BLOCKCHAIN TECHNOLOGY: USES AND TRENDS IN THE COLOMBIAN MARKET*

*Angel Alberto Vayoón Quimbao***
*Eduardo Mora Bejarano****

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ABSTRACT

New global market trends, in terms of science, technology and innovation, linked to the use and exploitation of Information and Communication Technologies (ICTs) as catalysts in the appropriation, transformation, use, storage and transfer of knowledge, require countries like ours to adopt these technologies to improve the sustainable management of innovative business models for economic and social development.

This study characterized and identified significant advances, benefits, and opportunities associated with adopting Blockchain as a model for sustainable development and social innovation. A bibliographic review was conducted to identify how adopting blockchain technology evolved in Colombia from 2010 to 2024, and the main sectors and cases that have driven this adoption. It was possible to identify that this technology has been explored and adapted in various sectors, promoting innovation, technical cooperation, improving transparency, and efficiency in key processes because of its functionality. As far as the Colombian legal framework is concerned, it shows that there is a favorable environment for its applicability in various economic sectors, including healthcare, education, finance, and industry. In conclusion, blockchain is positioning itself as a key driver of innovation with practical applications for process automation, with growing acceptance in multiple sectors of Colombia as a developing country.

Keywords: information technologies**,** computer application, automation, economic and social development, developing country, technical cooperation, Colombia.

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** MG. Fundación Universitaria del Área Andina. Facultad de Ingeniería y Ciencias Básicas. Bogotá, Colombia. E-mail: avaron2@areandina.edu.co Orcid: https://orcid.org/0000-0003-0643-358X

*** Dr. Fundación Universitaria del Área Andina. Facultad de Ingeniería y Ciencias Básicas. Bogotá, Colombia. E-mail: emora@areandina.edu.co Orcid: https://orcid.org/0000-0001-9641-8150

TECNOLOGÍA BLOCKCHAIN: USOS Y TENDENCIAS EN EL MERCADO COLOMBIANO

RESUMEN

Las nuevas tendencias de mercado global, en materia de ciencia tecnología e innovación, vinculado con el uso y aprovechamiento de las tecnologías de la Información y Comunicación (Tics) como catalizadores en los procesos de apropiación, transformación, uso, almacenamiento y transferencia de conocimiento, exigen que países como el nuestro adopten estas tecnologías para mejorar la gestión sostenible de modelos innovadores de negocio para el desarrollo económico y social.

En este estudio se realizó la caracterización e identificación de avances significativos, beneficios y oportunidades de la adopción del Blockchain como modelo de desarrollo sostenible y de innovación social, donde se hizo una revisión bibliográfica para dar identificar ¿Cómo ha evolucionado la adopción de la tecnología blockchain en Colombia entre 2010 y 2024 y cuáles son los principales sectores y casos de uso que han impulsado esta adopción? Donde se pudo identificar que esta tecnología viene siendo explorada y adaptada en diversos sectores, impulsando la innovación, la cooperación técnica, mejorando la transparencia y eficiencia en procesos claves por su funcionabilidad, en lo que concierne al marco jurídico colombiano demuestra que existe un entorno favorable para su aplicabilidad en diversos sectores de la economía entre ellos Salud, educación, las finanzas y la industria. En conclusión, blockchain está posicionándose como un motor clave de innovación con aplicaciones prácticas para la automatización de procesos con una creciente aceptación en múltiples sectores de Colombia como país en desarrollo.

Palabras claves: tecnologías de la información, aplicación informática, automatización, desarrollo económico y social, país en desarrollo, cooperación técnica, Colombia.

INTRODUCTION

Disruptive decentralized Blockchain technology is secure, innovative, and versatile, having the potential to be implemented in various areas of knowledge. Its immutable and transparent nature allows highly-efficient global commercial and financial transactions." [1].

In this analysis, we refer to the fact that blockchain derives the creation of all cryptocurrencies, peer-to-peer network technology, and this implies a model where no financial institution is necessary to facilitate moving currencies, or to conduct transactions, or ownership or origin verifications.

Accordingly, the most used cryptocurrencies in the global market are:

Bitcoins: The Original cryptocurrency, launched in 2009, Satoshi Nakamoto developed it anonymously, and it is the most popular. Moreover, its price movements have a strong impact on the rest of the cryptocurrency market. [2].

