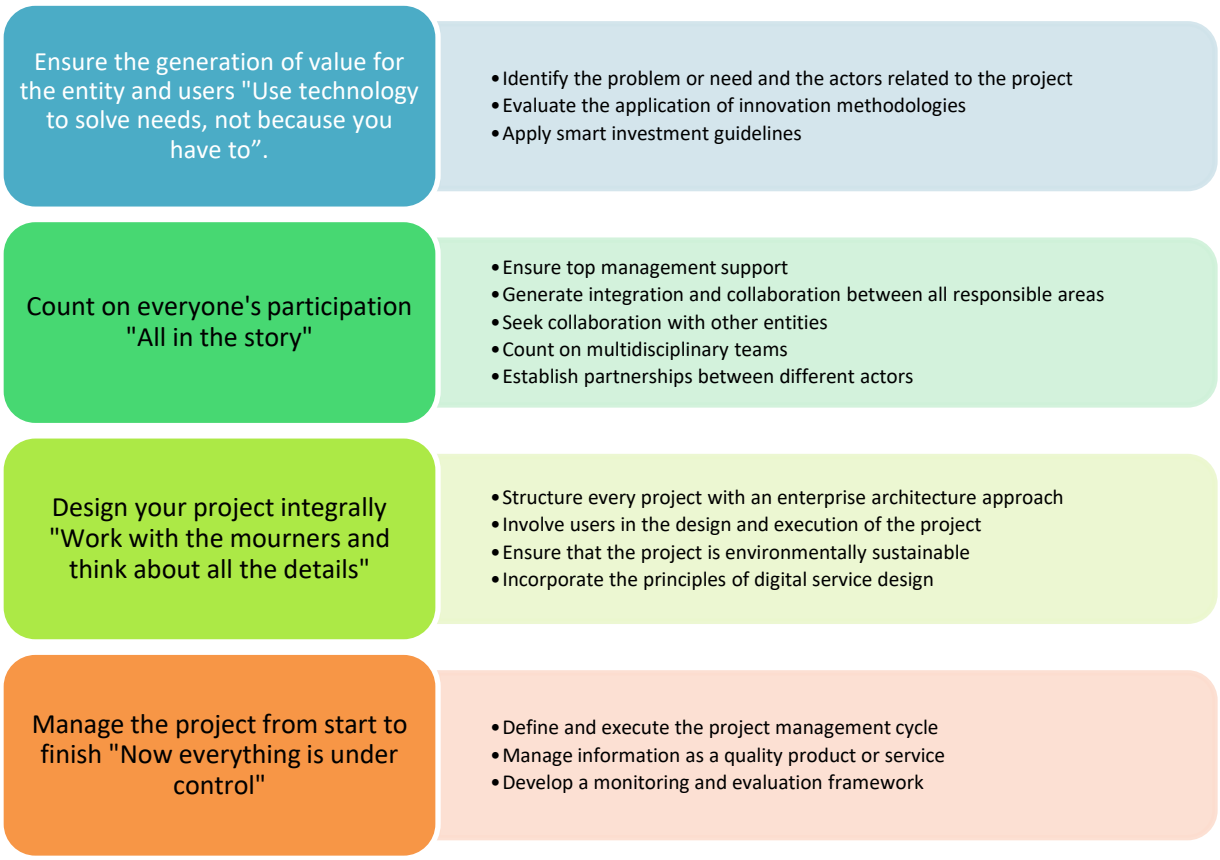
MinTIC has a complete guide that describes from the institution how to undertake a digital transformation project and how it should be appropriated so that those responsible and involved find the usefulness and benefit of innovation in their management.

Any project that makes use of ICT, must have a specific strategy of knowledge, use and appropriation, so that the entity develops concrete actions to generate digital capabilities in citizens, internal and external users and stakeholders related to the project. Similarly, it must monitor and measure the level of access and use of technological platforms and tools, to determine their level of use, impact and exploitation by users. Use the following instruments that will allow you to build the strategy of knowledge, use and appropriation, as well as take full advantage of social networks to communicate with users:

In the document, Manual for the implementation of Digital Government, you will find clear and concise guidelines to incorporate the transformation project within the institution.

[62] Consult the Digital Government Manual at gobiernodigital.mintic.gov.co

The diagram below gives some guidelines to consider as part of the transformation project:



Source: Manual for the Implementation of Digital Government, MinTIC Colombia
Figure 16 – Guidelines to be met in Digital Government projects in public entities

Finally, it is necessary to understand that any new process that generates changes, requiring that the step by step development and implementation is very clear to form the right team, and that it adequately understands the reasons and purposes of the transformation. Likewise, it is necessary to adequately plan the change management, so that the changes are assimilated in due time and are not untimely.

