

# *Preserve Security to Medical Evidences using Blockchain Technology*

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**Abstract**— Advanced privacy preservation approaches are used to be protecting sensitive and important data of various application areas like Communication systems, Healthcare, Education and Financial Sector. In the Healthcare area, the important and sensitive task is a medical certificate that acts as medical evidence of a person which helps for many purposes. Deception in issuance as well as in verification of medical certificates has existed for a long time in health care centers due to lack of reliable mechanisms. In the issue of medical evidence to a person, needs to consider a method which has advanced features like transparency, immutable, reliable and decentralized properties. Hence, in this paper, blockchain technology is used to design and develop a model with advanced features for reducing forgery in medical pieces of evidence. In this approach, a regulatory body will authorize the Health care centers (Hospitals) for issuing medical certificates to the required persons in a decentralized approach. Here smart contract system helps to verify the certificate authenticity from any authorized one in the world. The main strength of the paper gives the Blockchain-based model as a solution to the issue related to proof of a certificate of medical evidence.

**Keywords**—Medical Evidence, Blockchain, Smart Contract, Regulatory Body, Immutable, transparency.

## I. INTRODUCTION

Today blockchain became incredibly popular, change in the technology is only the constant to protect the information in the insecure digital era. As its name refers that a blockchain means a chain of blocks which consists of data. Initially, in 1991, a researcher group described the blockchain. The original intention behind the design and development of blockchain is to give timestamp for the digital documents. It causes to make tamper-free document [1]. This advanced technology became popular with its features like distributed, immutable and privacy. This distributed ledger featured blockchain is open to everyone for working on it. The blockchain has an interesting property no one can change the data if once stores it in the block of a blockchain. Each block in a blockchain consists of some attributes such as earlier block hash value, current data and the hash value of the current date and time stamp. Blockchain implements using bitcoin, ethereum, Ark, etc platforms [2]. Data attributes of a block differ from one platform to another platform. Initial block in the blockchain referred to as genesis block.

Proof of work is a mechanism used in blockchain technology to improve security. Miners can perform this task in blockchain to create a new block. Each block creation and add to the chain can take 10 minutes. It makes blockchain as a tamper free technology with its diffusion feature. Recalculate the proof of work for tracing not possible here. Because of, current block hash value depends on earlier block hash value in the blockchain environment. This mechanism can possible to use in various areas at the same time not possible to apply in all the areas [3]. This technology is used for where ever required to maintain sensitive data with immutable feature and flexibility to access the data means that used by the authorized persons at any time from anywhere. Peer to peer (p2p) communication used by the blockchain. Every node will have one unique identity that represents a hash value only. It improves blockchain security with its single way authentication (one-way authentication) nature.

The consensus is a protocol or agreements among the nodes or parties which participate in the blockchain. Different consensus protocols like proof of work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS) and Practical Byzantine Fault Tolerance (PBFT) and Ripple used in the blockchain technology [4,12]. These can give assurance on security and fault tolerance of the blockchain systems. All consensus protocols can be categorized into two types, such as

1. Absolute Finality
2. Probabilistic Finality

Each blockchain system has different application objective. Based on application objective consensus protocol has to be adopted. Blockchain operation can do using smart contracts. Smart contracts are used to exchange cryptocurrency within the blockchain based on certain conditions. To perform any operation over blockchain requires cryptocurrency that avails in various forms like bitcoin, Ethereum, etc. This blockchain technology can be used in various fields for creating Medical ledgers, Government orders, Education institutions, E-notary and even collecting taxes.

The paper remaining work discussed in the following way. Section 2 consists of a literature survey with comparative analysis. Proposed work methodology discussed in section 3. The executed smart contract has discussed in section 4.

## II. LITERATURE SURVEY

Tien Anh [1] did a research and analysis on different things here but they took four main dimensions like distributed ledger, cryptography, smart contracts and consensus protocol. They also represented the BlockBench, which is a framework for understanding the performances of private blockchains over the data processing workloads. Here they mainly evaluated Ethereum, Parity and also Hyperledger Fabric. They wanted to connect blockchain directly to the database using some interfaces like IWorkloadConnector interface. Here they also deploy the smart contract applications, invoking sending a transaction, and also for querying the blockchain states. The main aim of this paper is to bring blockchain performances closer to the principles of database system,

Basit Shahzad [2] worked to provide security to the voting data by effective hashing techniques. Concepts like block creation and block sealing are initiated in this paper. Here voter needs to register first then they check whether the voter duplicate one or not if voter is valid one then their registration will be done then election commission verify voter and allow then to vote. A data is maintained by election commission in which votes will be stored. The votes from each polling station are verified whether they are any duplicate/error votes if the votes are valid ones, the process is done using a blockchain technology then the data is tabulated and sent to election commission then they will declare. Here Merkle tree has maintained the records like distribution blocks and the degree of their decomposition. The actual polling process which is used on polling day, should able to include both physical and logical verification of the voter, based on availability of verification system available during polling data.

