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A Consortium Blockchain Model to Overcome Issues in the Global Patent Authentication and Management Process

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***Abstract*—Patent authentication and management is an important activity to protect the intellectual property rights of individuals and organizations globally. As the patents are territorial and the data management related to patent applications mostly happens with local intellectual property (IP) offices, the patent authentication and management (PAM) process is significantly inefficient and time-consuming on the global scale. Moreover, the data management issues in the patent process often lead to conflicts and legal actions among competing parties. Blockchain technology is widely recognized for its potential use in creating decentralized, secure, and transparent systems with immutable records. It hence seems to be a useful technology to overcome the issues in the patent domain. This paper explores the adaptability of blockchain technology in the patent domain. It presents the design of a consortium blockchain system, which is proposed as a solution to numerous issues stemming from inefficient data management. The proposed consortium blockchain design is based on the Ethereum architecture and is equipped with smart contracts to ensure the reliability of patent data as well as the real-time update of records. This paper further discusses the potential testing and validation strategies for the proposed model.**

Keywords — blockchain, patent authentication and management

I. INTRODUCTION

A patent is an exclusive right granted to an inventor that precludes others from commercializing, using, distributing, importing, or selling the invention without permission from the patent holder. According to the World Intellectual Property Statistics, 3 million patent applications were filed in 2019. As a result, an increasing number of people are eager to file patent applications for their inventions. A patent, on the other hand, is territorial, which means that its rights are restricted to a single country. This restriction is incompatible with the fast-paced corporate culture of today's economy. Even with the support of international accords like the Patent Cooperation Treaty, registering a patent in another country requires multiple patent filings in each target patent office, which is inefficient and costly (PCT). Figure 1 depicts the current patent authentication and administration system. It takes 3–6 months to complete a patent application, and 3–5 years to examine patentability. This is a long period during which new ideas can be introduced to the market, lowering the likelihood of this invention being commercialized in the future.

At the national level, intellectual property rights protection is seen as a major issue. This has an impact on the intensity of innovations and is critical in enhancing the drive of entrepreneurs to innovate. To safeguard these rights, the existing intellectual property rights system needs a tremendous amount of money and work. The existing PAM system has issues such as the length of time required for patenting, the absence of evidence of ownership before requesting legal action, low-quality patent approval, high search expenses, a high risk of expropriation, limited access for small inventors, and the complexity of undertaking a patent landscape of a given technology.[1], [2]

The objective of this study is to see if blockchain technology can be used to solve problems in the global patent authentication and management process. Through smart contracts in safe document management, blockchain can significantly influence immutability, trustworthiness, security, and federated features, and so will have a good impact on patent authentication and management. We plan to incorporate all of these capabilities into the PAM by utilizing the benefits of blockchain technology.

A. Blockchain Technology

Blockchain technology is a decentralized, peer-to-peer network that creates a transparent, encrypted, and immutable digital federated ledger system. The users themselves maintain this shared ledger, which does not require the involvement of a third party. Because data entered into the blockchain cannot be changed without being identified, the system is impenetrable. It has a wide range of applications because it can store any type of data, including cryptocurrency, transactional data, contractual data, design data, etc. Blockchain technologies are interesting in today's era, which is prone to cyber-attacks on centralized systems, because of their immutability, traceability, and lack of third-party invention.