5.4 Identification of needs and problems to be solved

Not all management problems can be solved with Blockchain technology, then you must be specific when defining what steps, you want to take towards the digital transformation. Being clear about the problem is fundamental to ask the right questions about whether Blockchain is in the range of technological options for transformation.

The framing factors of the problem be:

- Do you want the records to be immutable in time and should you keep a history of the data?
- Does the information value chain involve actors who do not share relationships of trust?
- Is it possible to dispense with real-time validation?
- Can we be more efficient by eliminating intermediaries?

So far, if the answers were YES, other aspects related to the problem can continue to be evaluated in more detail.

5.5 Document the use cases

Use cases allow defining whether a specific problem can be feasibly solved by adopting existing business models and rules. However, it is important to carry out a proper organizational diagnosis to identify whether difficulties may arise in the management or operation, especially in the following aspects:

- Documentary chain of custody. In this aspect Blockchain offers the best option available in the technology market. The documents that are stored comply with the security standards offered by this technology, and rules can be established for the exchange of documentation within each process. Sign digitally not only for recognition of actors in the chain, but also for authorization or acceptance of a given transaction. The documents exist in the digital environment, unmodifiable, secure and with the possibility of being shared by the citizen and/or the institution in question, with other institutions, thus favoring technological standards and interoperability.
- Use of Digital Citizen Identification. This is one of the most important elements of the Digital Government as a fundamental part of the interaction between the citizen and the State. With Digital Identity, institutions will be able to exchange data and consolidate information in a transparent and secure manner, protecting the identity of the citizen and ensuring that each institution only has access to information of its relevance.

5.6 Choice of Technical Standards

After having defined the process and its respective use case, the architecture of the solutions to be implemented must be decided. This plan must obey the needs of the State and the national and global guidelines that are followed in the Blockchain ecosystem.

The World Economic Forum is clear in mentioning that the set of guidelines and recommendations that are given to succeed in the definitions, plans and implementations Blockchain for an institution, are far from recommending one or another technology. However, the following are some guidelines that were used in the PAE's bidding pilot, as a base line of the decision making process for the use of one or another technological form to implement Blockchain, always taking care of the precept of being able to be interoperable with the rest of the digital ecosystem:

5.6.1 Selecting a blockchain Network[63]

Once the reading, writing and participation access is determined by consensus, the Blockchain protocol can be selected to support the new procurement solution. It is important to select a protocol with a very high network security. The network must also have an ecosystem of development and technical support. It is also beneficial if partners are working continuously to improve the network, from solving software problems to implementing updates and improving scalability. The Ethereum blockchain network currently has the highest network traffic rate, a key security parameter, and the largest ecosystem of validation nodes and technical contributors of any Blockchain network with smart contract management capabilities; however, alternative networks with high security and robust technical ecosystems may also be appropriate.

A network's mainnet is also highly preferred, all else being equal, because of its higher network security relative to a test network (testnet), or "test network" environments, which typically have fewer validation nodes and are therefore more vulnerable to adverse attacks that can compromise records and transactions on the network. Test networks can also be shut down or restored, putting an application and its records at risk..

[63] WEF. Blockchain Government Transparency Report. Op. cit

5.6.2 Consider the future scalability of blockchain [64]

In the future, if the software solution seeks to scale to multiple territories or jurisdictions with higher transaction volumes, the network performance on a public, unlicensed Blockchain network like Ethereum could be prohibitive. To solve the scalability challenges, the solution may need to change to employ one of the following architectures:

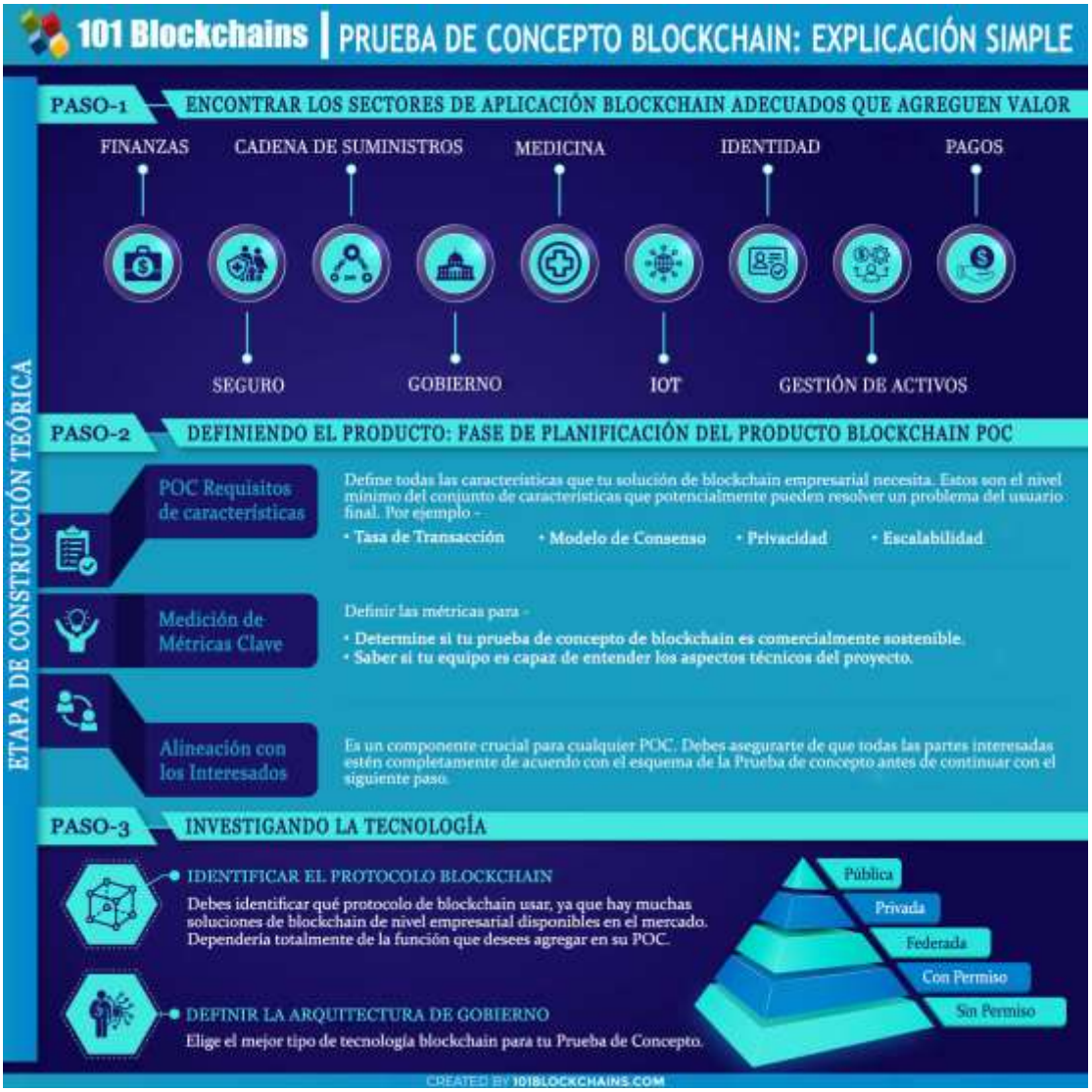
- A permissive Blockchain implementation
- A "hybrid" implementation with two blockchain networks at the protocol level: a permitted Blockchain can allow for higher transaction throughput while an unlicensed protocol is used for record keeping that prevents tampering.
- A new next-generation protocol-level implementation with advanced performance (e.g., Ethereum 2.0 for the network without Ethereum permissions)
- A "layer 2" scalability solution over an unpermitted Blockchain, such as "state channels" for Ethereum. However, their low transaction capacity performance can be a challenge that has not been solved in a conclusive way so far.

  Research for most next-generation protocol-level implementations and "layer 2" networks is still ongoing and not ready for production-level implementations.

[64] http://www3.weforum.org/docs/WEF_Blockchain_Government_Transparency_Report.pdf

5.7 Prepare the proof of concept before programming

Entering the technical domain, below is a chart that provides a simple explanation of the so-called Proof of Concept or PoC.



Source: Developed Min TIC from 101Blockchans.com (only in Spanish)

Figure 17 – Infography how comited the creation of a concepto blockchain test

There are many sites on the internet, generally in English, with technical content such as guide for decision making. It is recommended to visit established sites and with a agnostic approach to blockchain solutions.

Below[65] is detailed step by step to build that roadmap to create a prototype based on the proof-of-concept work of Nelson Rodríguez (2019).

