Survey

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Survey: Using Blockchain Technology in Smart Life Applications

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استخدام تقنية Blockchain في تطبيقات الحياة الذكية

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ABSTRACT

Background:

Blockchain is a database that is stored in chronological order in a secure and stable manner. Bitcoin was the initial application of Blockchain technology, but due to its benefits in terms of security, privacy, and autonomous control, it has been adopted by a variety of industries. Blockchain technology is created by cryptographically connecting blocks together. Because each block contains both its own hash and the one before it, no outsider can break the chain. Blockchain technology is used in a variety of industrial, commercial, security, supply chain, IoT, and others. This is because it has the advantages of controlling, organizing, and storing data. The purpose of this article is to list some of the applications and development areas of Blockchain.

Materials and Methods:

In Blockchain technology, security, stability (immutability), and decentralization are among the important things that make this technology useful in various areas of life that serve the user. These advantages were used to solve many problems facing the network, including those of productivity, processing time, and scalability. Various methods were used in the solution, including working on a change in the network structure, choosing a basic node (the manager), parallel mining, and competing with other miners.

Results:

Through recent studies, it has been shown that the Blockchain technology has been used in various fields, as it is characterized by many advantages, the most important of which are security, decentralization, and stability. Because of these advantages, it outperforms other technologies.

Conclusion:

Due to its advantages, the tendency to use blockchain technology has increased in many fields, including financial, agricultural, commercial, health, the Internet of Things, and others. It includes decentralization, distribution, reliability, and stability. There are other trends that have worked to improve the performance, efficiency, and security of the blockchain system itself, In the Internet of Things, healthcare, supply chain management, the banking sector, and digital marketing In addition to studies that include improving the efficiency, security, and development of the system.

Key words:

Blockchain **,** Consensus Mechanisms , Security , Performance.

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مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

الخلاصة

مقدمة:

Blockchain هي قاعدة بيانات يتم تخزينها بترتيب زمني بطريقة آمنة ومستقرة. كانت Bitcoin هي التطبيق الأولي لتقنية Blockchain، ولكن نظرًا لفوائدها من حيث الأمان والخصوصية والتحكم الذاتي ، فقد تم اعتمادها منذ ذلك الحين من قبل مجموعة متنوعة من التطبيقات. يتم إنشاء تقنية Blockchain عن طريق ربط الكتل معًا بشكل مشفر. نظرًا لأن كل كتلة تحتوي على كلٍ من التجزئة الخاصة بها وتجزئة الكتلة السابقة لها ، فلا يمكن لأي شخص خارجي كسر السلسلة. تُستخدم تقنية Blockchain ضمن مجموعة متنوعة من التطبيقات ، بما في ذلك الصناعية والتجارية والأمنية وسلسلة التوريد وإنترنت الأشياء وغيرها. هذا لأنه يتميز بمزايا التحكم في البيانات وتنظيمها وتخزينها. الغرض من هذه المقالة هو سرد بعض التطبيقات ومجالات التطوير الخاصة بـ Blockchain.

طرق العمل:

في تقنية Blockchain ، يعد الأمان والاستقرار (الثبات) واللامركزية من بين الأشياء المهمة التي تجعل هذه التقنية مفيدة في مختلف مجالات الحياة التي تخدم المستخدم. تم استخدام هذه المزايا لحل العديد من المشكلات التي تواجه الشبكة ، بما في ذلك المشكلات المتعلقة بالإنتاجية ووقت المعالجة وقابلية التوسع. تم استخدام طرق مختلفة في الحل ، بما في ذلك العمل على تغيير هيكل الشبكة ، واختيار عقدة أساسية (المدير) ، والتعدين الموازي ، والتنافس مع عمال المناجم الآخرين.

الاستنتاجات:

ازداد الميل إلى استخدام تقنية Blockchain في العديد من المجالات ، بما في ذلك المالية والزراعية والتجارية والصحية وإنترنت الأشياء وغيرها ، نظرًا لمزاياها ، بما في ذلك اللامركزية والتوزيع والموثوقية والاستقرار. هناك اتجاهات أخرى عملت على تطوير أداء وكفاءة وأمان نظام Blockchain نفسه في إنترنت الأشياء والرعاية الصحية وسلسلة التوريد والقطاع المصرفي والتسويق الرقمي بالإضافة إلى الدراسات التي تشمل تحسين الكفاءة والأمان وتطوير النظام.