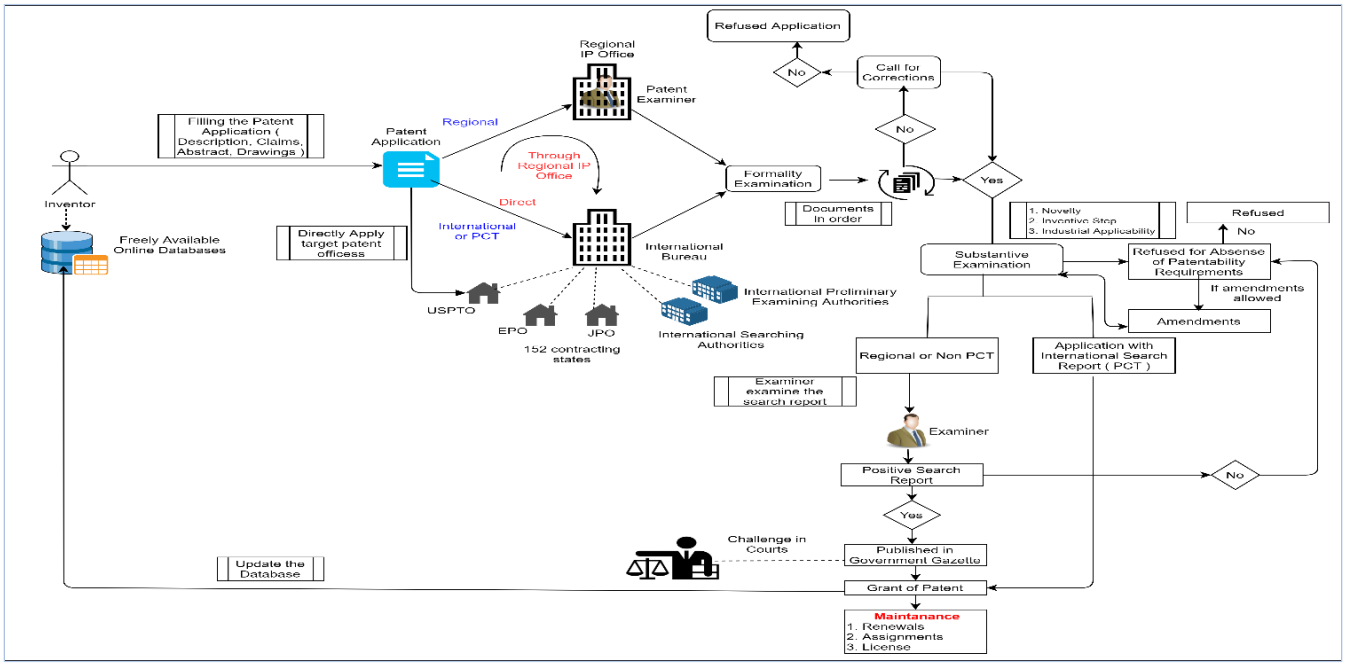

Fig. 1 The existing patent authentication and management system

Information is stored in discrete encrypted blocks that are linked by hash references in blockchain technology. These hash points build a chain or blockchain by connecting one block to the next. Individual transactional data is included in these blocks, which are time-stamped separately. A consensus mechanism ensures that all nodes agree on a unique sequence for adding entries to the blockchain and that all nodes verify the data that will be appended to the blockchain. Self-autonomy, trust, transparency and provenance, immutability, disintermediation, and collaboration are some of the benefits of blockchain technology. [3] Blockchain technology can also be used to create a distributed database, which will be extremely helpful in the preservation of public data. It can also be utilized in government processes to optimize and cross-validate systems. This technology appears to be best suited for key government processes like digital identity management, secure record-keeping, and document management.

Public permissionless blockchain, public permission blockchain, consortium blockchain, and private blockchain are the four types of blockchain. [4],[5]

Public permissionless blockchain: Anyone can connect to the network and write and access data in this sort of blockchain (e.g., Bitcoin). In this type of blockchain, there is no single owner of the networks, ensuring anonymity. Although this sort of blockchain is thought to be extremely secure, validating transactions take a long time because the amount of power required to verify each subsequent transaction grows. In this situation, proof of work has a greater influence than in other types of blockchain, where more nodes participate in transaction verification.

Public permission blockchain: In this sort of blockchain, everyone can connect to the network, but only a select group of people can write to it.

Consortium blockchain: This is a hybrid blockchain that combines the features of both public and private blockchains. Only a tiny set of authorized members in this network have access to the information. Therefore, only authorized users are allowed to make changes to the network.