Shuai Wang [3] discussed about smart contracts and how they are used, applications of smart contract, architecture and how it can be used in future. Smart contracts can be found in different applications like IoT (Internet of Things). They discussed the Ethereum network and Hyperledger Fabric transactional workflow. Here they also have done basic research on smart contract frameworks to know how it is working in different layers. They considered layers like infrastructure layer, contracts layer, operations layer, intelligence layer, manifestations layer, application layer. These all are worthless because the proposed framework is just an ideal framework. The proposed frameworks and all in this paper are used only for the researchers and practitioners to get an idea. These frameworks can be used in research and also any possible developments in present trends.

Zheng [4] designed and developed a platform called NutBasS. This NutBaaS is a service which provides blockchain service in different environments like cloud computing and network deployment, system monitoring, smart contracts analysis and testing also provided. This BaaS means Blockchain-as-a-service it is a combination of cloud computing and blockchain. BaaS main aim is to offer and allow users that they can build cloud-based solutions, host and manage their blockchain applications, functions on blockchain and also smart contracts. This is mainly useful to reduce deployment cost and also this simplifies the process. It is similar to Platform-as-a-service (PaaS). This NutBaaS has four layers

Resource layer, Service layer, Application layer, Business layer. In this Resource layer is the important layer and it is also called as Service Layer. By these services, some applications can be constructed such as Dapps and also some general solutions related to industries at the application layer. Application layer mainly helps people to find quick solutions to their problems or applications.

As mentioned above also some other researchers have been working on this platform for important applications like voting systems, educational certificates, RTO documents. Table 1 shows a summary of related works. Our proposed system has tested by considering issue the certain number of certificates (n) by each health care center. This approach has been discussing in the following section.

Table 1. Related work Summary

Author	Supports Regulatory Authority	Blockchain Technology	Certificate Revoke	Immutable
Prateek Pandey [5]	No	Bit Coin	No	Yes
Shuai Wang [7]	No	Bit Coin	Partial	Yes
Xuguang Wu [8]	No	Bit Coin	No	Yes
Edvard Tijan [9]	No	Bit Coin	No	Yes
Conti, M [10]	Yes	Ark	No	Yes
K. Lakshmi Priya [11]	No	Ethereum	No	Yes
Proposed Model	Yes	Ethereum	Yes	Yes

## III. PROPOSED SYSTEM

Medical certificates are precious assets as they form evidence for one's health as well as birth or death identity and eligibility. Fraud in issuance and verification of medical certificates has been a long standing issue in Medical community. Due to lack of anti-forgery mechanisms there has been substantial increase in fraudulent certificates. The need of the hour is to have a transparent and reliable model for issuing and verifying medical certificates to eliminate fraud in the process. Decentralized, Auditable and Tamper-proof properties of Blockchain makes it possibly the best choice for issuing and verifying medical certificates [12]. In this work a model is proposed, where regulatory body authorizes hospitals for issuing medical certificates to patients in a decentralized way. Anyone in the world can verify the authenticity of the certificate by triggering appropriate smart contract functions, thus eliminating any possibility of fraud in the process. Important roles of this approach are