الكلمات المفتاحية:

آليات الإجماع ، الأمان ، الأداء

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1- INTRODUCTION

Blockchain is a recent technology that has been applied to numerous fields and applications. Blockchain is a series of blocks linked together by hashing, where each block contains a hash and the previous hash, which makes it secure and cannot be hacked by attackers. Each block is the sum of verified transactions that are packaged and broadcast to the network. Blockchain is characterized by its transactions not requiring a third party [1]. This study splits the work into two sections: The first section explains how the Blockchain is used in various fields and applications, including IoT, security, health, industry, supply chain, and many others; Due to the use of the open channel, or Internet, for data transfer in all the aforementioned applications, security and privacy are top priorities [2]. Since these applications work with a large amount of data, it is important to take data heterogeneity, integrity, and redundancy into account in addition to security and privacy considerations [2]. The second section examines how the Blockchain is developed in terms of its performance, trust, scalability, and system productivity.

2-Blockchain Theoretical Background

Many important points should be explained to the reader when viewing a Blockchain. They include blockchain definition, types, and consensus mechanisms.

2-1 Blockchain

It is defined as blocks of transactions that are kept in a distributed database called Blockchain [3]. A decentralized infrastructure called Blockchain is extensively used in new digital coins. Blockchain networks create connected lists of data that are stored as blocks. Each block consists of two parts; the upper part (the head) contains the following information: block version, Merkle tree root hash, timestamp, nBits, Nonce, and parent block hash. Transactions and Its counter make up the block body [4]. as shown in Fig.1. The genesis block is the initial block in a blockchain that was hardcoded when it first began [5]. Each data block has a batch of transaction that checks the accuracy of the data and creates the next block. The blockchain incorporates a variety of technologies, including distributed architecture, peer-to-peer network protocol, encoding algorithm, smart contracts, identity authentication, cloud computing, etc. [6]. Data is stored in the blockchain network in the form of blocks. Each block contains detailed information about one of the operations that were performed on the network, and after storing it, the stored data is encrypted and a lock is placed on it that is difficult to penetrate and is called a hash. This process is repeated several times, and the information is stored and encrypted in the form of an infinite chain of blocks, as illustrated in fig.(1) [7].

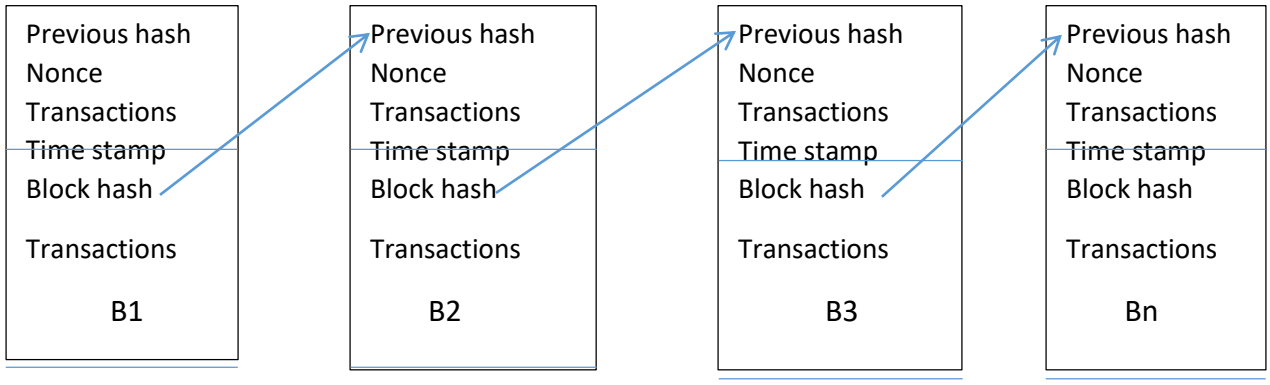

Fig. 1. Blockchain structure[7]

The main traits of the blockchain technology include the following: **Immutable:** A transaction added to the blockchain cannot be changed once it has to be verified [7]. **Decentralization:** No middleman or trusted third party is required to verify transactions [5]. **Detrusting:** Due to blockchain technology's decentralized nature, data flow between network nodes does not require mutual trust between participants [**8**]. **Open Source:** Most blockchain systems are opened to the public; everyone can audit the accuracy of the registers, and anyone can use blockchain technologies to create any kind of application they need. Types of Blockchain: Different rely on the consensus mechanism, which is a method for nodes to agree on a network state [**8**].

