Research Article

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A systematic review of medical information evaluation approach for P2P analysis in blockchain.

Yogesh Kushwaha[1], Niranjan Lal[2], Manisha Manjul[3]
[1,2]*SRM Institute of Science and Technology NCR Campus, Modinagar - India*
[3]*Govind Ballabh Pant Government Engineering College, New Delhi - India*

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***Abstract*—** During the last several years, blockchain has generated a substantial amount of interest in the field of healthcare. It can mitigate a broad range of significant challenges that are present in the systems that manage electronic health records. This report provides a comprehensive review of the previous research that has been done on the uses of blockchain technology in the healthcare business. This study analyses and examines 144 publications that explore the significance of using blockchain technology to enhance healthcare operations as well as the limitations of doing so. The purpose of this project is to provide evidence of the usefulness of the technology, as well as to draw attention to the challenges and opportunities that lie ahead for blockchain studies around healthcare. The article begins with a comprehensive overview of blockchain technology and the characteristics it has. After that, the bulk of the study is devoted to doing a comprehensive literature assessment of the publications that have been chosen to highlight the ongoing research topics associated with blockchain-based healthcare systems. Following that, the most important application areas are outlined, followed by a discussion of the solutions that blockchain technology may provide inside healthcare systems. A discussion piece is included at the end to shed light on the many constraints, difficulties, and potential future research possibilities.

Keywords: healthcare, blockchain technology, healthcare system, health record, future research.

*Corresponding author.
Email: yogeshkushwaha.phd@gmail.com (Yogesh Kushwaha).
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I. INTRODUCTION

From the days when medical professionals had to manually enter patient information into paper records, the healthcare system has gone a long way. Patients can now get access to their electronic medical records, and physicians can employ linked devices that are part of the Internet of Things to undertake real-time monitoring systems of patients' health and diagnosis. The improvements have been tremendous and should be recognized for their merit, as they have significantly raised the bar for the level of medical care and raised the bar for the degree to which life is overall. The lack of access to competent medical treatment has resulted in the potential to have devastating effects on society. An unreliable healthcare service is the result of unnecessary treatment, a diagnosis that is unreliable or inaccurate, healthcare procedures that are inept or dangerous, a violation of clinical practice rules, inadequate infrastructure, a lack of educated clinical personnel, and errors committed by both doctors and patients regarding medication. These problems have resulted in the loss of many lives and have had an impact on the economy of the nation. In India, the quality of healthcare was either inadequate or nonexistent in 2016, leading to the fatalities of 1.6 million citizens. This is twice as many people as passed away because of the absence of medical care in the previous year. The declining quality of medical treatment in India is responsible for the deaths of around 122 out of every 100,000 people in India each year.

Current studies on the technology have shown that it is useful in a variety of facets of healthcare, including the monitoring of biomedical equipment and pharmaceutical violations, the exchange of health information, the management of patient data, and data security [1-4]. The use of the technologies behind blockchain within the healthcare sector necessitates not only overcoming technical obstacles but also establishing a robust foundation in terms of network and hardware infrastructure [5]. Admittedly, in today's (ICT) information and communications technology construction, large manufacturers will supply specialized goods and services as well as professional equipment, which considerably reduces the challenges that must be overcome in the building of the facility. Blockchain networks offer a broad variety of applications in healthcare systems, many of which relate to privacy and security and are designed to prevent unwanted access to patients' medical records. Unfortunately, since there is not enough professional design of security standards, healthcare systems are vulnerable to a wide variety of security risks, including interoperability [6], authentication, data exchange, the transfer of medical data, and the consideration of mobile health [7]. In addition, since there are so many different types of created hardware devices, the primary concerns about blockchain technology in the medical industry are deployment and data management.

Overview of Blockchain

The successful creation of Bitcoin by Nakamoto brought to life an idea known as blockchain technology. The blockchain method is a notion that came into existence as a result. The term "distributed ledger" refers to a sort of ledger that will be used by several authorized parties to access the ledger and update information while maintaining its transparency and security. To be more specific, a blockchain is defined as a chronological series of blocks that constitutes a record of transactions that are both full and genuine. Each of the blocks is connected to the one before it by a reference, which is more commonly known as a hash value. This creates a chain when all of the blocks are linked together. The very first block is called the genesis block, and the block that comes before any given block is called its parent block. As there is no participation of any 3rd parties in the transmission of data over blockchain, there is essentially no chance of data piracy or manipulation. Another important quality of the blockchain is its persistent nature. Due to a shared ledger that is held across multiple nodes in the transaction having been recognized in the blockchain, it is no longer possible to delete that transaction from the blockchain [8]. Figure 1 represents the diagram of the blockchain.

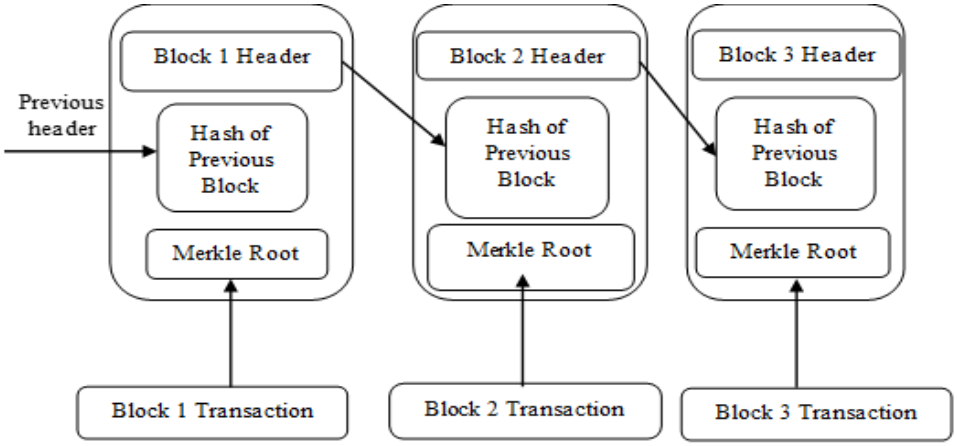

Figure 1: The diagram of the blockchain [9].
Source: Own elaboration.

A new block could also be inspected and traced back to the one that came before it using blockchain technology. A series of blocks can be strung together using this method. For recording block transactions, Merkel's tree is constructed [10].

Types of Blockchain

The term "blockchain" refers to a method that can be employed to verify any network and defines a means to link a node network together. These are referred to as authorized blockchains, and one example of this kind of blockchain is Ripple. Authorized blockchains are distinguished by the fact that the members of the nodes that are participating in the blockchain are already familiar with a working familiarity with the network [11] in addition to the Hyperledger Fabric [12]. Like Cryptocurrency [13] and Ethereum [14], blockchain networks are also a viable option. Access to the network and membership could be gained by anybody who is not a participant in the public blockchain. The capacity to move data and construct and exchange digital ledgers inside a peer-to-peer network is made possible by blockchain technology. Figure 2 presents an illustration of the blockchain's underlying architecture. Users can control and check the status of transactions. There is no need for centralized

authority in this situation. Due to the centralization of arbitrators, modifications, system setup, and service within the communications industry, the decentralized method results in a significant reduction in the costs associated with these activities. Despite its tremendous efficiency, it often has challenges with its capacity to scale.