Ethereum: It is a blockchain, and Ether is a cryptocurrency. It is the second most popular, known as a 'utilitarian' cryptocurrency, according to its creator, Vitalik Buterin, in 2014. The difference between Bitcoin and Ethereum is that the latter is not only devoted to storing coin transactions, but also to running computer applications, including games, coins, and smart contracts. [2].

Ripple XRP: Ryan Fugger (2004) created it and designed it to facilitate international fiat currency transfers. The number of transfers Ripple makes has gradually grown, reaching second place in the market capitalization table with a 36,000% growth. [3].

Litecoin: Charlie Lee (2011) created it as a similar alternative to Bitcoin. Its creator designed it to pay for goods and services daily. Transactions using Litecoin can be confirmed on a P2P network faster than Bitcoin transactions. [4]. [5].

Neo: It was founded in 2014, and promotes automation and asset management with smart contracts and Dapps such as Ethereum. [6].

Iota: David Sonstebo, Sergey Ivancheglo, Dominik Schiener, and Sergei Popov founded this technology in 2015. It is a cryptocurrency based on a Directed Acyclic Chart (DAG) structure. It facilitates micro-transactions at no cost and helps maintain the integrity of the information. [7].

Following this reasoning, ICTs (Information and Communications Technologies) provide the necessary infrastructure and tools to develop and deploy blockchain-based solutions that can be used to create other representation values, known as tokens:

1. Utility tokens are used in an ecosystem to participate in a service, such as casinos, where you buy your tokens or tokens that can then be used in your machines and restaurants.

2. Security tokens, digital representations of electronic assets, are like shares issued digitally. They can also be applied when tokenizing buildings, art, and other things. [7].

This technology requires the transformation of business models and internet functionality that will have to evolve towards a financial environment, generating a significant impact on governance, digital humanism, and social innovation. This enhances the synergy between entities that train human talent, like universities, and public and private companies. This technology is widely accepted in the Fourth Industrial Revolution and has been used in different organizations and industries, such as healthcare, computer security, manufacturing, publishing, financial, and government companies. [8].

This study aims to answer questions that help elucidate blockchain's potential, application, and uses. Furthermore, it is an innovative, disruptive technique that not only makes financial and commercial transactions more agile and efficient, but also other multiple fields of knowledge [8].

What is Blockchain, and how does it work?

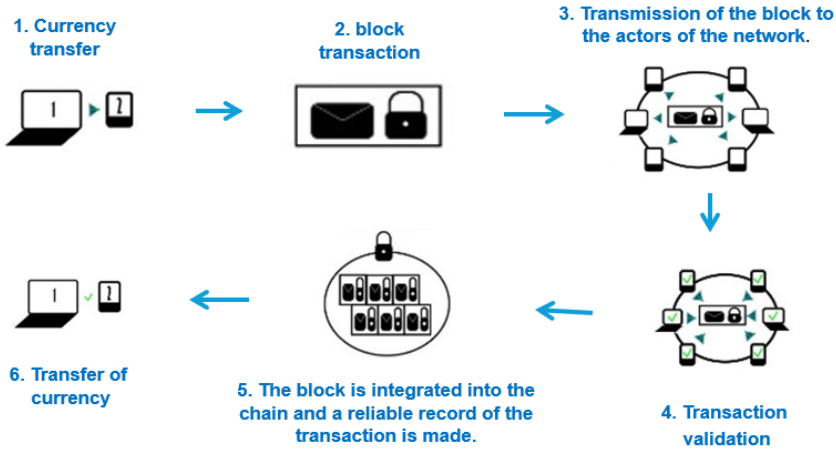
Generally speaking, there are various concepts, and of these, two have been the most appropriate to consider:

Concept 1: Blockchain is a participatory data store that functions as a public ledger, immutable to perform transactions. Users participate, and when a participant supplies information to the database, a report is registered in each global network node. [9]. Cryptographic methods and shielding information attributes protect this technology, and data access is achieved using an encrypted key, and an exact duplicate is stored in each network node of the series, constantly certifying information availability. [9].