2-2 Blockchain types

Blockchain can be public , private or Semiprivate [**9**]. Now let's take a closer look at the three possible types of Blockchain , as illustrated in fig.(2).

1- Public Blockchain

It is an unrestricted and authorized distributed ledger system. Anyone with access to the internet can log in on a Blockchain platform to become an authorized node and be part of the Blockchain network. It is an open network for all users since it enables anybody to participate in decision-making and all users maintain a copy of the data on their local nodes, like in the case of bitcoin , Ethereum [**5**], and Litecoin.

2- Private Blockchains

Private Blockchains are Blockchains that limit access or that only work in restricted networks. Private blockchains are used within businesses or other institutions, and only a limited number of individuals can join the Blockchain network. Outsider nodes cannot access the data unless they are invited. The governing organization determines the level of access, security, and permissions. Thus, although they operate similarly to public Blockchains in terms of use, private Blockchains have a more constrained network. [**10**]. Private Blockchain networks are deployed for voting, supply chain management, digital identity, asset ownership, etc.

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3- Semiprivate Blockchains

can be considered a partially private and permissioned blockchain, and part of it is public. It uses the features of both types of blockchains, in which one can have a private permission-based system as well as a public permission-less system. With a semi-private blockchain, the private part is controlled by a group of individuals, while the public part is open for participation by anyone [5][11].

2-3 Consensus Mechanisms

When there is no centralized body to oversee the ledger's status, Consensus procedures are required to determine the distributed ledger's current state and to maintain security. There are many schemes to perform consensus in Blockchain they include:

1- **Proof of work (Pow):** The goal of the PoW system is to solve a challenging mathematical puzzle, and miners who succeed in doing so are rewarded. When mining with the PoW algorithm, miners must group transactions into a block and apply a brute-force method to identify a nonce [**12**]. When the solution is identified, the miner broadcasts the pertinent information to the network so that other miners can validate the newly discovered block [**13**]. The network nodes calculate the stated answer of a mathematical conundrum, and the initial node can construct the following block and receive the mining reward [**7**].

2- **Proof Of Stake (POS):** It replaces proof-of-work (PoW) and is a well-liked consensus method. Prior to mining or verifying block transactions, PoS-based blockchains must select validators based on the number of coins they have in the network [14]. PoS members shorten the time it takes for transactions to be approved by voting for leaders based on their participation in a blockchain system. The fundamental principle of PoS is that nodes with more money in the system are less likely to cause systemic harm. [**13**].

3- **Delegated Proof Of Stake (DPOS):** Is a brand-new blockchain consensus mechanism with a different fundamental design from PoS. The decision made by the board of directors in the actual world is comparable to the DPoS method. Stakeholders choose a delegate via voting. Based on stakes held by stakeholders, the system determines the number of delegates with the greatest votes, and the delegates take turn generating the block in the designated order [6]. The deputies are selected by continuous voting throughout the system, but if a selected block deputy fails to produce a block, a reserve deputy will take its place. The reserve producer's likelihood of being selected in the future will also be diminished as a result of its prior failures **[13]**.

4- **The Federated Byzantine Agreement (FBA):** The membership is opened, and each node does not need to be known and validated in advance because it is a public blockchain. Quorum slices, a subset of a quorum, are used in an FBA. The quantity of nodes necessary for a network to come to a consensus is known as a quorum. A node may consent to follow the decisions made by a particular quorum slice if it believes them to be totally reliable. The new block can be subject to a consensus decision among validators and permanently archived in the local blockchain **[10].**

3-Blockchain Developing

In order to improve the system's performance and efficiency in light of the Blockchain technology's rapid development, studies on security and privacy concerns have been conducted. The scalability issue in existing Blockchain systems has been successfully addressed by improving distributed consensus methods from the control plane, while the security issue has been adequately addressed by modernizing block structures and encryption algorithms from the data plane.