STEP 1: FIND THE RIGHT BLOCKCHAIN APPLICATION SECTORS THAT ADD VALUE

Determine a viable sector in which the blockchain application generates value:

STEP 2: DEFINE THE PRODUCT CONCEPT

In the second stage of the theoretical construction, one should think of the blockchain proof of concept as any other product. You have to have a solid plan along with the full support of all stakeholders.

In planning the product, a meeting should be convened with all stakeholders. In addition, it may be necessary to bring together the people involved in the project as the need arises. There are three main components to consider at this stage:

1. POC feature requirements

   Define all the features required for the institutional blockchain solution. After deciding on the blockchain application in a specific sector and for a specific solution, it is necessary to add the features that are required to solve an end-user problem. For example:

   - Transaction Rate.

   The transaction rate depends entirely on the sector in which you are going to use it.

   If a company must handle a large amount of cash transactions every day, then high transaction rates are needed.

   On the other hand, if the solution would apply to a low to medium sized organization that does not require high levels of transactions, then it

[65] Rodríguez, Nelson, (2019), Blockchain Proof of Concept: Enterprise PoC Guide. 101 Blockchain. https://101blockchains.com/es/prueba-de-concepto-blockchain/

would be prudent to settle for less. There is no need for an unnecessary number of functions if they do not add value to the project.

- Consensus Model

Another important feature to consider is the consensus model is the way in which agreement should be reached among users.

There are many consensus protocols, however, each of them comes with its own set of advantages and disadvantages. According to the type of process to be transformed, it is necessary to balance which consensus protocol would be appropriate for the Blockchain proof of concept.

At the same time, we must not ignore what is happening in the field of interoperability capabilities that others are implementing, with the aim of being convergent and having ecosystems that know how to communicate with each other.

- Privacy

Privacy is an important issue. If an organization does not want everything to be open, then it will be necessary to add privacy options. Using the authentication process would work highly in this matter.

If the project is about identifying or storing confidential information, then privacy is an important concern.

-Scalability

Blockchain's in-network solution has to be scalable. This is one of the main limitations of some Blockchain technology developments. That's why when many users start using a certain network, it becomes very slow losing the faster performance.

So for PoC, it is necessary to add scalability between the features.

Once the problem to solve have been understood, adding the features that solve the problem is a task that requires a lot of technical expertise that can be found in the market today.

2. Measurement of Key Metrics

Metrics must be defined and defined, and it is important in One Metric That Matters (OMTM) for two main reasons:

- These metrics will guide the development team during the prototyping phase of the Blockchain Proof of Concept. In addition, every effort must have a direct relationship with these metrics.
- It is necessary to define how the returns will be obtained in case of a successful Proof of Concept Blockchain.

As a proof of concept, these metrics should include

- Determination if the Blockchain Proof of Concept can be commercially viable. Because once the Blockchain Proof of Concept project is completed, a decision must be made whether to move to the production level or not. In addition, you also need to measure the possible returns if you move to the production level. In the case of public institutions this metric can be related to factors other than economic investment and can be better oriented towards the level of efficiency and services that can be successfully transformed with the highest level of internal adoption and with the citizenship.

- It is also necessary to know if there is a team with technical knowledge of Blockchain. In case you don't have a technical team available, you can generate capacities or request resources to make the implementation adequate.

3. Alignment with stakeholders

Alignment with stakeholders should be a crucial component of any PoC, enabling assurance that all stakeholders are in full agreement with the proof-of-concept outline before proceeding to the next step.

It is advisable to take as much time as necessary to reach agreement, because the type of investment of time and resources that is put into the exercise should yield good results

STEP 3: RESEARCHING THE TECHNOLOGY

After having a solid idea of which characteristics to include and how to approach the roadmap, it is necessary to define the actions to be taken by the team. This team can be an external team, affiliated or allied to the government's Blockchain initiatives. This team will research the technology based on the requirements that the institution has and will create the best platform to develop it. Here are two steps:

Identify the Blockchain Protocol

- It should be identified which Blockchain protocol to use, as there are many enterprise-level Blockchain solutions available on the market. It would totally depend on the function that you want to add in the PoC.

- Verify the performance of each platform and choose the one closest to the Blockchain proof of concept. However, the technical team will oversee this part mainly. In addition, meetings should be organized to see which platforms they chose and how they will address the situation.

- Defining the Architecture that governs the solution.