Private blockchain: The data in this blockchain network can only be viewed by a select set of authorized nodes. Only the network operator can write to the network.

B. Potential to use Blockchain in Patent authentication and Management

Along with the patent authentication and management process, the immutability, trustworthiness, reliability, and federated features of Blockchain can be gained at any level. At the moment, each intellectual property office's patent records are housed in databases. Such information may go out of sync. To combat this, data must be validated and updated frequently. The advancement of blockchain technology has the potential to greatly assist IP offices all over the world. The integration of these technologies into patent databases helped them. The Blockchain has a lot of potentials when it comes to establishing proof of original inventorship. It will aid in the reduction of lawsuits while also identifying the proper inventor/creator/proprietor. The filling data kept on blockchain will have sufficient explicit significance in deciding the rights of the first filler under a

"Priority Date" notion. Blockchain technology can be used to synchronize internal and external search databases. Patent investigators will be able to find anticipation in inventions by using a single unified platform for patent search.

Patent data is stored either on paper or electronically by intellectual property offices. In a court of law, those registries have legal validity in certifying the holders' rights. Blockchain technology can be used to keep records that ensure data accuracy. Furthermore, these registers enable real-time record updating in the event of a right transfer. Because blockchain is a linked list that employs hash pointers instead of normal pointers, data verification would be much easier and tamper-proof. Each blockchain node is given the task of locating the next node and determining if it has changed. Blockchain technology has a lot of potential for interacting with IP offices all over the world. Faster research, more reliable patent data management, advanced licensing, and increased credibility will all benefit from incorporating this technology into IP offices' day-to-day operations as soon as possible.

C. Blockchain Usability

Blockchain technology got its start in 2008 with the launch of Bitcoin. In a white paper, Satoshi Nakamoto titled Bitcoin: A Peer-to-Peer Electronic Cash System. [6] [3] gives an overview of blockchain technology, including its present applications and ramifications. According to the report, no third-party mediators control data on a blockchain network, and all transactions must go through a cryptographic validation mechanism. In a decentralized and distributed network, blockchain is a chain of blocks that holds information with digital signatures.

Decentralization, immutability, and transparency are all characteristics of blockchain technology that make systems safer and more resistant to tampering. Blockchain technology has applications in financial and social services, risk management, healthcare facilities, and other industries, in addition to cryptocurrency. [7] At the moment, it looks that blockchain technology is best suited for digital identity management, secure records management, and document processing, all of which are vital governmental functions. A blockchain is a secure, verifiable record of all monetary and governmental transactions. Furthermore, blockchain technology ensures that document management system administration is secure. [8]

D. Consortium Blockchain

A consortium blockchain is a type of blockchain that enlists the help of authorized nodes to keep the distributed ledger up to date. In this type of blockchain deployment, only approved nodes are included. Consortium blockchains have emerged as a significant concept and architecture for integrating the freedom and anonymity of private blockchain transactions with public blockchain governance. [9] In research, the topic of consortium blockchain has gotten very little attention. This method can be used in PAM systems to improve infrastructure while also enhancing service quality.

Consortium blockchain will ensure that:

- Transaction limitations will be decreased as a result of transaction confirmation delays
- No transactions fee
- Blockchain data privacy will be improved.
- The special pre-approved set of nodes does the verification of the operations.

E. Review of Smart Contract in the context of blockchain

According to [10], a “smart contract is a type of computer program which runs on the blockchain and is executed by all consensus nodes. It is made up of program code and a storage file.” Any user can create a contract by uploading a transaction to the blockchain. A contract's program code is fixed when the contract is created and cannot be modified.

The combination of blockchain technology and smart contracts allows for more flexibility in inventing, designing and addressing real-world problems at a cheaper cost and faster than traditional third-party-based systems. The importance of blockchain technology's smart contract integration has been a focal area for development since it allows for peer-to-peer transactions and databases to be maintained open in a secure and trustworthy environment. Smart contracts can be traced and are not subject to alteration. A smart contract is a computer program that stores all transaction data and executes it automatically. [11]

F. Blockchain consensus mechanism and Practical Byzantine Fault Tolerance (PBFT)

Consensus algorithms are critical in assuring the security and efficiency of the blockchain network. A blockchain application's performance can be greatly improved with the right algorithm implementation. [12]. In a distributed, untrusted environment, this strategy allowed all nodes on the public ledger to reach a consensus. The blockchain system's security, availability, and performance are all decided by the consensus process.