Concept 2: Blockchain technology is accepted as a distributed ledger technology that breaks traditional paradigms and allows those involved to execute transactions, confirm settlements, and transfer assets at small costs. [10]. The flow model of cryptocurrency and blockchain transactions is developed as follows: User 1 initiates a transaction for User 2, through a peer-to-peer blockchain network. A cryptographic

identity (a pair of keys, one public and one private) is verified and used to uniquely identify the two types of users.

Figure 1. Diagram of a Transaction on the Blockchain



Source: Adapted from "Insider. Pro I Financial Times" (2018).

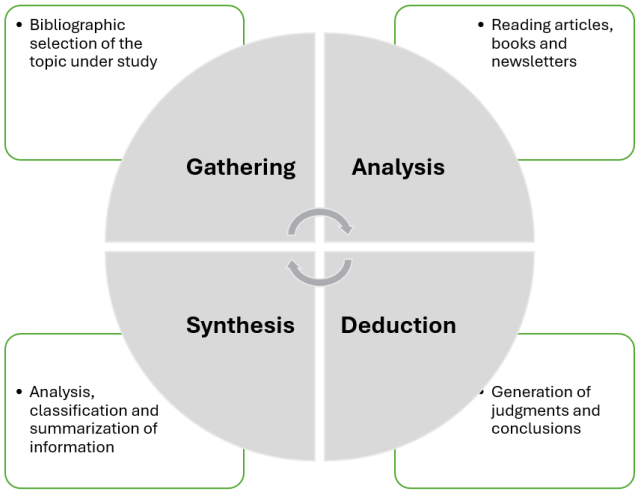
Transactions will be issued to the blockchain network's memory pool for verification and validation. A new block is generated by obtaining a certain number of suitable nodes, and this is called reaching a consensus. When this is achieved, a new block will be produced throughout the network, including transactions made during this time and on the ledger of the blockchain. Each node updates a corresponding copy and associates it with the original block through a digital signature. [7].

1. METHODOLOGY

This research conducted a systemic review of the literature, considering aspects such as formulating the research question: How has the adoption of blockchain technology evolved in Colombia from 2010 and 2024, and what are the main sectors and cases that have driven to adopting it?

To answer this question, the study conducted a critical analysis of bibliographic information, syntheses of the results of previous studies, deductions, and conclusions.

Figure 2. Research methodology



Source: own elaboration.

Phase 1: Selection of bibliographic material about the study.

Phase 2: Reading books, scientific articles, and newsletters on the advances, evolution, and applicability of blockchain in Colombia.

Phase 3: Analysis, classification of the information to make an abstract.

Phase 4: Analysis of the information, judgments, and conclusions.

In the first stage, a literature review was conducted to analyze the information regarding the use of blockchain and its applicability in the global production system, including analysis studies and applications that aimed at the use of 4.0 technologies in development processes that link societal actors.

2. RESULTS

An analysis of blockchain's functionality and the favorability of the Colombian legal framework shows that there is an environment conducive to the applicability of this technology in various economic sectors. They include healthcare, education, finance, and industry. In 2019, Dinero magazine published an article entitled "This is how blockchain business is going in Colombia", highlighting that blockchain applicability in the country reached US$4.8 million in 2018 and that it is still in an embryonic phase, noting that "projections indicate that this business will go from US$4.8 million registered in 2018 to US$92.7 million in 2024. This is according to data from Frost &

Sullivan consulting firm and the Vice Presidency of Innovation and Sectoral Intelligence of Procolombia's calculations" [11].

They mentions that the state will promote the automation of digital elections, property titles and academic certificates, according to Alejandro Fernández, creator and CEO of Token Sport and blockchain consultant, highlights that there are interested sectors such as agriculture, cannabis pharmaceutical companies, emphasizing what has been done by Ruta N, in Medellín, where the "Center for the fourth industrial revolution" was inaugurated. focusing on the research, development, and use of this technology. [11].