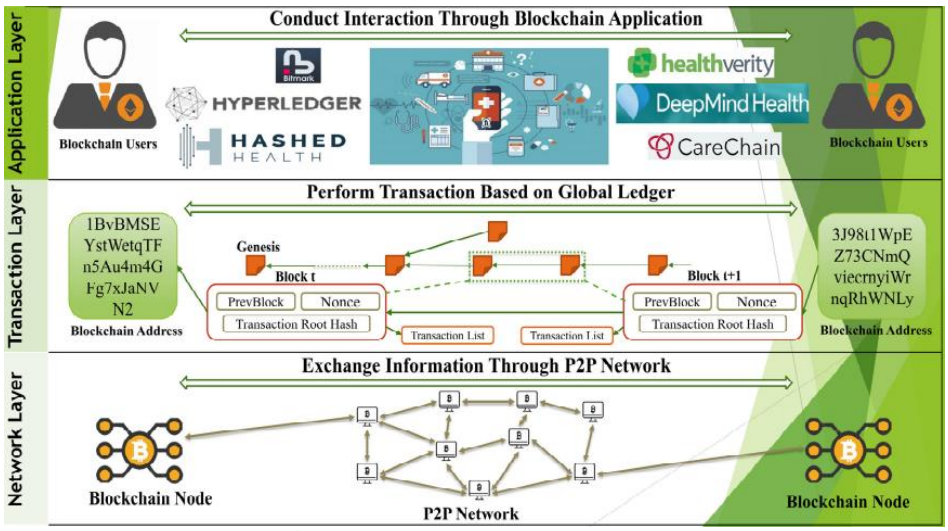

Figure 2: The architecture of the Blockchain [9].
Source: Own elaboration.

Public Blockchain

A blockchain is public if it allows anybody to join the network and access the blockchain without the need for special authorization. Using a smart contract that requires evidence of effort, every person in the community could take part in the issuing of permits. In most cases, the creation of a blockchain is motivated by the desire to decentralize power securely. The placement of (Peer-to-Peer) P2P blocks is intended to demonstrate whether or not there is decentralization. Before gaining access to the database to look at previous transactions, a node in the transactions is represented by the cryptographic tree based on the Merkle hash function. All nodes in the blockchain are kept up to date with transactions. Anybody can sign up to become a node and offer them the blockchain files. The reiteration of a blockchain network that is consistent across all nodes provides security for the system. The inefficient procedures for lawful transactions have been made much more efficient as a result of these blockchains. It takes a significant amount of electrical power to verify a transaction, and this power needs only grow as the network expands to include new nodes [15].

Private blockchain

This type of blockchain is a limited form of blockchain in which users' information is subject to heightened levels of monitoring. To participate in the verification and validation of transactions, individuals in the P2P network need to have authorization. Nonetheless, businesses are free to take part in the verification and validation of transactions regardless of whether they have the authorization to do so. Blockchains that are accessible only by those with certain permissions need a high degree of technical competence to verify and validate transactions. Private blockchains are constrained by the absence of decentralized systems, but public blockchains are not subject to this limitation. Public blockchains can create safe databases via the use of decentralized systems [16].

Consortium Blockchain

This type of blockchain combines both blockchains above into a single network. This arrangement allows for some degree of decentralization inside the network. It is possible to execute data transactions for both public and private blockchain systems, and peers can be chosen ahead of time. A private blockchain and a consortium blockchain are two very different things. Blockchain consortiums are made up of very trustworthy entity models that are stored in blockchains and untrustworthy entity models that are stored in public blockchains. Conventional centralized systems are what people often refer to as private blockchains. For transaction verification and confirmation, strong encryption mechanisms are required. It is still necessary for the blockchain consortium to be perfect in terms of trustworthiness, validity, and accuracy [17].

P2P Analysis in Blockchain

Blockchain technology conducts in a dispersed P2P way, which provides many benefits compared to conventional or centralized architectures. These advantages include the elimination of a single failure point, which offers the network exceptional reliability, and the ability for nodes in the network to work in a paired manner, which tends to increase the computing power. In the proposed system model, it is assumed that every health organization desiring access to Electronic Medical Reports (EMRs) must undergo registration with the blockchain process, providing their organization's details. After successful registration, the organization needs to apply for wallet assignment (as shown in Figure 3). This process involves generating a combination of public and private keys for each organization. These keys are utilized according to the cryptographic requirements of various applications. Additionally, each wallet is assigned a unique wallet ID (W_ID), which serves as an identifier for the respective health organization [18].

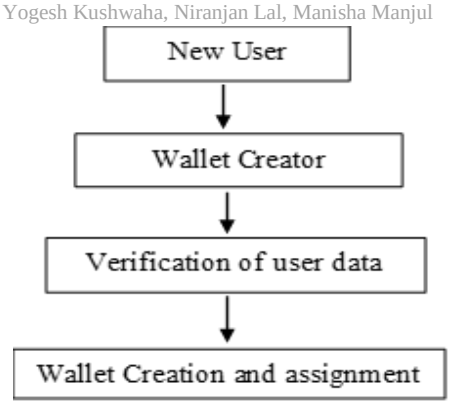

Figure 3: Steps for Wallet Assignment [18].
Source: Own elaboration.

Problems of the conventional healthcare system

The perfect healthcare system would provide uninterrupted connections, making it possible for patients and suppliers of healthcare services to work together regardless of organizational or geographical constraints. It should also stimulate the development of safe platforms and apps for exchanging health data, which will allow for improved diagnostic capabilities and healthcare services.

There is a lack of privacy and integrity of health data, there is a lack of accurate and comprehensive health patient histories, and there is a dearth of reliability, which helps prevent problems. Network congestion, segmented and incorrect health information, gap that exists in workloads caused by incoherent and provider healthcare solutions, and a severe lack of reliability, help avoid problems in the platform for the interchange of data that processes information obtained from different healthcare systems, all act as barriers to the provision of personalized healthcare in conventional healthcare systems. Personalized healthcare can only be provided when these barriers are overcome. The most important aspects of these concerns are outlined in Figure 4. In traditional health care, the doctor makes the diagnosis for the patient and then manually enters the patient's health information into the neighborhood pharmacy machine which is the primary repository of information at the hospital. Since there was no way for the user's smartphone or the local machine to communicate with one another, there was no option for real-time diagnostics. The hospital can get access to the centralized database where all of the patient's medical records are kept. On the other hand, consumers have little control over the information about their health, and there is an absence of confidentiality, openness, and authenticity in the data.