Governance architecture is the second crucial factor in the Blockchain proof of concept. That is why the best type of Blockchain technology must be chosen for the Blockchain proof of concept project. A fundamental question to be made is if a solution is required in a private or public network, then we present the main characteristics of four types of architectures that can be considered in the adoption of a blockchain solution:

5.8 Build the blockchain prototype[66]

At this stage the prototype for the implementation of Blockchain will be built, it is expected that the stakeholders and technical team should already be aligned with the deployment structure

5.8.1 Choosing the Blockchain

The choice of the chain of blocks would include the creation of the architecture, the governance model and the characterization.

- Reviewing the architecture

  You should start by reviewing the core architecture of Blockchain's proof-of-concept project. Therefore, the technical team begins by creating the genesis block as a starting point. All other blocks are traced back to the genesis block. This is the first block of the chain. The choice will depend on what the thematic lines of institutional development for the digital transformation will be, with a view to converging and having scalable technical solutions.

- Develop the governance model

  Once the architecture is finished, the technical team develops the governance model. It is expected that at this point it will be known which governance model is best suited to the interests of the project. In the case of the private governance model, you would need to add an authentication process to restrict users.

  Additionally, it should be linked to the identification database, so that it can match the user authentication and give access to authorized users.

[66] Elaborated by Emilian Enev, based in her document How to put together a Blockchain Project, en colaboración solicitada por el autor.

- Adding the functions

  When the architecture and governance model is finished, additional functions are added that focus on solving the specific problem in the Blockchain proof of concept. Some platforms offer modular architecture.

  In addition, using this architecture, you can connect separate functions and experiment a little to see which works better.

5.8.2 Choosing the Blockchain platform

There are many blockchain platforms on the market for testing. Adopt the blockchain platform that best serves you to develop the specific application. In doing so, consider the following:

Determine if the blockchain platform is suitable for developing smart contracts and verify the flexibility of the platform.

1. Determine if the blockchain platform is suitable for developing smart contracts and verify its flexibility.
2. Examine whether you require a platform that provides facilities for a blockchain under private, public, or hybrid networks under private, public or hybrid networks.
3. Verify the transaction costs, the number of transactions required per second and the possibility of congestion per second and the possibility of congestion due to the number of global transactions. transactions.
4. Identify privacy and permissioned platform requirements.
5. Review whether you require a blockchain platform for asset handling, management or operation of assets.
6. Check if you require an open source platform.
7. Determine what type of consensus algorithms the blockchain platform supports.
8. Establish whether the blockchain platform allows integrations with other vendors or developers.

Once the framework is defined, it is important to start the step-by-step[67] for the development of the blockchain application. It is important to mention, that for the following recommendations no particular type of blockchain is chosen, then it can be agnostic and as with some blockchain, most popular

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programming languages can be used which reduces the entry point and allows knowledge to be in more hands when programming.

DLT/blockchain technology has its limitations in the sense of being specific in its use. Each limitation must be aligned with the functional and non-functional requirements of the project, which are outlined below:

5.8.3 Functional Requirements[68]

These include

- Functional characteristics: determines what you want the application to do.
- Its definition is closely related to determining how the process to be transformed works.
- Behavior and usage situations: How the application should react to user contact, what type of actions lead to to what kind of behaviors within the application, according to the process to be transformed.
- User experience: It must be determined how the application supports the user's process of informing the user so that transactions are verified.

5.8.4 No functional requirements

Within the design stage of each software system, a set of non-functional requirements related to system properties and operation behavior need to be defined. For the planning and execution of a good blockchain project, it is necessary to consider the following aspects:

- Capacity: related to the operational capacity of the system. In the case of a blockchain project, the number of transactions that can be processed per unit of time so that the system remains online and usable and operationally consistent.

- Performance: The question to be answered is what can be the lowest performance that is accepted or satisfies the user experience in a way that does not lead to frustration and possible user defections?

- Reliability: The process of placing transactions on a blockchain involves a flow that must be very robust with proper error and retry management. This is necessary to be able to define transaction times and rollbacks due to system errors.

[68] Ibídem

- Security: One of the pillars of DLT/blockchain systems and the great differentiator compared to conventional information management systems. In the blockchain context there are several aspects to consider:

- Private key storage.

- Modes of access to smart contracts

-Security mechanisms implemented in the smart contract.

5.8.5 Interface Specification

In many cases, a blockchain module is managed as a functional layer that is used in programming the REST Interface[69] REST, or Representational State Transfer, is an architectural style for providing standards between computer systems on the web, making it easier for systems to communicate with each other.