On the other hand, Colombia Fintech is based on "technological evolution to revolutionize the production, provision of services and procedures of the usual investor dynamism", according to data from the organization's website, it currently has subsidiaries in the financial and stock market sector, such as data credit, banks, stockbrokers, insurance industry and companies specialized in technological solutions such as: Net, Java, IBM, Oracle, iOS and Android, consulting companies in the area of mobile services and digital transformation, software development companies for finance, offering IT outsourcing services specialized in the development of custom software and computer applications that use artificial intelligence. [12],

Figure 3. Fintech Members

Source: https://www.colombiafintech.co/miembros

Similarly, the newspaper La República published that the financial superintendent Jorge Castaño mentioned that a reliable computer system was implemented in the country to manage requirements and programs that use blockchain; It is worth clarifying that this technology is in a development phase; Therefore, the prudent use of this and the setbacks that arise become a challenge for the company, the State and the beneficiaries both nationally and internationally since they encourage identical debates.

The importance and advancement of blockchain is so important that, according to values disclosed by Oracle, there are more than 2,500 licenses issued, in addition; this is estimated that by 2027 more than 10% of international GDP will use this technology, as it can be adapted to any business model. [13].

For example, a clinic that adopts blockchain could track medicines, trace items, preside over inventory control and have specific information when required. In this way, there is a total context in productivity, minimizing the loss of products in their evolution, excluding the lack of data, and helping to protect requests by increasing quality, by controlling the components used for their manufacture [13].

Currently, experiments with organizations from different productive sectors are flourishing, where it is estimated that, for every ten companies in the country, only one goes to blockchain and another seeks advice, for this reason, the technology is in full growth.

In addition, analysts at Tigo Une pointed out that there is still a need to "advance legislation around blockchain, the government has taken steps to establish policies on this technology, which could become an enabler for the adoption of the 5G network", so its maturation would not generate until after 2022. [13].

Therefore, researchers from different latitudes focus their projects on the applicability of blockchain for its potential to address issues of privacy, security and interoperability or inefficiencies that affect public health; currently, there is talk of smart health mediated by this technology using digital tools such as tokens, wallets, smart contracts and oracle services.

This innovation revolutionizes the way financial information, individual and collective health, is accessed and used in a wide variety of systems and applications. Important steps have also been taken in healthcare through telemedicine, the development of medical equipment, and health simulation and research to leverage artificial intelligence and big data technologies, leading to completely disruptive health models. [14].

In recent studies Min tic, Ministry of Science, Chambers of Commerce and the Chamber of Industry and Commerce of Colombia have taken blockchain into account as a technology, since no registered licenses were found at the technical, technological or research level, the only studies that have come to light are those carried out by students/researchers from various higher education institutions in the country, mentioned below. [15].

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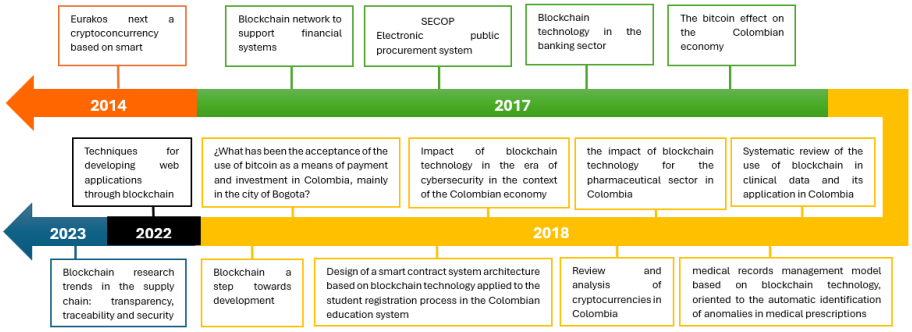
Figure 4. Timeline of blockchain research in academia



Source: own elaboration.

The first study on blockchain was carried out at the Autonomous University of Bucaramanga in 2014, the project was called Eurakos Next: A Cryptocurrency Based on Smart Contracts that proposed the invention of a digital asset based on Eurakos that works through smart contracts, with the aim of making agreements between several countries, to implement blockchain based on Ethereum guidelines. [16]

In the period between 2017 and 2024, various research projects were presented by undergraduate and graduate students from different universities in the country, who presented research proposals on blockchain seeking economic and social development for the country; These are some articles published:

- (Electronic Public Procurement System) a smart contracting method for public tenders in Colombia, using blockchain to demonstrate its effectiveness and control contracting efficiently in different sectors of the Colombian economy. [7].
- Byzantine, blockchain network for the support of financial systems (prototype of APP application) for users to access financial banking services through their cell phones. [17].
- Analysis of the impact of blockchain technology on different productive sectors, in the era of cybersecurity in the context of the Colombian economy. [18].
- "Blockchain Technology in the Banking Sector", in which actions that this sector is taking were shown. [19].
- "The Bitcoin Effect on the Colombian Economy", research in which the influence of cryptocurrency on the Colombian economy was analyzed. [20].
- "Analysis of the impact of blockchain technology for the pharmaceutical sector in Colombia, evaluating its application in e-commerce through benchmarks in the value chain of this sector". [21].
- "Design of the architecture of a smart contract system; based on blockchain applied to the process of student registration in the Colombian education system", researches the design of the architecture of a smart contract system, for the management of the registration of people to reduce the risk of fraud in the Colombian education system. [22].
- "Drug prescription management model, implementing blockchain in order to control and report adverse effects, contraindications, recommended doses and medicinal interactions, based on Colombian regulations.", aimed at the automation of anomalies in medical prescriptions. [23].
- Systematic review of the use of blockchain in clinical data and its application in Colombia", consisted of conducting an analysis of the application of blockchain, so that, through studies and synthesis of the extracted and analyzed data, methods and solutions can be developed to be applied in the processes of health entities. [24].

- "Review and analysis of Cryptocurrency in Colombia", the research is based on an explanatory review of the cryptocurrency market in Colombia, describes costs of use, transactional ease, and user privacy, explores any challenges of a legal-political nature faced by cryptocurrencies, uncertainty and user confidence, and political confrontation in neighboring countries. [25].

- "What has been the acceptance of the use of bitcoin as a means of payment and investment in Colombia, mainly in the city of Bogotá?" The establishments that use Bitcoin as a form of payment in common transactions are analyzed, to determine the acceptance of this cryptocurrency. [26].

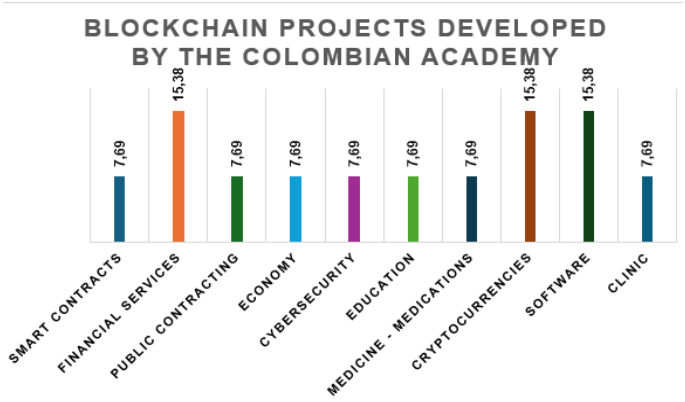
- "Blockchain, a step towards development", this research outlines the initiative of the Fintech and Regtech project, focused on the usability of blockchain technology for its implementation in applications, to improve and optimize these processes that are estimated to be harmful. [27].

- Techniques for developing web applications through blockchain" research that focuses on identifying appropriate techniques, tools, models, and programming languages for the design and development of a secure application using blockchain. [28].

- Research trends on blockchain in the supply chain: transparency, traceability and security, research aimed at identifying and analyzing research trends, based on the original and structural studies of this topic in Scopus, between 2000 and 2022. [29].

Currently educational institutions have research on blockchain, therefore, as results of the previous research mentioned by the Colombian academic sector, it is represented in the following graph:

Figure 5. projects developed by the Colombian Academy



Source: own elaboration.

The above graph shows the projects developed in the country by academia where it is very clearly perceived that the sectors in which it is most inclined are financial services, cryptocurrencies and software development with 15.38% and those that contain the least favorability are smart contracts, public procurement, economy, cybersecurity, education, medicine-medicines and the clinical sector with 7.69%. However, it is important to understand that this technology is in an embryonic process, as assured by the consulting firm Frost & Sullivan and the Vice Presidency of Innovation and Sectoral Intelligence of Procolombia" [11].