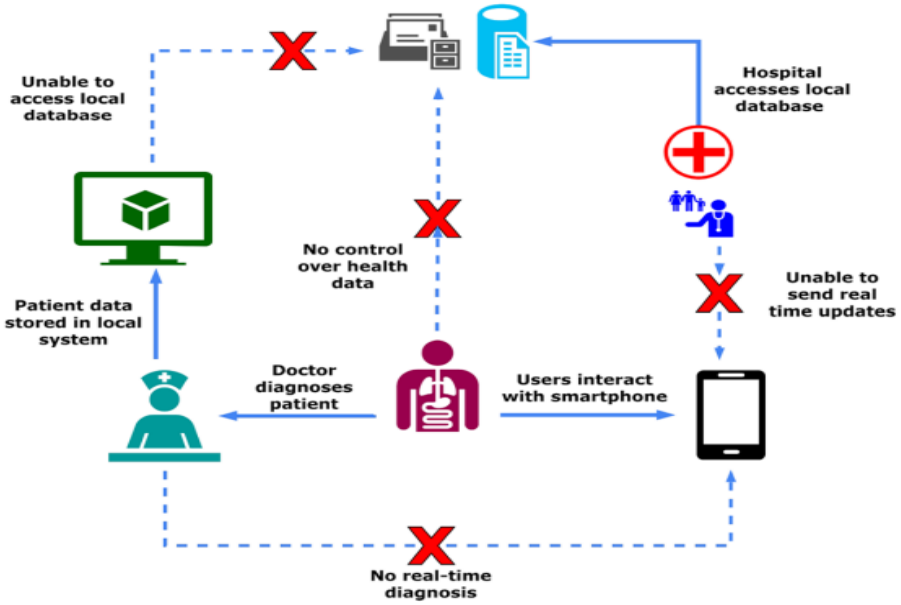

Figure 4: Healthcare system failure to connect data from multiple organizations [19].
Source: Own elaboration.

Major Healthcare Blockchain Applications

In the next section, the author will investigate the key applications of blockchain technology in the health sector that could be advantageous, for example managing medical data, which includes the exchange of healthcare records and images as well as the administration of healthcare logs. The several areas of use for blockchain technology in healthcare systems are shown in Figure 5.

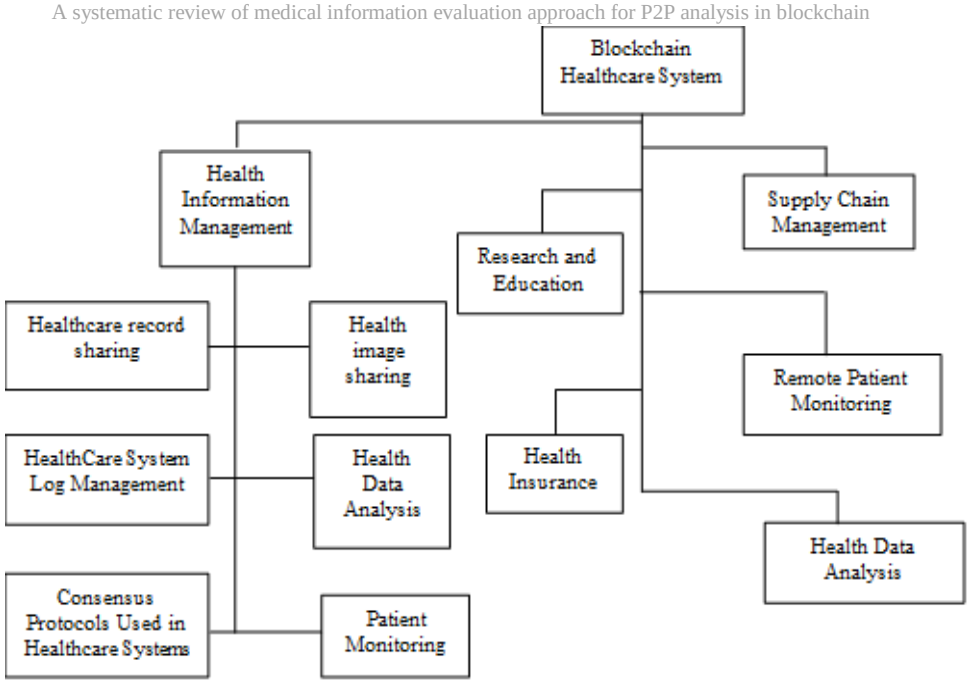

Figure 5: Healthcare Blockchain applications [9].
Source: Own elaboration.

Health Information Management

This section will study the many uses of the technology behind blockchains that could be applied in the area of medicine, such as the management of sensitive patient information and the processing of healthcare information. The potential for blockchain technology to vastly enhance patients' health and overall quality of life lends it to societal relevance in the area of medicine. Using the same line of reasoning, computing has the potential to alleviate some of the issues that exist in this sector. The discipline of informatics, for instance, makes a contribution to the automation of medical records by guaranteeing a more dependable transmission of data, applications in other domains, and log management [20, 21].

Healthcare Record Sharing

The exchange of medical records is among the initial uses of the technology behind blockchains to be used in the healthcare sector. Because it involves the personal information of the patient and is considered to be sensitive data, this is a challenging task. A comparable kind of design applies an intriguing approach to carrying out the process of health information management by supplying improved protection and shared heritage to swap data to achieve study objectives. This kind of architecture is similar to the one described in the previous sentence. In addition to this, it can administer tests and do user evaluations on a variety of user demographics. One of the many elements that are included in the architecture of MedRec is the capability to supply patients working with a consulting agency, together with the medical history of the specific agency. Patients are thus able to make educated choices about their healthcare. They are also able to facilitate the standardization of health data because they are flexible, and they also propose a variety of public data standards in a variety of forms.

Healthcare Image Sharing

It is possible to describe information on healthcare using a variety of data formats, in addition to images. At the moment, there could be certain problems linked to the exchange of healthcare information that can be seen in photos [22]. This idea has various meanings behind it since it refers to an architecture that works with comparable types of information. They aim to propose an architecture for picture sharing that is based on this endeavor, and they want to do it as soon as possible. Patients can safely and methodically share their medical photographs. While the basis for this architecture is a network administration platform that was centralized and originally built in a decentralized approach, the Radiological Society of North America (RSNA) was responsible for designing this system. The RSNA networks recognized several issues that needed to be addressed, and the Image Sharing Network (ISN) was created to solve these issues. One of these issues is the registration of photographs in repositories for the sake of study so that they will be studied securely. If the owner gives their permission, the photographs can be viewed [23].

HealthCare System Log Management

The creation of historical data to assist error analysis, intrusion detection, and other services is made possible via the usage of logs, which makes the idea of log management a vital component of a computing system [24]. When accessing patient information inside the healthcare system, this kind of administration is essential since it gives users greater control over the process.

Industry-Specific Approaches

The previous sections analyzed several policies for the administration of electronic health records. It is vital, considering the increasing number of people who are becoming interested in the blockchain idea, to investigate specific applications that are primarily geared toward

businesses. Business strategies often involve plans targeted at addressing market-related difficulties and enhancing profitability. These goals can be accomplished via a variety of means.

Healthcare Consensus Protocols

In blockchain networks, the consensus rules serve as the primary organizational structure for transaction environment management. The transition procedures can be coordinated and validated with the assistance of certain precisely specified algorithms. They help confirm nodes' access to a suggested system for the most part, but there's always a danger that the data network transmission could implement an unpleasant sprout. As a result, it can be useful in preventing fraudulent transactions on the network [25].