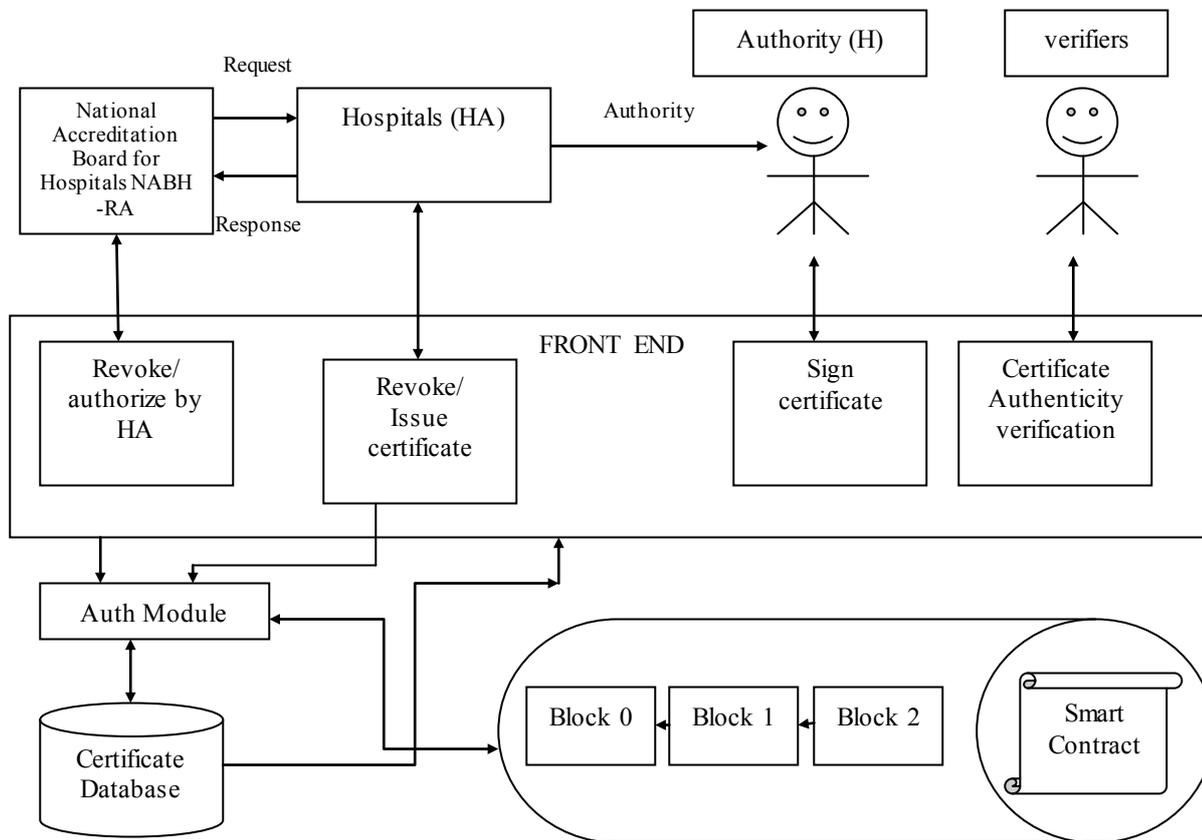


Fig 1. Blockchain based proposed Methodology

1. Regulatory Authority
2. Medical Evidence issuer

These two roles should need to authorize the medical evidence of a person. Authorization of a medical evidence represents by a digital signature which included by a unique hash value. Each valid certificate has a unique ID that can be sharing to the user. Remaining transaction details store at blocks as a transaction as shown in fig 1.

*Operations of Authority:* The main operations performed by the authority persons are

- *Registration ( )*: Every hospital and user take registration under RA with unique IDs (UID).
- *Issue certificate ( )*: It takes user and hospital UIDs and purpose and *validity ( )* as inputs. Later, *sign ( )* executes to generate hash sign of the certificate.
- *Revoke certificate ( )*: Using user UID removes the details from blockchain by corresponding authority.
- *Verify Certificate ( )*: It takes registration number and printed hash value on certificate to check the certificate.
- *Validate certificate ( )*: This takes period of validity as an input to issue certificate.
- *Authentication ( )*: No hospital can possible to issue or revoke certificates unless they are authorized by RA.

*Operations of user:* The user of medical evidence can able to perform only verification ( ) operation to check whether his health evidence records existed at blockchain repository or not.

Remain all operations allowed to regulatory authority from health care centers and National accreditation Board.

*Process of Block chain Creation in Ethereum:*

- Step 1: Install geth and Ethereum.
- Step 2: Create Transaction and Authority Accounts.
- Step 3: Generates the genesis block.
- Step 4: Private Ethereum Instance starts as a part of functional blockchain

This approach runs on ethereum based testrpc and solidity platforms by including smart contracts for all the operations. Eth value (gas) has to be reducing while performing every operation on blockchain platform [13,14]. So before performing every operation verifies the Ethereum balance as shown in fig2. For each and every authorized health care center one individual block has to be allotting in which health evidences of a person stores as a transaction. These can never be possible to do alter, trace and delete. Hence it has referred as immutable. Any authorized person can verify the evidences at anytime from anywhere due to its decentralization nature.