On the other hand, the legal issue of blockchain and the use of cryptocurrencies is discussed; for the year 2014, the Financial Superintendence of Colombia, issued a circular on the risks of operations carried out with "Virtual Currencies" in Colombia, where it expresses the following section which was taken to the letter:

The use of "virtual currencies" such as Bitcoin exposes the public to the following risks:

According to the Bank of the Republic, Law 31 of 1992 establishes that the peso is the only means of payment of legal tender with unlimited liberating power. Consequently, bitcoin is not an asset equivalent to legal tender in Colombia since it has not been recognized as a currency in the country. It also points out that it is not an asset that can be considered a currency, according to the criteria of the International Monetary Fund, since it does not have the support of the central banks of other countries. Therefore, the exchange regulation is not contemplated with respect to bitcoin and therefore cannot be used in the operations controlled by the Exchange Regime contained in External Resolution No. 8 of 2000 of the Board of Directors of the Bank of the Republic. [30].

Virtual currencies are not supported by physical assets, nor by a central bank, nor by the assets or reserves of that authority, so the exchange value of these could be drastically reduced and even reach zero. Therefore, people are exposed to high volatility in the price of the instrument, given the widespread speculation that persists. [31].

In 2016, Semana Financial Magazine Nacional published the news entitled Is bitcoin legal in Colombia? It is a digital currency developed as a means of payment for goods and services in virtual transactions; however, the Bank of the Republic imposed barriers to its use. [32].

In an interview, the professor of the Universidad de los Andes expert in financial transactions, Dr. Juan Carlos Varón, indicated that cryptocurrency does not have any type of legal backing worldwide and that the Financial Superintendence restricts banking companies and investors to refrain from accepting payments in cryptocurrency. [32].

Previously, a proposal for Bill 028 of 2018 (http://leyes.senado.gov.co/, 2018) was circulated, which explored ways to regulate virtual money transaction procedures, granting inspection and control to the Ministry and the SIC. Superintendence of Industry and Commerce. [33].

Experts think that it is hasty to enact a law that regulates the use of cryptocurrencies, since their potential has not been fully extended, even though transactions with these currencies are constantly growing, this has generated certain judgments about this bill, which presented technical and legal inconsistencies as FedeSoft states. Fintech and Blockchain Colombia, one of the most censored sections is that of requesting state approval to negotiate with cryptocurrencies, which challenges the free and indeterminate access to blockchain, in addition to criticizing the tax burden. [34].

Meanwhile, state institutions and universities in the country currently offer courses, diplomas, and seminars, these are any training courses:

Table 2. Blockchain training in Colombia

Level	Institution	Specialty	URL
Graduate	Sergio Arboleda University	Blockchain development of decentralized applications on Ethereum (daaps)	ttp://www.usergioarboleda.edu.co/educacion-continuada/diplomado-en-blockchain-desarrollo-aplicaciones-descentralizadas-ethereum-daaps/
Course	Universidad de los Andes	Blockchain and cryptocurrencies beyond bitcoin	https://educacioncontinua.uniandes.edu.co/es/programas/curso-blockchain-y-criptomonedas-mas-alla-de-bitcoin
MOOC	Javeriana University	Blockchain Technology Fundamentals	https://educacionvirtual.javeriana.edu.co/fundamentos-de-la-tecnolog%C3%ADa-blockchain
Course	National University (Medellín)	Blockchain	https://medellin.unal.edu.co/educacioncontinua/tecnologias-de-la-informacion-y-las-comunicaciones/216-curso-decodificando-la-blockchain-y-los-contratos-inteligentes.html
Course	Colombiaprende de Min tic	Blockchain	http://www.bogotaaprendetic.gov.co/cur11.html
Seminar	Chamber of Commerce	Blockchain cryptocurrencies	https://www.ccb.org.co/Eventos-y-capacitaciones/Nuestros-eventos/Formacion-Empresarial/Seminarios-virtuales/Blockchain-y-criptomonedas
Course	Network of universities for the promotion of research in information and communication technologies.	Tokenization of real-world assets	https://uxtic.co/spip/index.php

Source: own elaboration.