Patient Monitoring

In this part of the chapter, the objective is to conduct some kind of study of the rules, testing, and research that will help a patient track their status utilizing their sensor by providing them with assistance. In this section, the author will also look at study ways in which the quality of data could be improved as well as the limitations imposed by the healthcare system. The many different strategies for cutting down on energy use are also receiving a lot of attention.

Supply Chain Management

In the healthcare industry, particularly the pharmaceutical industry, blockchain technology is employed for supply chain management. If patients are given medications of poor quality, they would suffer serious consequences. Despite the prevalence of this issue, the application of blockchain technology inside the pharmaceutical industry offers the opportunity to find a solution to it [26].

According to Engelhardt, who carried out a study on the topic, many businesses are now working on a method to utilize the blockchain to identify fraud involving prescription medicines. They are Nuco, HealthChainRx, and Scalamed, three different industries [27]. Everyone who is involved in the process of filling a prescription for medication that is linked to the blockchain network, including the retailer, the person receiving the medication, the pharmaceutical company, and the healthcare provider, can view and access the transaction records. It can detect any alteration that can be made to the prescription. To combat those who produce fake medications, the creators of Hyperledger Fabric came up with the idea of a counterfeit medicine project [26].

Research and Education

One of the beneficial applications of the first use of blockchain technology can be found in the sector of education, while the second application can be found in the medical field of research. Under the scope of blockchain applications for clinical research, the data contribute to the debunking of misconceptions and the elimination of unfavorable findings in the study. Since this anonymity mechanism encapsulates patient data, the blockchain makes it simple for patients to consent to the use of their information for diagnostic purposes in medical facilities like clinics and hospitals [28]. A study that relies on information dependent on the blockchain is simpler to carry out as a result of the blockchain's inherent transparency and universality. Because of these factors, the blockchain is expected to bring about a revolution in the field of biomedical research.

Telemedicine Patient Tracking

In this section, the author will cover the methods by which blockchain technology could assist with the monitoring of distant patients. The collecting of biological information via the use of a smartphone or sensor is what is referred to as remote patient monitoring, and it allows for the condition of the patient to be monitored from any place that is not within the hospital. Biomedical data that has been acquired remotely can be retrieved, shared, and stored using blockchain technology [29-31]. The remote monitoring of the patient system is shown here in Figure 6.

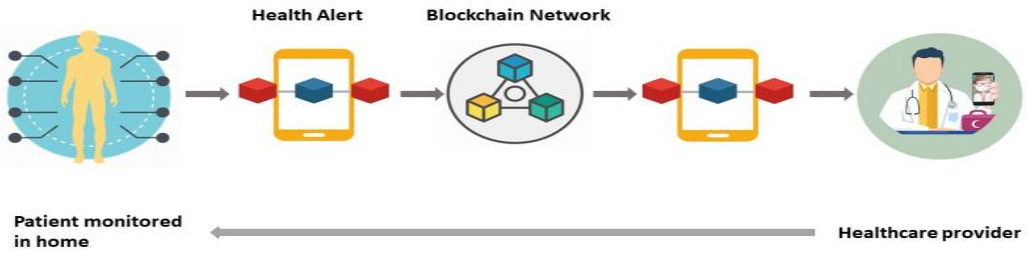

Figure 6: Telemedical Monitoring [9].
Source: Own elaboration.

Health Insurance Claims

Due to the immutability, decentralization, and openness of the blockchain, it is possible to seek assistance in the instance of medical insurance claims. The processing of insurance claims within the health service is a sector that has committed to the deployment of blockchain technology. This topic has been discussed in a great deal of literature, including. On the other hand, there aren't that many instances of these systems' prototype implementations that the author can find. The fact of the matter is that there is an outstanding example of this that is known as MIStore. As can be seen, MIStore has been converted to operate on the Ethereum blockchain platform, which is good news. Pokitdok is the name of the business that has shown interest in forming a partnership with Intel to establish a blockchain-based platform that would handle claims for medical insurance and healthcare [27].

Supply Chain Management

Blockchain offers a chance for all developing technologies to make use of their full potential. For example, deep learning could use blockchain to better forecast healthcare data and lessen the likelihood of patients receiving substandard care. The implementation of blockchain technology is covered, which lays out a strategy for how this could be accomplished. Deep learning makes application of blockchain technology to categorize arrhythmias [32].

Blockchain-Based Healthcare Systems

This part covers the prospective remedies that have been offered by the preceding research as a reaction to the numerous technical hurdles that have been identified. The most recent group of important goals for the safety of healthcare systems, all of which need to be solved includes audibility, non-repudiation, audibility, integrity, authenticity, expandability, privacy, legitimacy, trustworthiness, traceability, and non-repudiation. Other objectives include scalability and traceability. A previous study has made an effort to address every one of these security challenges, but some of it has concentrated on a particular facet of the health information system's overall security needs. In light of this, the findings of the previous study are organized into categories according to the extent to which they contribute to the accomplishment of various security goals.

Medical Data Safety Solutions

Its capability provides an additional safeguard for the system's network that houses the healthcare information repository. As a result, the network is less susceptible to attacks directed at a single point of failure, and it is also less likely to be targeted by ransomware or denial-of-service attacks. Authors in the field [33] by incorporating a cipher manager into a blockchain and making use of various encryption techniques before the transfer or reception of network data, were able to strengthen the security components of the current HER (Electronic Health Record) system while also reducing the system's level of complexity. Every patient has their own unique identity and identification inside the blockchain system, which prevents any unauthorized use of information and offers robust data security. In [34], a unified and consortium blockchain has been developed to increase the accuracy of diagnostic procedures and the efficacy of therapy. This was done to tackle the problems with security and scalability that were present in the Health Information Exchange (HIE) platform that was already in use at the time. In addition to this, authors in [35] by using blockchain technology and homomorphic encryption, author improved the safety of the procedures used to administer insurance policies and ensured the secure storage of patient information in a distributed manner.

Medical Data Integrity Solutions

In [36] the authors presented a method that could be applied to transform the transition from a centralized local database to a distributed one as a solution to the challenge of maintaining the security and integrity of medical data in the centralized database. This approach offers enhanced levels of confidentiality, anonymity, and dependability by making use of the defining qualities of blockchain technology. In addition to that, this medical information is used to build a hashed copy by this development system that is kept ensuring that the data's integrity is maintained. After that, it is possible to offer to provide organizations with data copies that want to retrieve (for example, medical study institutes), to protect the data's authenticity while avoiding the risk posed by an administrator of the database who has malicious motives. As a consequence, when organizations demand possession of patient medical information, smart contracts immediately carry out the procedure. By storing patient records in a decentralized database, putting in place an authentication system, and encrypting patient information using a symmetric key, managed to accomplish authenticity together with scalability and safety in the management of medical data. The authenticity of the participants in the medical study was used to validate the data's integrity. If an attacker attempts to alter or erase data that has been saved on a blockchain built using Hyperledger Fabric, the data will be inaccessible to them.