Smart contract for issue\_cert ( ) algorithm has showing the attributes what have been requiring to implement the proposed system using blockchain technology. Eth-Gas balance required to perform these operation and to store at blockchain as a transaction. This methodology is very costly with supportable advanced features like immutable, transparency, privacy and

distributed. Here instead of storing the attribute values, stores hash value of the results in blockchain. Hence no one can trace back the process. Miners can mine the block here for performing transactions [15].

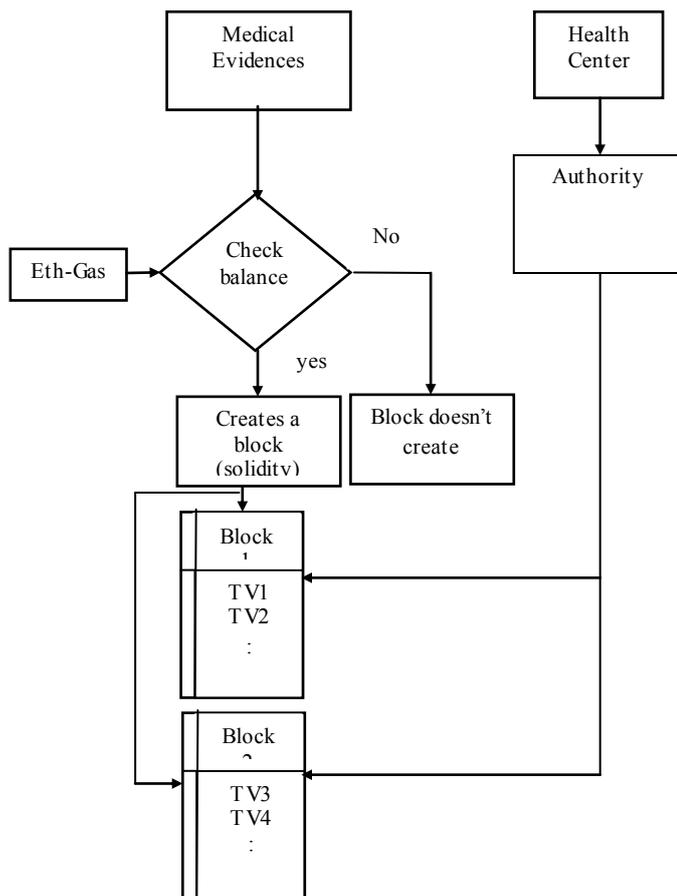


Fig 2. Process of blockchain creation using Ethereum

#### IV. RESULTS AND ANALYSIS

Fig 3 shows the ethereum based Eth balance which one required to perform operations. Cost of various operations in proposed model has shown in Table 2. It consists of certain function name, cost of the operation in terms of gas (eth) and location of the transaction and transaction hash value generated while in migration mode [16,17].

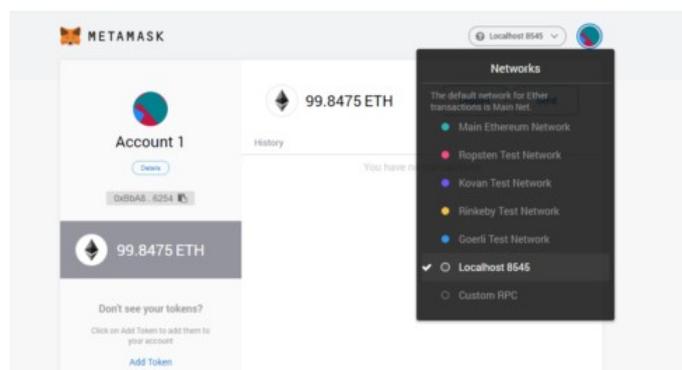


Fig 3. Eth balance

#### Algorithm : Smart contract for issue\_cert ()

- Step 1: If certificate already exists then goto step 2 otherwise goto step 3  
 Step 2: Revert  
 Step 3: procedure
- i) Set the hash of Medical Cert struct corresponding to user ID (UID) and health care center account address with cert hash.
  - ii) Set the ID of user struct corresponding to user\_ID (UID) and health care center account address with UID.
  - iii) Set the Health care center name of Medical Cert struct corresponding to user ID (UID) and health care center account address with healthcare\_name
  - iv) Set the User name of Medical Cert struct corresponding to user ID (UID) and health care center account address with User\_name.
  - v) Set the medical Evidence Reason of Medical Cert struct corresponding to user ID (UID) and health care center account address with evidence.
  - vi) Emit Cert\_Added\_event