BLOCKCHAIN APPLICABILITY SUCCESS STORIES

Ubitquity, LLC, registered in Wilmington, Delaware, USA, founded in 2015, offers an easy-to-use SaaS (Software-as-a-Service) platform and API (Application Programming Interface), to improve the overall experience of real estate transactions, with its patent-pending platform, Ubitquity introduced a registration and tracking system, which by using blockchain that adds transparency to the process, property information and reduces search time. [35]

The process brings value to the different actors in the real estate ecosystem with a decentralized registration methodology that helps increase trust in the information that is recorded, with blockchain seeks to strengthen and not replace its existing analog counterpart: physical or paper records in real estate and its customer base includes title companies, municipalities/land registry offices, aviation, abstraction and custody companies. [35]

In addition to being pioneers in the real estate sector, Ubiquity cemented its position in the industry by partnering with Brazil's real estate registry office in 2017, called the Imóveis registration cartório, to improve its land and real estate registration process. This is because this country faces a high rate of corruption, lack of property rights and registrations, a centralized system that has facilitated the abuse of it; this pilot in Brazil added an extra layer of efficiency and confidence to the currently inflated system. [35]

Likewise, the University of Nicosia, a world leader in the field of blockchain, is the first school to use this technology to manage student certificates received from MOOC platforms. [36]

The Chinese government was the first to use a service platform that employs blockchain. The district of Chancheng (China) reached an agreement with the software company 21ViaNet China Inc. in 2016. In Foshan City, where they created the "Province's Guangdong Big Data Comprehensive Experimental Area", a blockchain platform was built to manage information, construction guarantees, data security and credit, to enhance mutual trust between the state, enterprise, and citizens. [9].

This project is based on the one-stop services in Chancheng District, which started in 2014 and serves to create government institutions where different services are offered on various platforms. This strategic cooperation agreement and blockchain application of e-government focuses on two objectives:

First: Solve the problem of individual credit by building a digital identity system, using blockchain to preserve all records of the exchange system and trading in a cloud system to verify the origin and authenticity of data during transmission. Establish a

trusted personal identity that includes authentication and digital signature capabilities, providing reliable identification of individuals as a core part of one-stop-shop services.

Second: Reveal reliable information related to sustenance. Currently, the Chancheng government applies blockchain for food security, using an app called Smart Farmers Market. It has contracts with seventy-three agricultural markets, which allows it to upload and disclose test data of products during processing, production, transport, and marketing, ensuring the quality and safety of the products. [9].

Proposals for Blockchain use cases in Colombia.

Through the UxTIC Network, the university has been linked to form a community for blockchain research, with the aim of extending knowledge, participating in activities such as the university tour where the traceability of private or state projects is carried out, in the network there are also communities such as Token Partner43, recognizing institutions that implement this technology, where it is observed that human resources lack knowledge about blockchain, therefore the network is looking for mechanisms to provide training in this regard. [37].

In 2020, the magazine dinero published an article mentioning that the clinic of the Americas in Medellín implemented blockchain that applies monitoring, control, and supply of medical devices such as catheters, pacemakers, among others. [38].

The technology companies Cornerstone and RoadLaunch and Boston Scientific Colombia conduct a registration and control of the acquisition and inventories of therapeutic instruments with technology that incorporates IBM Blockchain, supported by Hyperledger Fabric; They also direct this progress so that the Colombian health system offers quality care to patients. [38].

The management of the clinic in charge of Dr. Juan Gabriel Cendales, states that "due to the implementation of blockchain, it has been possible to reduce the supply of raw materials to just 24 hours, by 90%, the duration of the billing process and by 60% the failures in purchase orders", in the same way; indicates that it is the first case of use of this technology model in the area of health in Colombia. [38].

De igual manera la "Agencia Nacional de tierras de Colombia" llevo a cabo la versión beta de una propuesta en 2018, bajo la tutela de la Universidad Nacional de Colombia patrocinado por el Ministerio de Ciencia, Tecnología e Innovación, el Ministerio de las Tecnologías de la Información y las Comunicaciones y la Agencia Nacional de Tierras - ANT. Se creo un prototipo para acopiar información encriptada del proceso de conferir la reposición de terrenos disminuyendo riesgos de adulteración,

asolación u exclusión de resoluciones luego de la aprobación convirtiéndose en la primera entidad del estado en usar blockchain en política pública. [39].