Medical Access Control Solutions

The authors of [37] built a safe and decentralized authentication provider to solve the problem of centralized authentication to protect the system from specific security risks that arise when patient information is transferred from one provider to another. This was done to solve the problem of centralized authentication. Authentication and authorization problems in today's electronic health record (EHR) health systems, which are related to the transfer of confidential material across a large number of healthcare service providers, are taken care of by the suggested solution. Remarkably, blockchain technology could be put to use as a verification method. In [38] authors recommended that a blockchain-based approach could be used in conjunction with IoT RPM to verify the identity and securely connect with devices that have been preserved by healthcare systems. Using a system based on blockchain technology could allow users' identities and authorization to be protected against risks like these as nobody can physically erase information from the ledger.

Medical Data Interoperability Solutions

The blockchain for electronic health records was combined with AI [39] to improve the privacy of medical data as well as its security and its ability to connect with users. The proposed solution solves the challenges that the medical system is having concerning interoperability and the interchange of medical data amongst the several healthcare service providers. The usage of blockchain transactions makes it possible for a wide variety of EHR stakeholders to collaborate, and it also helps to stop data from being fragmented. Considering the backdrop of an unstable cloud platform, [21] addresses the issue of compromising patient confidentiality in medical data interchange interoperability across medical big data suppliers by using properties of blockchain technology as a solution. The usage of blockchain ensures error-free and efficient data transfer across all of the EHR providers because of the technique for reaching an agreement that oversees the distribution and synchronization of data among all of the many suppliers of EHR systems. By using the Fast Healthcare Interoperability Resources (FHIR) protocol of the HL7 standard with blockchain technology, the problem of making therapeutic decisions in the community that was particularly safe, secured and readily available in exchanging data was addressed. Because of this combination's efforts, information exchange was effectively improved, which led to improved treatment options.

Solutions to Huge Patient Data Problems

Blockchain solved the issue of patient confidentiality that occurred during the interconnection of medical data interchange across various suppliers of healthcare services. In [40] authors developed the Healthcare Data Gateway (HDG) is a revolutionary blockchain-based architecture to handle and transmit medical data in an effective, secure, and confidential manner while maintaining patients' right to privacy. The progress of the architecture provides a solution to the problem related to medical systems regarding the collection, storage, and analysis of personal health records without infringing on patients' right to privacy. Additionally, the innovation of architecture ensures that patients have ownership and control over their data, rather than having it spread out among various providers of healthcare. Authors of [41] proposed an OmniPHR blockchain-based design for incorporating PHR among patients and medical professionals to tackle problems affiliated with patients' distributed datasets regarding preserving and fetching current and redundant features. These issues arise because patients' data records are spread out across multiple locations. Figure 7 depicts the Healthcare blockchain percentage.

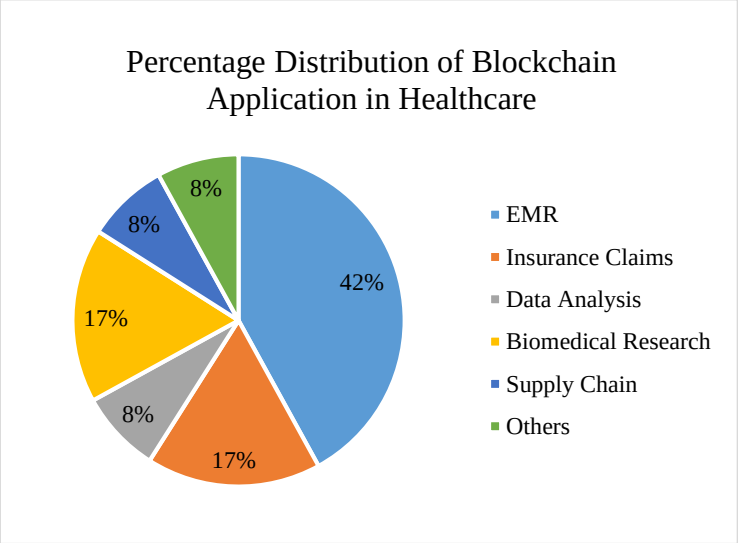

Figure 7: Healthcare blockchain percentage [42].
Source: Own elaboration.

II. METHODOLOGY

Throughout the medical study, a wide range of concerns, including those about the confidentiality of data, the veracity of information, the exchange of data, the administration of patient records, and many more, could surface. The next version of the internet, known as the blockchain, could be able to resolve these problems [43]. Emerging technologies such as blockchain have been assisting those working in the healthcare investigation field in their efforts to find solutions to these issues. The most important use of blockchain technology in the medical business is the structuring of supply chains for medicinal drugs. Supplying organizations is crucial in all fields of business, but because of the growing complexity of the healthcare industry, it is of utmost importance in this sector [44]. Since there were so many moving parts and so many individuals in question, supply chains were vulnerable to fraudulent attacks and had vulnerabilities through which they would be exploited. Blockchain technologies provide a secure and risk-free environment to combat such problems and, in certain instances, stop fraud from happening by requiring an increase in data availability and enhanced product reliability. This is because blockchains are required to initiate an increase in data availability and enhanced product reliability. It is difficult to manipulate the blockchain because a record can only be validated or amended via a blockchain network. This makes it tough to manipulate the blockchain.

The development of technologies based on blockchains has attracted the curiosity of a great number of people. Several people quickly concluded that the system could be applied for several reasons, including the collection of taxes, manufacturing, and education. This section examined the potential uses of distributed ledger systems in the medical sector, specifically regarding report provenance and precision of costs for illnesses [45]. When a patient visits a physician for therapy, there is always a chance that, once the diagnosis is established, the physician will suggest unneeded tests or persuade the patient to undergo procedures that are not essential to purchase from particular medical institutions. This occurs after the doctor has established that the patient has the condition being treated. Moreover, a patient will decide to switch from their primary care physician to another practitioner to begin treatment [46]. Whenever a patient decides to move physicians, all of their medical records, laboratory test results, and prescriptions, together with the correct billing information, must be recorded in the distributed ledger. This makes it such that either the patient or the new physician is informed of how much medication has been taken and how funds have been spent on each technique. Even though all the data are also stored just on the blockchain, no provider will be able to change a patient's medication or expenditure bill without first obtaining their permission. If a patient has many tests or takes multiple medicines while receiving treatment, the receipt or record of each document should be stored on the blockchain. In this way, even if substantial costs are incurred for treatments because of healthcare shops or laboratory tests, which are then updated during surveillance checks, the records can still be maintained. It will be difficult to make any more modifications once the invoice has already been prepared and posted within the blockchain if every other behavior of the patient is kept inside the blockchain. If this is the case, the blockchain will be immutable. In the following content, the author looked at two very separate situations.

Definition of research questions

The first thing that must be done to conduct a literature review is to establish a list of research questions. This paper aims to offer an overview of the existing studies on the use of blockchain technology in healthcare systems. With all of this in mind, the author came up with the following research questions:

- *RQ1: What is Blockchain Technology?*
  Blockchain is an open-source, distributed, and immutable database that streamlines the process of documenting transactions and keeping track of assets inside a business network. A blockchain will be thought of as an ever-growing database of records, which are referred to as blocks, and is held together by encrypted links between each block on the chain. Each block stores information about previous transactions, a timeframe, and a cryptography hash of the block that came before it. The timestamp provides evidence that the transactions were there at the time that the block was being generated. Since each block has information about the block that came before it, which makes them interrelated, the blocks can be thought of as essentially creating a chain. Because of this, once a transaction has been recorded on a blockchain, it cannot be reversed without also redoing all the blocks that followed it, making blockchain transactions irreversible.