3-1 Blockchain Security

Data is now more readily available due to its developments in computer technology, except there are numerous risks to the online data, such as theft and manipulation. One method that has made it possible to shield data from some of the dangers connected with data storage and dissemination is cryptography. Cryptography is necessary for any cryptocurrency due to its fundamental component of the Blockchain technology [15]**.** Hash functions, digital signatures, symmetric encryption, and asymmetric encryption are some of the research areas that make up modern cryptography. Cryptographic proofs applied to distributed networks enabled the creation of trust-less economic systems, giving birth to Bitcoin and other decentralized digital currencies[16]. The Bitcoin protocol uses cryptographic proofs to protect the network and guarantee the accuracy of every transaction. Digital signatures ensure that each user can only use his or her own wallet's funds once and that these funds cannot be used more than once. Another important element of the Bitcoin Protocol is the Hashcash function, Hashcash makes use of a cryptographic function called SHA-256. BlockP2P is a new optimization technique that boosts broadcast efficiency while maintaining security. In the beginning, BlockP2P uses the K-Means technique to perform the geographical proximity sensing grouping [**9**]. Algorithm DEMiDRA (DE) is suggested to optimize resource allocation and co-mining decisions for Mobile edge computing (MEC) enabled wireless Blockchains instead of using the evolutionary algorithms (EAs) , Additionally, a tabu technique is created to discourage unpromising miners from engaging in mining [**17**]. Developing the idea of blockchain technology while integrating it with other cutting-edge technologies One such technology is the smart contract, which integrates with several blockchain frameworks and permits anonymous transactions and decentralized consensus between various untrustworthy parties [18]. Participants in systems based on blockchains may be malicious. Suggesting the use of the Proof of Karma consensus technique (PoK), In PoK, both new and current nodes have an equal opportunity to profit by rising to the top and submitting a legitimate block to the Blockchain. To encourage and dissuade the nodes' honorable and harmful actions, PoK levies penalty and offer incentives.[**19**]. Users have to regist in the system to get an ID for each one, which is a smart contract. The user enters the registration key as an input to the program during the registration process in the form of a string. A public-private key pair using the(Elliptic Curve Digital Signature Algorithm) ECDSA technique is generated by the program using this registration key and the current date[**20**]. The approach is resistant to attacks such as internal impersonation attacks and common attacks. Leveraging Blockchain technology, provides a message authentication technique for information anonymity and decentralization. Incorporate

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consensus mechanisms used to build Blockchain systems, such as Proof of work (PoW) and Practical Byzantine Fault Tolerance (PBFT), into the authentication procedure [**21**].

3-2 Blockchain Performance

There are numerous techniques to boost the effectiveness and performance of the Blockchain system, such as parallel mining, competing with other miners, and others. Clustering Miners and Transaction Allocation technique (CMTA) are used to overcome the drawbacks of the Blockchain mining process. The CMTA consists of three stages, the first of which groups Blockchain miners into clusters according to their hash power, the second of which calculates transaction complexity, and the third of which distributes the transactions to the clusters [**22**]. The use of parallel mining increases system scalability, which is the aim of parallel mining. A strategy for increasing the scalability and transaction speed of proof-of-work-based, permissionless Blockchain networks has been put forth. An approach introduces parallel proof of work, in which all miners compete to solve the puzzle simultaneously, which can improve both system capacity and performance [**23**]. In [**24**], the researchers proposed a protocol to improve the efficiency of the Blockchain via a key strategy that switches from a chain data structure to a graph data structure and employs another mining mechanism to enable parallel mining. Work on transforming the Blockchain's peer-to-peer architecture into a decentralized, group-organized structure by parallel mining utilizing the proof-of-work method [7].

4-Blockchain in other fields

This section goes over some of the applications that makes use of the blockchain. IOT, supplies chain, health records (electronic health records (EHRs), electronic medical records (EMRs), and personal health record systems(PHRs), banking sector, and digital marketing .