Practical Byzantine Fault Tolerance (PBFT) is presently being used as a consensus approach in many blockchain projects since it has various advantages, including high transaction throughput and reduced energy loss. [13] The PBFT consensus algorithm is the first high-performance consensus protocol with optimum byzantine fault tolerance. The PBFT protocol is a Byzantine Fault Tolerance mechanism with a simple algorithm and a large number of applications in distributed systems. PBFT ensures that during each round of consensus, nodes maintain a shared state and take consistent action. Because

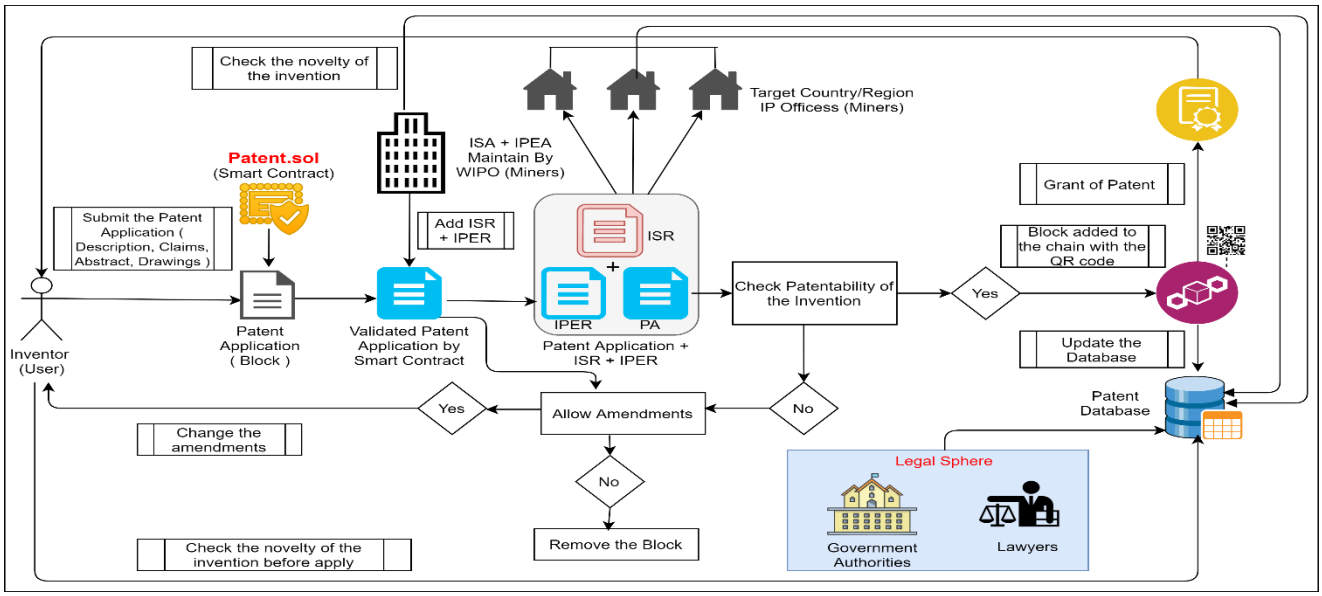

Fig. 2 Blockchain based patent authentication and management ecosystem

it meets the goal of great consistency, PBFT is referred to as an absolute-finality consensus protocol. [14]