- *RQ2: What is a Healthcare data system?*
  A population's healthcare can be paid for, organized, and provided for via their healthcare system. This is what the author means when the author talks about a healthcare system. It encompasses concerns over access (to which services and for whom), expenditures, and resources available (healthcare workers and facilities). The purpose of a medical system is to improve the overall health of an individual in the most efficient way possible, considering the resources that are at society's disposal as well as the many requirements that must be met. By the turn of the twenty-first century, most nations and the United Nations came to see access to healthcare as a unique and essential benefit that is required either as a matter of fact or following fundamental human rights. This view was widespread at that point. While doing a study on healthcare systems, it is necessary to consider the various ways in which various systems respond to generally accepted norms and principles.

- *RQ3: How can the data be secured in the healthcare system?*
  The healthcare business presents several challenges when it comes to the protection of data. Protecting patient privacy while also providing quality patient care and adhering to the stringent regulatory requirements established by HIPAA (Health Insurance Portability and Accountability Act) and other regulatory requirements, such as the General Data Protection Regulation, which was (GDPR) enacted by the European Union, a difficult balancing act that medical practitioners and their business associates are required to perform. Even though protected health information (PHI) is one of an individual's most delicate (and for offenders, useful) private information, the guidance for healthcare professionals and other organizations that manage, use, or transfer patient information include stringent data protection requirements that are accompanied by hefty penalties and fines if they are not met. This is because PHI is among an individual's most delicate (and for offenders, valuable) private information.

- *RQ4: What is a P2P network?*
  When two or more personal computers (PCs) are linked to one another and exchange resources without passing via a central server computer, this configuration results in the formation of a P2P network. A P2P network could represent an ad hoc connection, which would consist of two or more computers linked together using a USB for file sharing. P2P networking can also take the form of a fixed infrastructure, in which copper lines are used to connect six personal computers located in a single workplace. Alternatively, a peer-to-peer network can be a network that is considerably larger and is characterized by using specialized protocols and applications to establish direct links between users over the internet.

- *RQ5: What is the application of blockchain in healthcare?*
  The potential use of blockchain technology in healthcare could be broken down into five key categories:
  - *Administration of Health Records and Information*
  - *Management of the Supply Chain*
  - *Academic and Scientific Investigations*
  - *Monitoring of Patients Using Remote Connection*
  - *Statements for Health Insurance Coverage*
  - *An Examination of Medical Records*

Conducting the search

As a component of this attempt, a Systematic Literature Study (SLR) examines the Possibilities of the MEDINFO Blockchain Evaluation Method for P2P Analysis and relevant benefits in credibility, trustworthiness, organization, and transparency. The key academic literature collections that make up the first information sources are the databases that are housed in IEEE, Science Direct, Springer, and Scopus respectively. When writers are researching a certain subject or topic area for a study, they will undertake SLRs to gather data on pertinent studies that have been done in that field. The most recent search was performed and several database searches using keywords were carried out to identify essential academic content. There was no time constraint placed on the search for the vital terms within the subject and title, in addition to the search inside the subject and title, and the abstract (Scopus and others). The only forms of documents that were permitted to be submitted were the study, evaluation, procedures paper, bibliography, and article.

The Coding and Analytical Procedure

The author created a database of the papers, assigned codes to them, and carried out the analyses with the assistance of the data analysis program NVivo12. The author was able to categorize the papers following the various study questions with the use of a coding system that was developed by the author. The author also utilized the computer to categorize basic information about every article, such as its title, publisher,

year of publishing, and name of the publisher. This information was compiled using the application. The authors comprised a professor, four people who were working on their Ph.D., and two people who were working towards their master's degrees. To begin, the author assigned codes to each member of the population to determine the fundamental characteristics of the articles, such as the nature of the studies (whether theoretical or experimental) and the countries from where the writers originated. After that, the author assigned codes to each of the studies to answer each of the survey questions, which were as follows: what definitions, subjects, advantages, and disadvantages of blockchain are discussed in these papers? The author built sub-categories inside each of these nodes to reflect the numerous responses that the author discovered.

III. RESULTS

In this section, the author presents the initial analysis of the population. The author categorized the studies by publication year, geographic distribution, and type of paper using NVivo12 software. This section reports on these data items.

Scrutinizing of paper for study

As a component of this attempt, a Systematic Literature Study (SLR) examines the Possibilities of the MEDINFO Blockchain Evaluation Method for P2P Analysis and relevant benefits in credibility, trustworthiness, organization, and transparency. The key academic literature collections that make up the first information sources are the databases that are housed on Science Direct, Research Square, and MDPI, ResearchGate respectively. SLRs are carried out by authors if they are looking into a certain research problem or subject area so that they will gather information about relevant studies in that sector. On January 25, 2022, the most current search was conducted in addition to other keyword searches of databases carried out to identify essential academic content. There was no time constraint placed on the search for the vital terms within the subject and title, in addition to the search inside the subject and title, and the abstract (Scopus and others). The only sorts of documents that were permitted to be submitted were articles, reviews, proceedings papers, bibliographies, and articles. Conference papers could only be submitted as articles or reviews.

Figure 8 depicts the systematic review of identification and inclusion. This gives us elaboration about the PRISMA diagram is a graphical representation of the flow of studies through the systematic review process, highlighting the number of studies identified, screened, assessed for eligibility, and included in the final review. Based on the given information, researchers can construct a PRISMA diagram as follows:

The first step in the systematic review process is the identification of relevant studies. In this case, the identification of studies was carried out through database and register searches, resulting in 1,249 potentially relevant studies. Additionally, 1,000 new studies were identified through other sources.

Following the identification phase, the next step is the screening of the identified records. Out of the 2,249 records identified, 321 were screened for eligibility.

After the screening process, some records may be excluded for various reasons. In this case, 144 records were rejected during the screening phase. The reasons for rejection could include irrelevant content or duplication.

Next, reports were sought for retrieval. Out of the 321 screened records, 177 reports were successfully retrieved. However, 42 reports were not able to be retrieved for various reasons, such as unavailability or access restrictions.

The retrieved reports were then assessed for eligibility. Out of the 177 retrieved reports, 135 reports were included in the assessment for eligibility. The remaining 42 reports were not assessed due to their unavailability.

During the eligibility assessment, some reports may be excluded if they lack sufficient data. In this case, 78 reports were excluded due to insufficient data, leaving 57 reports eligible for further analysis. It is also mentioned that some reports were excluded because they were unpublished. Specifically, 108 reports were excluded for being unpublished, meaning they were not publicly available or accessible. Finally, after the rigorous review process, 57 studies were included in the systematic review. These studies met the predetermined criteria and provided valuable data for the review.

This PRISMA diagram summarizes the various stages of the systematic review process, from study identification to inclusion in the final review, providing a clear visual representation of the flow and outcomes of the review.