4.1- Blockchain in IOT applications

The authors highlight the significance of using blockchain in IoT applications, and many suggest that there is a safe and portable IoT authentication solutions built on the blockchain [1]. By providing various blockchain layers, the system optimizes the Bitcoin blockchain for IoT. Each tier has distinctive characteristics that set it apart from the previous tiers and the Bitcoin Blockchain. It offers a tiered architecture that utilizes a decentralized public blockchain at higher-end devices for stronger confidence and a centralized private immutable ledger (IL) at the local IoT network level to decrease overhead [**25].** Performance assessment of IoT network security and privacy systems based on the blockchain Many different types of IoT applications were examined for their blockchain-based security and privacy mechanisms [**26**] The use of blockchain to address security and privacy issues for IOT-based on green agriculture, where challenges against such agriculture are divided into five categories, including assaults on privacy, honesty, confidentiality, availability, and integrity features, leads to blockchain-based solutions for green IoT-based agriculture, including: blockchain-based public key infrastructure (BPKI), blockchain-based machine learning (BML), blockchain-based distributed key management (BDKM), blockchain-

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based access control (BAC), blockchain-based reputation and trust (BRT), blockchain-based authentication and identification (BAI), and blockchain-based Secure SDN (BSDN) [**27**].

4.2- Blockchain With supply chain

The Ambrosus and Modum systems use a variety of tracking devices, including sensors, tags, and tracers. The product plays a major role in choosing the best tracking device. An efficient monitoring system aims to decrease the production and distribution of dangerous or inferior products by improving branding and the monitoring system. In order to ensure the quality and safety of food, Radio-Frequency Identification (RFID) is used to conduct tracking and monitoring. Then, the blockchain is updated with all pertinent data to build a trustworthy, open, and secure decentralized platform [**28**] Data sharing in the supply chain can be set up and controlled by smart contracts, with the required nodes sharing pertinent information at the appropriate frequency. Connecting the transactional Enterprise Resource Planning (ERP) system to the blockchain is the most effective approach to sharing information [**29**].

4.3- Blockchain in healthcare applications

When used in healthcare, Blockchain improves security while granting patients access to their medical records. The likelihood of being targeted increases when medical data is exchanged in a dangerous environment. Therefore, the stakeholders in the health sector share information safely to facilitate its security[**30**]. Blockchain technology is used in this field because it is characterized by accuracy, security, privacy, and other features that set it apart from other technologies This is because there is an urgent need to adopt a more patient-centered approach in healthcare systems and to increase the accuracy of electronic patient records [**31**]. The researchers described how to leverage various systems or technologies, such as the Gem Health Network, which employed Ethereum to construct a shared infrastructure, to solve the issue of patients' medical health records and information inconsistencies and Medical negligence dangers. The omniPHR is a different design that is created to assist with patient companion records. The distinction between electronic health records (EHRs) and personal health records (PHRs) is the key problem that omniPHR tries to solve. With the aid of Blockchain technology, the decentralized records management system MEDREC manages electronic medical records (EMR) data. Mobile computing and wireless sensing are components of the PERVASIVE SOCIAL NETWORK (PSN), a network-based healthcare system [**32**][**33**]. Inter-Planetary File System (IPFS) and Blockchain are two cutting-edge technologies that are combined to provide a decentralized system for the complete process of storing and retrieving medical records[**34**]. To address the issue of medical health record data security, IPFS and blockchain technology are now being used for the storage and preservation of medical records [**35**].

4.4 - Blockchain With banking sector and digital marketing

since remittances in the classical banking sector are incompetent, and the banking system's inability to react quickly enough to the digital age's rapid environmental change. Banks must utilize Blockchain technology to facilitate more efficient payments, quick and secure transactions, and better remittances. [**36**][**37**]. Compared to current interbank payment systems like SWIFT,

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Blockchain technology offers quick payments and money transfers. For instance, PayPal uses Blockchain technology to speed up the verification and processing of major payments. Second, Blockchain technology enhances security by enhancing the reliability and security of financial transactions, decreasing forgery, and safeguarding private data in the face of bank cyberattacks [**36**]. Blockchain technology has many benefits for use in digital marketing. The safety of users' private information is the first of these advantages. Both from the perspective of consumers and from the perspective of the standing of the business, the security of this data is crucial [38]. The security of payment methods and the security of websites where enterprises conduct business are further advantages of Blockchain technology. Additionally, one advantage of businesses utilizing Blockchain technology is the defense of the rights of online shoppers as well as the authorization and safeguarding of digital assets [36].