PBFT is a state machine replication-based consensus mechanism. Services are reproduced in numerous nodes of a distributed network as a state machine. The state of the service, as well as the activities it performs, are saved in each replica of the state machine. This method can ensure that the system runs normally when the number of defective nodes does not exceed one-third of the total number of nodes. A message inquiring about the content of messages received by other nodes should be sent to each node. There is one primary node out of n nodes in the PBFT method, and the other backup nodes are referred to as replicas. The view-change component of the PBFT algorithm is also crucial. When the primary node goes down and is unable to finish the data request within a certain amount of time, the other replicas initiate a view-change, and the replacement primary node takes over once the conversion is performed. By broadcasting to the entire network in each round and enabling each node to vote for the primary node, the PBFT approach can handle both non-Byzantine and Byzantine problems at the same time. This complex technique assures that PBFT maintains its consistency, availability, and anti-fraud attack features.

G. Related Works

Wei-Tek Tsai et al. (China, 2017) presented blockchain integrated microfilm IP protection framework that focused primarily on scripts and names, which were used to distinguish one microfilm from another and could be kept in a blockchain database. [15] Savelyev and Alexander Ivanovitch noted significant legal concerns that arise when misusing blockchain technologies in the copyright elements in 2017. They analyzed existing issues with digital availability of copyrighted works, solutions available in blockchain technology, and related issues that must be taken into account in this topic. [16]

In 2018, Kensuke and Marcus presented a copyright protection mechanism based on blockchain technology. Martin Holland et al. [17] discussed the use of blockchain technology. In addition, digital rights management was highlighted as a key technology bottleneck in the transition to additive manufacturing processes. It was also a step toward defining and preventing IP theft in the 3D printing supply chain. They proposed the Secure Additive Manufacturing Platform (SAMPL), which created a secure and trusted foundation for additive manufacturing technologies. [18] Fran Casino et al. stressed the inclusion of information and transactions in blockchain integrity verification applications that are associated with the development and longevity of products and services when reviewing the systematic literature of blockchain-based applications. Provenance, counterfeiting, and IP management are just a few of the major uses. [19]

Gonenc Gurkaynak et al. (2018) used a blockchain-based architecture to improve the functioning of IP offices, improve customs processes for detecting counterfeit products, and increase the efficiency of the right holder's IP rights management. They took many steps to help the growth of blockchain technology, including promoting it among the general public and successfully integrating it into a variety of services and registration/transaction channels in IP administration. [20] Alexander Schönhals and colleagues have emphasized blockchain-based strategy to safeguard innovative ideas and the first product design and concept development. [21] Martin Zeilinger explored the use of blockchain technologies to improve the exclusive digital art market in 2018 [22].

The majority of current research, on the other hand, focuses on strategies to protect copyrights and trademarks. Because the applicant is the only user type in their suggested solutions, applying these tactics to patent protection is difficult. Examiners are required in patent applications, unlike copyright and trademarks, because patents are often technical. For patent authentication and management, we need to design a more appropriate blockchain-based system paradigm.

II. METHODOLOGY

This research is being done to propose and examine a new consortium blockchain model to address issues with worldwide patent authentication and management. Expert comments were obtained by conducting structured interviews with specialists in the intellectual property office to identify the process of the existing system and its limitations. A thorough literature review was also conducted to determine the state of knowledge in the associated domains. The identified challenges, constraints, and flaws are then solved through the creation of unique architecture. The potential testing and validation procedures for the proposed model are also discussed in this study.

A. Blockchain-based patent authentication and management system

As previously noted, there are significant technological, legal, and economic difficulties with the current PAM system. All of these problems led to major defects that impacted the business environment and the innovation cycle. The existing PAM system, it is said, lacks the efficiency and flexibility needed to respond to market changes. Incorporating blockchain technology into the PAM system would address all of these concerns while also enhancing the efficiency of innovation processes in the country's economy, for all of the reasons stated above. Everyone who needs to patent their inventions will be encouraged by the recommended process.

Figure 2 depicts the proposed blockchain-based patent authentication and management ecosystem. All stakeholders are included, including inventors, the World Intellectual Property Organization (WIPO), the International Search Authority (ISA), the International Preliminary Examination Authority (IPEA), global IP offices (USPTO, EPO, JPO), lawyers, government officials, and any potential relationships between participants in this platform and the system's workflow.