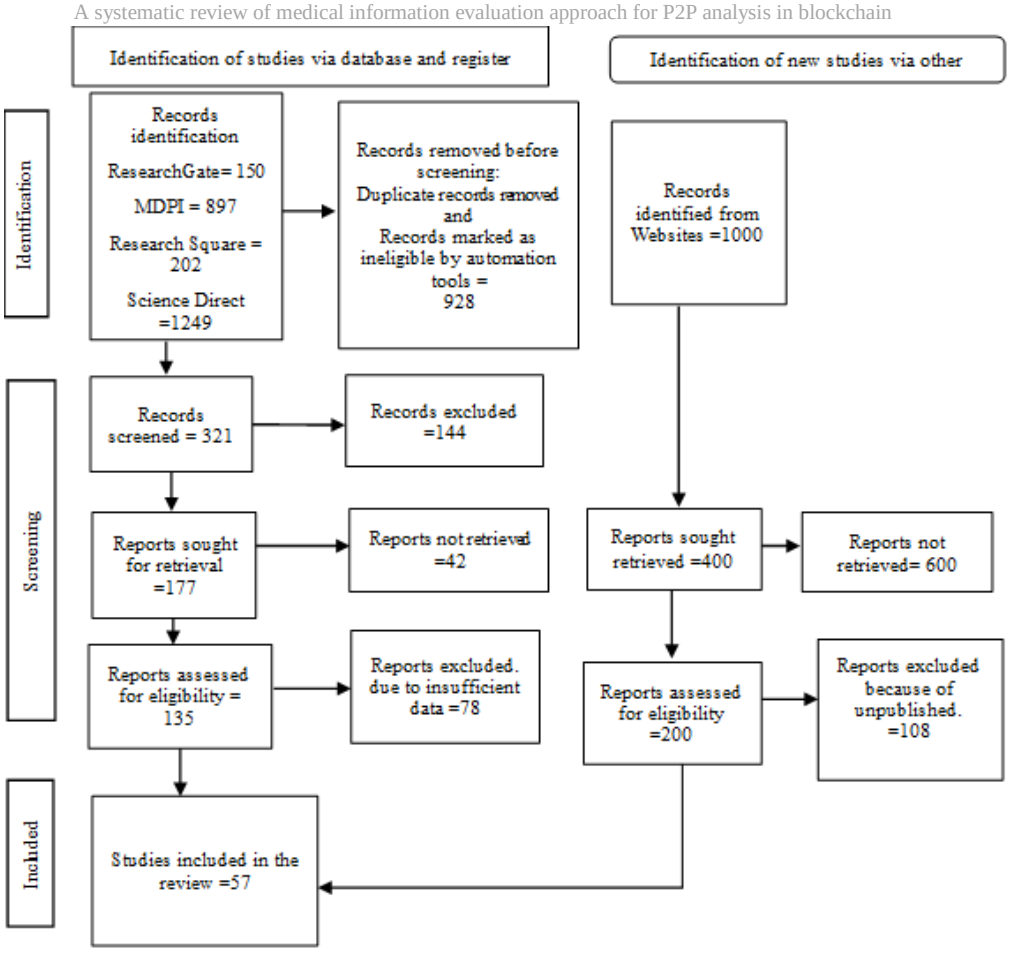

Figure 8: Systematic review identification and inclusión.
Source: Own elaboration.

Year of Publication and Global Reach

The number of publications that were produced in each year during the history of the population is shown in Figure 9. 2018 was the year that saw the publication of the first paper. The following is a breakdown of the publication date dispersion throughout time: 15 papers were published in 2018, accounting for 6.5% of total publications; 20 papers were published in 2019, accounting for 8.3% of total publications; 30 papers were published in 2020, accounting for 12.5% of total publications; 35 papers were published in 2021; 50 papers were published in 2022; and 90 papers were published in 2023, accounting for 37.5% of total publications. Given the time gap between academic study and publication, an author would anticipate seeing this quick increase in trajectory on a fascinating modern technology that was first made publicly available in 2008. The articles were taken from a broad range of different periodicals. Strategic Change was the journal that released the most articles out of all the journals in the sample group.

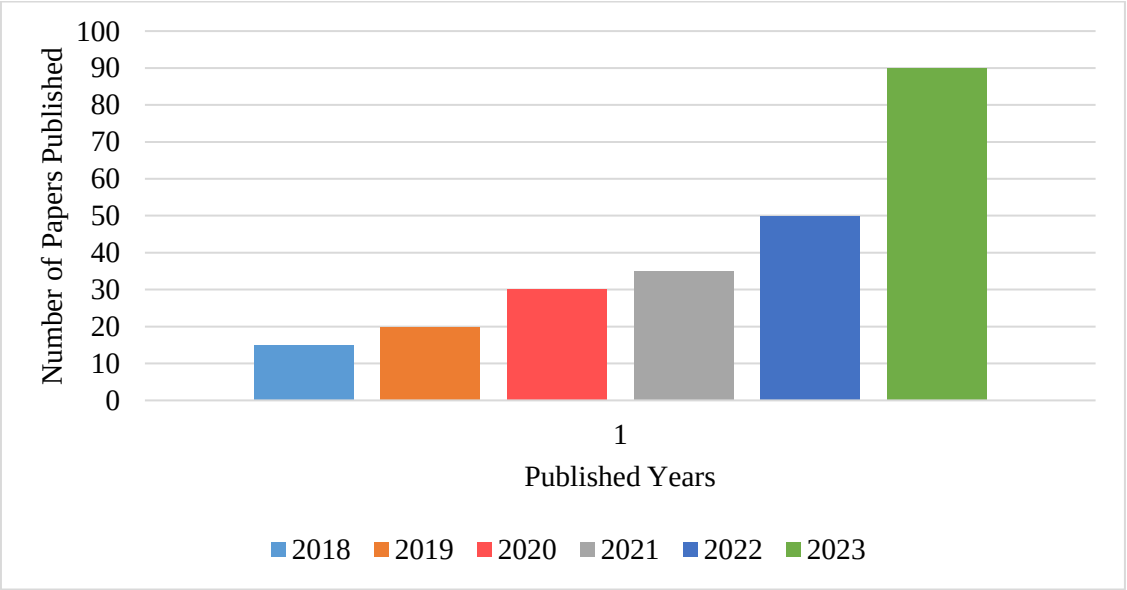

Figure 8: Selected paper publication year.
Source: Own elaboration.

In addition to this, the author performed an analysis of the geographical spread throughout the continents as depicted in Figure 9. North America (37%) and Europe (43%), followed by Asia (14%), were the areas that included the most articles overall. Oceania (Australia made up 4% of the total), Africa, and South America each made up 1% of the total. Oceania had the lowest number of the three areas. Active blockchain initiatives and academic research are being conducted all around the globe, with a considerable number of them focusing on tackling social concerns like identity and economic ones like banking. At this point in the field of study, there are a much greater number of papers coming from nations in the global north than there are from countries in the global south. Figure 10 depicts the Continental distribution.