Table 1: Summary of the Technologies Used for Each Application

Ref	Paper Title	Developing Blockchain	Applications	What author do
[7]	Improving Blockchain Consensus Mechanism via Network Clusters	Performance		Work on transforming the Blockchain's peer-to-peer architecture into a decentralized, group-organized structure by utilizing parallel mining and the proof-of-work method.
[9]	BlockP2P: Enabling Fast Blockchain Broadcast with Scalable Peer-to-Peer Network Topology	Security	-----	BlockP2P uses the K-Means technique to perform the geographical proximity sensing grouping.
[17]	A new differential evolution algorithm for joint mining decision and resource allocation in a MEC-enabled wireless blockchain network	Security	------	The algorithm DEMiDRA (DE) is suggested to optimize resource allocation and co-mining decisions for MEC-enabled wireless blockchains. Instead of using the evolutionary algorithms (EAs), Additionally, a tabu technique is created to discourage unpromising miners from engaging in mining.
[18]	An Overview of Forks and Coordination in Blockchain Development	Security	-----	Developing the idea of blockchain technology and integrating it with other cutting-edge technologies One such technology is the smart contract.
[19]	Proof of Karma (PoK): A Novel Consensus Mechanism for Consortium Blockchain	Security	-----	Suggesting the use of the Proof of Karma consensus technique (PoK), which imposes penalties and offers incentives.

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[20]	FileShare:A Blockchain and ipfs framework for secure file sharing and data provenance	Security	-----	A public-private key pair using the Elliptic Curve Digital Signature Algorithm (ECDSA) technique is generated by the program using this registration key and the current date.
[21]	Distributed Blockchain-Based Message Authentication Scheme for Connected Vehicles	Security	-----	provide a message authentication technique for information anonymity and decentralization Incorporate consensus mechanisms into the authentication procedure.
[22]	A Proposed Technique for Enhancing the Mining Process in Blockchain Architecture	Performance	-----	Clustering miners and transaction allocation (CMTA) are used to overcome the drawbacks of the blockchain mining process.
[23]	Improving transaction speed and scalability of blockchain systems via parallel proof of work.	Performance	-----	use parallel mining, in which all miners compete to solve the puzzle simultaneously, which can improve both system capacity and performance.
[24]	Improve blockchain performance using graph data structure and parallel mining	Performance	-----	Use a key strategy that switches from a chain data structure to a graph data structure and employ another mining mechanism to enable parallel mining.
[25]	Towards an optimized blockchain for IoT		IOT	By providing various blockchain layers, it offers a tiered architecture that utilizes a decentralized public blockchain at higher-end devices for stronger confidence and a centralized private immutable ledger (IL) at the local IoT network level to decrease overhead.
[27]	Security and privacy for green IoT-based agriculture		IOT	Blockchain-based solutions for green IoT-based agriculture (BPKI, BML, BDKM,BAC,BRT,BAI,BSDN) Blockchain-based
[28]	The power of a Blockchain-based supply chain.		supply chain	Radio-Frequency Identification (RFID) is used to conduct tracking and monitoring in order to ensure the quality and safety of food.
[29]	Blockchain technology: supply chain insights from ERP		supply chain	Data sharing in the supply chain Connecting the transactional Enterprise Resource Planning (ERP) system to the Blockchain is the most effective approach to sharing information.
[30]	A Survey of Ransomware Attacks for Healthcare Systems		Healthcare	described how to leverage various systems or technologies, such as the Gem Health Network, the omniPHR The distinction between EHRs and PHRs, the decentralized records management system MEDREC manages EMR data. Mobile
[31]	A systematic review of the use of blockchain in healthcare		Healthcare	

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[32]	Blockchain in healthcare applications: Research challenges and opportunities		Healthcare	computing and wireless sensing are components of the PSN, a network-based healthcare system.
[36]	Blockchain for transformation in digital marketing		banking sector and digital marketing	Compared to current interbank payment systems like SWIFT, Blockchain technology offers quick payments and money transfers.

5- Conclusion

Due to its rapid development, technology is being used more and more in various facets of life. However, privacy and security issues are among the major challenges it faces. The use of encryption and the hash function to solve the security problem and the use of an ID for each user to solve the privacy problem are only a few of the solutions offered by the blockchain. not dealing with just one node because decentralization is something that all nodes have to cope with. The performance and effectiveness of the blockchain have been improved through the use of a variety of algorithms, including consensus algorithms, parallel mining, a change in the structure, or work on integrating the blockchain with a variety of other fields, including health and supply chain, IOT, etc. The purpose of this article is to list some of the applications and development areas of Blockchain.

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Conflict of interests.

There are non-conflicts of interest.

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