To be sure that the services offered by the functionality and determine that it is properly consumed, the interface must be clear and simple so that the rest of the systems can communicate with it. This includes the internal coupling interfaces with the DLT/Blockchain and the external interfaces that operate at higher levels with other systems.

5.8.6 Development of APIs

Blockchain-based systems require a clear and secure way to access the functionality that the Smart Contract poses. Therefore, so-called APIs must be established in the application layer logic to the rest of the system to make the DLT/blockchain system easier to use and consume as a service. These APIs should be aligned with the functional requirements and contribute to meeting the non-functional ones in the same way.

5.8.7. User interface: the development of the experience

This is one of the most important elements of the development and implementation of a blockchain project. This is an iterative process, which requires having an external group of users engaged to review the navigability of the system, test each menu and each input to validate the expected functionality.

The feedback obtained should be part of the modifications to be made on the interface in order to obtain a satisfactory user experience that encourages users to adopt and use permanently and sustainably an application and processes given in the digital domain.

[69] Watch link about Rest en Codeacademy: https://www.codecademy.com/articles/what-is-rest

5.8.8 Network Implementation

To accomplish this task, the technical committee in charge of the implementation must have the resources needed for a correct implementation.

If third parties are involved in the development of the solution, they should be involved from the beginning of the project design, so that the problem is addressed in a systemic way and the desired solutions are obtained. It is important to consider the following aspects:

- Scalable: they can grow without having to develop from scratch. Modular and with transversal interactions with other systems.

- Maintainable: with resources available in the market, avoiding the high costs of proprietary technologies.

- Interoperable: implementations that can communicate, deliver, and receive information from other blockchain systems so that the state effort does not grow in silos, but as part of a robust and long-term strategy of digital transformation of the state.

5.8.9 Integration [70]

Blockchain transformed systems do not exist alone in the digital domain. A good design and implementation of a blockchain system exists and interacts with other systems smoothly and without causing disruption to current functionalities or systems other than the one being transformed.

For the realization of these integrations you need:

- Technical team of existing systems: They are the ones who give the guidelines from the beginning, about which systems will be affected, generate contingency plans and transition to the new operating model. They interact closely with the blockchain development team and communicate seamlessly with them. They should form a single team during design, testing, implementation and production deployment.

-Integration map: refers to where the new system will be connected, what technical variables for receiving and delivering information must be covered in the new blockchain model and what robustness and security requirements must be met so that the entire system continues to operate regularly.

[70] Development with the support elaboration of Emilian Enev, based in his document How to put together a Blockchain Project,with the request collaboration of the autor

- Testing protocol: validation with the current "owners" of the existing systems to ensure that there is no loss of functionality and that, on the contrary, with innovation the systems are strengthened. The security implications of the systems and information must be taken into account in order to maintain or improve the current conditions in this aspect.

5.8.10 Contract Deployment[71]

This step has to do with the presentation of the automation at the application layer. This means that the system is online and available for use in a test or production environment. Respective validations are performed that the systems involved in the design respond positively to the Smart Contract deployment activity and that the information that has been chosen to be disposed in the DLT/Blockchain is asserting the process that has been designed as well.

In this process, the integrity of the information, the writing on the blockchain and the different levels of accessibility that those involved in the specific process that has been decided to transform are reviewed. The latter means that only authorized entities will be able to view some or all the information as appropriate and will be able to interact with these statuses.

5.8.11 Deployment of high-level APIs[72]

APIs are these programming mechanisms that connect to other information systems, other than the application with the smart contract, that complete the system integration and make the information move between the different software elements that coexist in a given system. At this level, it is necessary to check that the systems involved in the digital transformation do not suffer affectations or integrity, loss of connectivity with other systems, security failures and other actors involved in general in the management of information.

This deployment activity is executed while the rest of the systems involved are monitored and test transactions are executed to validate that what was planned and implemented is consistent with the process design.

5.8.12 Testing (intensive testing and status validation)[73]

Testing of any computer system is mandatory. This phase verifies the behavior of the entire system that has been transformed, its interactions with other systems, response times, information integrity, process security, failure control mechanisms, and whether user interactions rigorously comply with all the parameters established at the time of planning and implementation.

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[71] Ibidem.
[72] Ibídem
[73] Ibídem

The testing protocol is performed on all components of the implementation, server side, user interfaces and all other layers through which authentication mechanisms, logging, availability control systems, alarms, security, pass the information to interact with existing subsystems, Smart Contracts and blockchain.