También el "Banco de la República de Colombia" realizó un convenio en cooperación técnica con Ripple en el año 2023 para optimizar la automatización de pagos de alto valor apoyados en blockchain de código abierto y sostenible energéticamente y además instruir a entidades públicas nacionales y territoriales por medio de pruebas interactivas y colaborativas en tiempo real sobre cómo la velocidad, escalabilidad y transparencia de ésta tecnología lograrán transformar métodos de pago y la gestión de datos, con esto impulsar la innovación y la eficiencia y así explotar toda su capacidad de transacciones seguras y transparentes. [40],

3. DISCUSSION

MinTIC in Colombia, advances in training plans for the adoption of blockchain; holding events and training workshops, offering information on the capacity, advantages, applicability and inclusion of transformation of this technology; exposing the various companies founded in DLT, supported by tasks of promotion of the information technology (IT) industry, led by the Ministry of ICT in conjunction with Fedesoft. [34].

In accordance with this, the national government published the "Reference Guide for the adoption and implementation of projects with Blockchain technology" of the Ministry of Information and Communications Technologies of Colombia (MinTIC) is designed to facilitate the integration of blockchain in the country's public entities. A guide published in 2021 and recently updated, which aims to improve transparency, security, and efficiency in this environment. [39]. However, it is not enough; at the end of 2023, the country had 5,188,402 companies, including large, small and from all types of productive sectors, according to figures issued by DANE [41].

Although the blockchain trend can be considered promising, according to research data, it can be determined that the use is still incipient compared to the number of organizations. According to the Digital Economy Observatory of the MinTIC, less than 0.5% of companies in our country have opted for this technology and 3% are in the process of implementing it. [42].

Above all, because blockchain is considered as a great intensifier of options for companies in the industrial sector in general, arousing interest by creating new markets, with a reduction in costs within the company presenting services, solutions, confidentiality and decentralization of information, because it not only has these characteristics, but also has high security, since you only have access with an encrypted key.

Colombia, being a developing country, could take advantage of this option, because these services are a guide to increase the quality of life of the community in general, such as the registration of intellectual property and real estate, storage of critical documents, execution of smart contracts, monitoring of investments, expenses, supply chains or the promotion of the Internet of Things (IOT + DLT). among others. [42].

For the use of blockchain in Colombia to have a significant impact on sectors from the public to the private, more research must be carried out to generate strategies to promote the appropriate use according to each line of the economy and that contributes to social development; Therefore, it is considered that the national government should create a public policy that provides legal certainty to companies and individuals and seek international cooperation to align regulations and practices with global standards. That it encompasses the following considerations:

1. Education: Involve subjects focused on blockchain in undergraduate and graduate careers to learn about all its benefits, in addition to creating seminars, workshops, conferences and webinars for companies, public officials and the common citizen. both in universities and technical training centers

3. Promotion of innovation and entrepreneurship: Through tax incentives and economic support for startups and companies that develop blockchain-based solutions, creating incubators and specialized communities to support entrepreneurship and new business development.

4. In the state: Implement blockchain to improve transparency in public administration to combat corruption through the monitoring and auditing of transactions, in addition to adapting registration systems and certifications such as property titles, vehicle registrations and other official documents, promoting the creation of collaboration networks between companies, universities and governments for the development of projects; It is also important to advance bilateral agreements with other countries that have adopted blockchain to share knowledge and technologies.

5. In the industry: Promote the use of this technology to improve efficiency and security in banking transactions and digital payments, in supply chains to improve traceability and transparency, develop solutions for the management of medical records and patient data management.

6. Technological infrastructure: Investing in this area is necessary to support blockchain applications, such as data centers and high-speed networks and strengthen cybersecurity measures to protect applications and information.

4. CONCLUSIONS

Blockchain is a versatile technology of data distributed in blocks where all nodes have a record of the information, where we go from a centralized logic, with someone who controlled all the information, to a normalized and homogeneous distribution system where the information is in the cloud and is accessible to all users.

It is a logical system in which no one can monopolize the content: all users of the system agree on which single database they will converge, because it is decentralized, it is very secure, it does not belong to anyone, therefore, it cannot be modified. If one of the computers on the network stops working or your system is altered by malicious software or hacking, the information is not lost as it is on the other registered computers.

It is a fantastic opportunity for the country since as it is implemented, public and private industries from different sectors of the national economy will be positively impacted by this technology in the coming years, among the current ones we can mention the Health, Financial, Judicial and Government sectors.

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