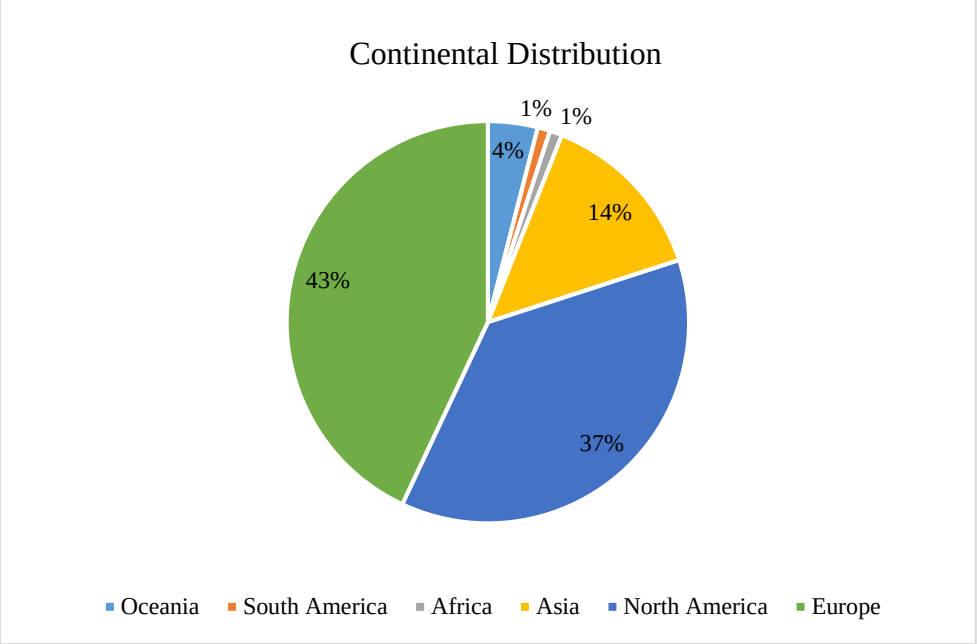

Figure 9: Continental distribution.
Source: Own elaboration.

IV. DISCUSSION

In this part, the limits of the use of blockchain in the healthcare sector as well as the difficulties related to this technique are discussed. In addition to this, it casts a spotlight on future research objectives and directions that will be taken in this industry.

Limitations

Previous research suggests that there are technical hurdles to overcome, even if it is acknowledged that there are certain restrictions. The purpose of these studies reviewed has been to investigate the development of innovative techniques, conventions, and proof of idea for the use of blockchain in the medical industry. Based on the investigation, the author has grouped the present limits into four categories: assumptions, constraints, performance, and ethics and protection.

Constraints

Previous studies have several shortcomings, that could be categorized into four distinct tiers, which have been recognized by the researchers. These specified dimensions demonstrate that such restrictions go beyond what can be supported by actual evidence. In addition, the costs of maintaining and extending blockchain-based structures include the costs of data research and framework components, as well as judgment and some social spectacles. The next paragraph will go into additional detail about these topics.

Costs Additional expenses that were categorized as constraints in this research were linear procedure costs, which varied depending on the features of the organization. These costs were expensive. For instance, patients result in increased operating costs, and evaluation times could be lengthened due to applicants' increased engagement in the application [47]. The transactions and execution expenses are determined according to the dimensions of the length of the string as well as the length of the input [48]. Since patients must seek international smart contracts using their stored data, the amount of time spent looking is another cost factor that is being explored; nevertheless, the runtime should be kept to a minimum [49].

Data and analysis: There have been a significant number of studies done on the limits of the data, such as the absence of presentation of sample data. The training data that is required for data-driven simulation and testing is not easily accessible. The poor quality of the testing data has prevented other research from reaching their full potential [50]. These kinds of restrictions could prevent the organization from finishing or even getting started on the rule testing that is linked to authentication. It is also possible for the testing phase of the development structure to affect it. For instance, if the recommended structure that was described is influenced by an insignificant portion of the information, then it is not only an inefficient use of space, but it also undermines the effectiveness of the method for recognizing multimedia pictures.

Platform and framework elements: The blockchain platform, when applied to certain components of the more sophisticated structure, has the potential to function as an obligation for the advancement of this structure. There have been several reports in the past that have constraints,

one of which is the need for Tangle to have at the gateway stage to establish a connection that is unmediated with the sensor [51]. This restricted repository, on the other hand, is made possible by a fog layer, in addition to semantic inter-operative capabilities and inheritance systems. It is important to properly prioritize significant entities to avoid problems, particularly in times of emergency, which might cause disagreements when it comes to selecting a choice. In addition to this, it is essential to make certain that consumers will be awarded the entire reward whenever they provide data. Numerous research has highlighted additional constraints that need updated methodology, such as the limitation of a complex system that is reliant on PSN for medical and the limitation of another approach, such as the Optimized of Authenticated Messaging, among other limitations (MAM) module library. These limitations have been identified in a variety of contexts, including medical care and blockchain technology [52].

Societal environment: There has only been a very limited amount of study done on the issue of the sociocultural context of blockchain healthcare construction. For instance, there is a possibility of conspiring together to commit information fraud. It is also possible that it will be restricted owing to an incapacity to monitor medical abuses that have been recognized by their built architecture. This ability will rely on the user's countrywide online access link. One further illustration of this would be if refugees were denied access to a country's healthcare system.

V. CONCLUSIONS

This study intended to carry out a comprehensive evaluation, survey, and categorization of important research publications on blockchain systems and their deployment into a variety of medical applications so that specific literary patterns can be detected. This was done to determine whether or not there is a pattern in the literature. The qualitative and quantitative organization of 144 research papers on the use of blockchain technology in the healthcare industry was described in this report. The author conducted an analysis of the variety of blockchain platforms available as well as the many blockchain strategies that were used or recommended in the articles that were reviewed. The blockchain platform makes it possible to construct decentralized apps in which the flow of data transfers cannot be managed by any third-party entity. Together with a date and other relevant details, the data transfers made by the entities are recorded in a decentralized network in a format that is clear, verifiable, secure, and unchangeable. Moreover, the data transactions are immutable. In addition, the technology behind blockchain could be used for a wide range of purposes within the realm of healthcare, such as the exchange of data, the management of logs, the distribution of medication, the conduct of biomedical research and instruction, the monitoring of patients remotely, and the analysis of health data. Even though blockchain technology brings a great deal of System 2023, 11, 38 37 of 44 value to healthcare systems, it does have a few limitations. The author also assessed the recommended remedy that was presented in the articles that were reviewed to address these shortcomings. The author concluded that the impact of blockchain technology on healthcare systems is mostly in the phase of documentation, despite the significant interest in blockchain technology. There has not been a substantial lot of research carried out in this field yet, nor have there been any healthcare applications developed using blockchain technology.

VI. DECLARATIONS

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Ethical Statement

The manuscript in part or in full has not been submitted or published anywhere. In other words, the authors ensure that the manuscript is not a duplicate publication.

Conflict of Interest Statement

The authors did not receive support from any organization for the submitted work. All the authors declare that they have no conflict of interest.

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Author contribution

Yogesh Kushwaha: Data curation, writing-original draft, formal Analysis, Validation, Writing - review & editing.

Dr. Niranjan Lal, Dr. Manisha Manjul: Conceptualization, Methodology, Visualization, Investigation, Supervision, Writing - review & editing.

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