Inventors may conduct a preliminary search for already claimed patents and the patentability of their concept before filing for a patent. A single unified platform for patent search is given since international IP offices maintain (examine and update data regularly) the same database. An inventor who wants to file for a patent submits an e-request with the invention's information. Smart contracts look for

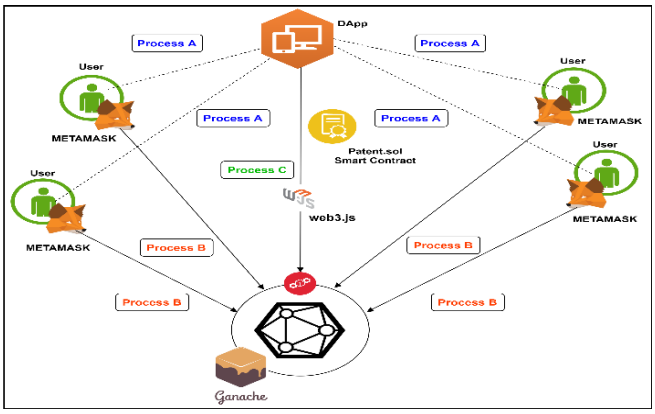

Fig. 3 Overview of the Decentralized App

already claimed patents, which will be incredibly useful in compiling the ISA report, according to the invention's keywords. The patent smart contract stores the validation e- request on the blockchain when it has been validated. The International Search Report (ISR) and International Preliminary Examination Report (IPER) are then added by the ISA and IPEA, respectively. Then, at the same time, all of the target patent offices take such e-requests and validate the details by approving or rejecting them. The patent is given once they are authorized, and it is transmitted to the smart contract holding the patent data, as well as the owners' information. Before storing the information in the database, the smart contract verifies that the user who initiated the request is the patent owner. It also verifies the legitimacy of the IP offices that verify patent data.

The owner creates an e-request in the event of a change of ownership, which is subsequently stored on the blockchain in the patent smart contract. The patent examiner then authorizes the e-request, and patent information is sent to the smart contract, which holds patent ownership information, and the owners' information is updated. The smart contract confirms that the individual who generated the request is the actual owner of the patent and that the patent examiner who approved the transaction is legitimate before updating the owner's data.

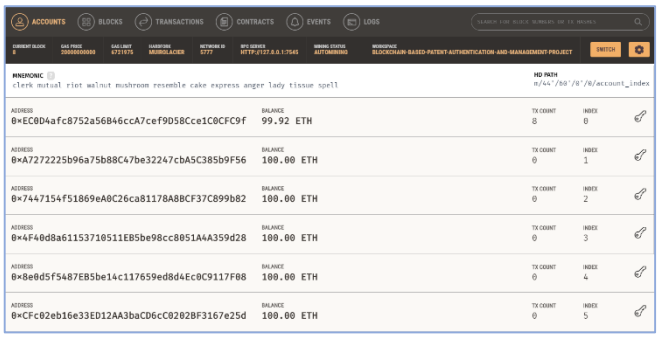

Fig. 4 Ganache Test Client with generated accounts

B. Testing and Validation Strategies

A prototype of the Ethereum blockchain-based decentralized application (DApp) shown in Figure 3 is being developed to demonstrate the architecture and overcome the highlighted hurdles and constraints. The difference between this model and the Public Ethereum blockchain is that under the Bitcoin design, Proof of Work is carried out by network miners who are compensated in 'ether' for their efforts. In this case, the PBFT consensus is given to a collection of authorities that includes the World Intellectual Property Organization (WIPO), IP offices, and others. Consortium Blockchains are the name for these blockchains. As a result, when a new transaction occurs and a block is created, the authorities must validate the transaction before the block can be added to the blockchain. The patent details may be inserted as data into the block by the patent.sol smart contract. After the block has been verified, it is uploaded to the blockchain.