The tests must be performed in an automated way and also manually, to detect possible failures and that these are recorded in a log of failures that are subsequently reviewed and corrected by the development team and then validated again in the test environment provided for the project.

5.8.13 Documentation and user manuals[74]

The documentation of the transformed processes can be specified in 2 distinct parts:

- Systems to be transformed: the entire design, implementation protocol and transformation to be executed, which is done as part of the planning stage of the project.

- Technical documents of development and migration of systems: all the documents that have the source codes, architecture and source code, architecture, libraries, and methodology: all the documents that have the source code, architecture, libraries and methodology of implementation on this documentation depends how to scale the project and in this way, it does not depend on a single supplier that can make functional modifications on what has been implemented.

The previous step is of particular importance since it drastically reduces the risk involved in software development and support projects of the hidden costs.

Adequate documentation ensures a low entry point to updates, modifications and changes to be made to the implemented and modified systems.

Finally, it is required to audit very precisely this stage of the project, so that there are no gaps of information or parts of the development that have not been adequately delivered.

5.8.14 Project Registration System75

The system should collect information in accordance with the management needs of the institutions in these aspects:

Bottleneck processes: elements of the institutional management that do not offer efficiency and that can be replaced by software components. Useful in

[74] Ibídem
[75] Ibídem

processes where traceability of information, unique records per transaction, direct interaction between the citizen and the transaction and the institution.

- Documentation authenticity processes: Processes in which the citizen is asked for multiple documents are requested for a specific procedure and their validation criteria are defined.

- Processes in which the physical presence of the citizen is mandatory, to replace it with a digital identity: blockchain offers a way to authenticate the identity of the citizen identity of the citizen who carries out a given procedure without the need for physical presence.

The above and many elements of internal processes common to many institutions can be capitalized by these institutions through this project registration system. The usefulness of this system is reflected in:

- Identification of needs in a consolidated way: in this way, with the same developed developed software element can benefit a group of institutions.

The time to incorporate interoperability between institutions is reduced, since places of interaction, since it identifies places of interaction and information exchange that can become a common core for important groups of institutions.

- Storage of software elements: Reduction of implementation costs, architecture costs, development time, etc.

5.9 Scale the minimum viable product

One of the main aspects that this guide seeks is that the entities develop scalable minimum viable projects and transcend the realization of pilots as the only objective to be achieved through the implementation of blockchain.

To scale the minimum viable product, it is important to properly plan the development of tests, determine who are the actors that should develop the tests, as well as indicate those responsible for design, programming and technology, and the actors that are required to test the pilot.

For the development of blockchain projects, below are some elements to be considered in the implementation to develop a minimum viable product as a necessary part of the development of the Proof of Concept[76].

1. Determine the objective of the Minimum Viable Product: establish what are the problems to be solved with the application, the conditions of cost-effectiveness, time management and how improvements will be made based on user feedback. In addition, establish metrics to evaluate the viability of the blockchain product.

2. Conduct an internal Minimum Viable Product launch: one of the fastest ways to receive feedback. Also, determine if a launch or presentation to a small group of users is necessary.

3. Scale the Minimum Viable Product: Based on the results, assess whether the product needs to be improved or whether it can be scaled immediately to achieve the purpose for which it was designed.

[76] Rodríguez, Nelson, (2019), Blockchain Proof of Concept: Enterprise PoC Guide. 101 Blockchain. https://101blockchains.com/es/prueba-de-concepto-blockchain/

5.10 Risk Management

To have a good record of lessons learned from the aspects to be improved, there must be adequate risk management. Entering this new field of public management with the support of technology should mitigate the risks of digital transformation that can be listed are:

5.10.1 Have the support of the directives

In any change project, which challenges the current paradigm of implementation of the institutional mission, it must be borne in mind that changes aimed at improving management must be accompanied by management support. Therefore, the projects of digital transformation of state institutions must be introduced by the areas that manage the processes and understood by the management. A transformation process that does not include management support for its implementation has a very low probability of success.

5.10.2 Define the problem to be solved, before choosing or implementing a technology

It is very common in a digital transformation process with Blockchain technology that there is a group of enthusiasts who are eager to help a process solely guided by using a specific technology. Before choosing technical/technological solutions and preparing an implementation, it is important to identify, first, which problems are to be solved by the incursion of technology. Not knowing well what you want to solve and how to achieve it can bring a lot of frustration to the teams, putting at risk not only the current efficiency of their execution, but also the perception that the technology itself is "not what you need" and thus wasting a substantial opportunity to improve the institution's processes.