DApps in Ethereum are programs having a graphical user interface that make it easier for users to interact with the blockchain. Smart contracts handle the application's business logic, while HTML, JavaScript, and other front-end technologies are used. Because contract code is redundant and expensive to run, DApps are meant to do only the essential operations on the blockchain, while anything else that could be done on the client-side is handled by the application's front end.

Process A - For the authentication process, the system users' (Inventors/WIPO/IP offices) metamask browsers will connect to the Blockchain.
Process B - To complete the PAM transactions, the users will communicate with the DApp.
Process C - To write transactions to the blockchain, the DApp will link to the Ganache blockchain.

To get results, it is also tested in a ganache simulated environment with produced actors and data. Ganache is a blockchain simulator that may be used to create a private Ethereum blockchain. It allows you to inspect the state of the blockchain while also controlling the chain's operations. It will make it possible to do all actions on the main Blockchain for free. Figure 4 depicts the wallets that were created, together with their wallet addresses. Case studies such as accepting or rejecting patents, adding remarks to the patent application by target patent offices, verifying patent ownership, transferring patent ownership, and conducting a patent landscape are used to assess the platform's capabilities. Mock data is used to simulate the input and output data that is required during testing.

Ganache is a private blockchain for testing purposes. On a public Ethereum network like Rinkeby, you can try this. The Proof-of-Authority consensus mechanism is provided by the Rinkeby network, whereas the Proof-of-Work consensus mechanism is used by the Ethereum Ropsten network.

III. RESULTS AND DISCUSSIONS

A blockchain-based PAM system provides live data on patents with easy searchability because the blockchain network contains all data related to patents registered on the system. This also assists in determining who owns a patent. By offering a comprehensive overview of certain technology in the framework, it prevents other patents from being replicated. As a result, our technology will search for similar patents in a speedy, methodical, and straightforward manner. Because every transaction is permanently recorded and cannot be edited or altered in this system, the blockchain-based PAM architecture would make the transition of patent ownership easier. Examiners, inventors, and lawyers would benefit from the blockchain-based PAM system because it would save costs. In legal procedures, lawyers might use the system's unchanging data to prove ownership and the presence of eligible patents. As a result, this system unifies several PAM-related services into a single interface.

The novel technology for manipulating the PAM system must be implemented at the national level, with a system peer node included in each IP office in the country region reaching agreements in all patent applications. The management of this framework, including the WIPO, should be opposed by the government. As a result, we're pushing for the creation of a consortium blockchain platform that oversees the consensus process and includes regulated bodies like the WIPO and regional IP offices. If this does not happen, the private sector will gain control of many platforms, making dispute resolution and legal empowerment much more difficult. The system's viability, dependability, and efficiency are all enhanced by this platform. As a result, there will be no need for a third party to oversee patent-related transactions because the platform's scalability has been assured. To develop a regionally coordinated national database of patents that may be used as evidence in national courts, the system should be linked to all national IP offices throughout the world.

IV. CONCLUSIONS

This study looked into the problems with the current PAM system, which are mostly connected to time, cost, security, and dependability. Combining blockchain technology and the PAM system, in response to the aforementioned problems, would solve all of the system's flaws and boost performance capabilities, minimizing bottlenecks in the present system. To address these issues, a blockchain-based PAM platform was proposed, which would bring together all PAM system stakeholders, including inventors, WIPO, regional IP offices, ISA, and IPEA, to ensure that all patent information is shared among all IP offices while maintaining the security provided by the blockchain.

It is capable of meeting the requirements of IP offices all around the world. It will be much easier for IP offices to

accomplish results in terms of faster inspection, reliable record management, and smart licensing if they can quickly integrate this technology into their daily operations. Patent prosecution, protection of patent rights, and the resolution of patent infringement issues will all benefit from this technology. The importance of blockchain as a widely used database was also investigated in this study (which is critical in cross-validated reliable systems like digital identity management, secure record-keeping, and document processing in government operations).

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