5.10.3 Make decisions based on data, not instinct

The digital world is built on a foundation of data. Before starting a digital transformation project with Blockchain technology, it is necessary to have a good insight, that is, the keys that help us identify the real needs by doing some internal research. With data at hand, institutions can have a good assessment of what they want to transform and thus think about how to do it and make the corresponding decisions.

5.10.4 Agile organizational culture and security[77]

The digital transformation is not without risk. Organizations face the challenge of being agile in their digitization but recognize that they face difficulties in carrying out these plans. A recent Deloitte survey of 166 organizations around the world shows what are the main obstacles that delay the time it takes for companies to turn ideas into initiatives.

According to the Global Digital Risk Survey 2019 report, seven out of ten companies recognize that they face obstacles in bringing ideas to market with agility. 65% of the companies surveyed point out cultural barriers, 58% mention that processes and inherited methodologies slow down their progress, while 56% say that lack of talent is an impediment.

> "One of the challenges companies face for a rapid adoption of the digital transformation is the lack of qualified human teams. In addition, there is a growing need for profiles that combine knowledge of new technologies with an understanding of how to evolve the business. This is a challenge," says Manel Carpio, a Risk Advisory partner at Deloitte.

Many of these barriers make it difficult for companies to adopt new technologies beyond pilot testing. 20% of the respondents admit to having encountered difficulties in articulating and implementing the business model. Lack of maturity in the skills and governance model of companies, talent shortages, cultural opposition or budgetary constraints are slowing down digitization.

The report also concludes that the digital transformation has generated new digital risks, such as privacy, which is impacted by technologies such as big data, artificial intelligence or the Internet of Things (IoT). Carpio also mentions the bias introduced by artificial intelligence algorithms and the cyber security risks in IoT devices.

From a technological point of view, the cloud (85%), agile development methodologies (80%) and programming interfaces (77%) lead adoption levels. Less than 10% of respondents have managed to scale up technologies such as the Internet of Things, robotics, machine learning, Blockchain or natural language processing.

[77] Section developed since the expansion article (2019) https://www.expansion.com/economiadigital/innovacion/2019/10/18/5da47890468aebac148b457e.html

From the above, it can be inferred that the adoption challenge contemplates a settled and mature culture in terms of change management, which we will see later in this chapter.

5.10.5 Orientation towards the citizen and other actors

In the digital transformation, two groups of large actors are involved: internal and external clients. These groups must interact to generate successful transactions (procedures, services or procedures). The simplification of the processes before the citizen, the external client, and the user experience are fundamental for the project to have a landing zone within the citizenry that demands smooth interactions with the institutions, which turns these risks into great opportunities by reducing costs and increasing institutional efficiency.

The same applies if we look at the field of interoperability, in which it is mandatory that there is a common language that all institutions speak, from the technological and architectural point of view.

5.10.6 Decentralize the design of blockchain architectures and technologies

One of the biggest risks of the digital transformation, lies in choosing and defining which architectures, which networks and Blockchain protocols should be used for each sector and field of application. If it is done badly, the State can end up with a technological tower of babel that will be impossible to interoperate, taking away from digital transformation and Blockchain technology some of its greatest attributes, such as process efficiency and transversality in inter-institutional interaction. It is strictly mandatory that the transformation processes be accompanied by a specialized and interdisciplinary technical committee that sees the digital transformation horizon in a broader sense than individual institutions.

Likewise, it is necessary to prevent the implementation of technological "silos" in such a way that in the future it will prevent the development of processes that are interoperable with other platforms, machines, or software.

5.10.7 Change Management [78]

Change management is one of the preponderant challenges in the digital transformation:

[78]Section developed since the article from Ariel Jimenez Gil (2018) https://funcionc.com/2019/06/18/gestion-del-cambio-reto-digital-publico/

- Prepare and facilitate the development of new information technologies. The role of the State is fundamental in mobilizing the digital ecosystem, and therefore having a positive impact on industry.

- The challenge must be oriented to digitize the operation of both its public entities, its services, as well as the information to the citizen to ensure greater productivity, transparency, and access.

- When implementing technological projects, the state's organizational complexity has its own characteristics for facing changes: hierarchical structures, multiple internal and external controls, long decision-making processes, among others. Despite the internal structure and processes, any process of using emerging technologies must involve detailed change management planning so that the implementation of the initiative is successful.

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