Table 2. Cost of operations in proposed model

Function name	Gas Used	Block No	Transaction Hash
Contract Creation ( )	154537	5	TX 0x4074b62edaff790d0ea253357521e6cac6ac895f722a42603c569c9833b9583c
Registration ( )	13325	4	TX 0x62b65b01eac9adf2521aec64f54082a59c7358b1fd65faaaf220c95da5954eb
Verify ( )	41671	3	TX 0x81ba21ffe70d586b3d7faf5932917055f91b19f0e0d3f3422e48db8f0df59119
Issue ( )	114931	2	TX 0x11517800df8a65d6770d4d6358faadfc39fe73c3c5ef1ddd8df434a1c318b682

Fig 4 represents block creation on ganache platform for medical evidence smart contract. It shows that gas used while in creation of a block. Each block transaction has shown in fig 5. It represents gas used for the transaction along with address of the transaction holder. All these values were representing with a hash value generated by Ethash algorithm on Ethereum platform or by SHA algorithm on bitcoin platform [24,25]. Fig 6 represents the contract information how it will be executing on blockchain platform. Here ethereum and ganache is used to compile and execute the smart contracts for medical evidences. Fig 7 shows that block size increment while increasing workload. In case workload increases means issuing of medical evidences rate increases, regulatory authority can monitor and find out the solution to main certainty. It leads improve the efficiency of the system [18]. In blockchain environment, minors' role is important to mine all the transactions.

CURRENT BLOCK	GAS PRICE	GAS LIMIT	HARDFORK	NETWORK ID	RPC SERVER	MINING STATUS	WORKSPACE	SWITCH	⚙️
5	2000000000	6721975	PETERSBURG	5777	HTTP://127.0.0.1:7545	AUTOMINING	PERFECT-KNOWLEDGE		
BLOCK 5	MINED ON 2019-09-14 17:28:03		GAS USED 154537		1 TRANSACTION				
BLOCK 4	MINED ON 2019-09-14 17:22:16		GAS USED 154537		1 TRANSACTION				
BLOCK 3	MINED ON 2019-09-14 17:10:44		GAS USED 13325		1 TRANSACTION				
BLOCK 2	MINED ON 2019-09-14 17:06:17		GAS USED 41671		1 TRANSACTION				
BLOCK 1	MINED ON 2019-09-14 16:59:09		GAS USED 114931		1 TRANSACTION				
BLOCK 0	MINED ON 2019-09-14 16:40:51		GAS USED 0		NO TRANSACTIONS				

Fig 4. Block creation with Gas Used

CURRENT BLOCK	GAS PRICE	GAS LIMIT	HARDFORK	NETWORK ID	RPC SERVER	MINING STATUS	WORKSPACE	SWITCH	⚙️
5	2000000000	6721975	PETERSBURG	5777	HTTP://127.0.0.1:7545	AUTOMINING	PERFECT-KNOWLEDGE		
TX HASH <b>0x4074b62edaff790d0ea253357521e6cac6ac895f722a42603c569c9833b9583c</b> <span>CONTRACT CREATION</span>									
FROM ADDRESS 0xBA508D384e3E7f7f45AaF84Eca62b28Ed6Ca4C84			CREATED CONTRACT ADDRESS 0x57609f0f1DBC13330aFAf20f28e0E5efeFc7D80a			GAS USED 154537		VALUE 0	
TX HASH <b>0x62b65b01eac9adf2521aecd64f54082a59c7358b1fd65faaf220c95da5954eb</b> <span>CONTRACT CREATION</span>									
FROM ADDRESS 0x57f9b44C0b42FE18e501Fafe87c544424AE758b1			CREATED CONTRACT ADDRESS 0x60fd8d5653932685D22886c1C53c15c38739E6f5			GAS USED 154537		VALUE 0	
TX HASH <b>0x047453f669752d68c27659f0a65b9c07b73e806bd011e92e2d338ba4f5b2d849</b> <span>CONTRACT CALL</span>									
FROM ADDRESS 0x57f9b44C0b42FE18e501Fafe87c544424AE758b1			TO CONTRACT ADDRESS 0xc0723b02E650F05a2ed06Ede79Da21487209A977			GAS USED 13325		VALUE 0	
TX HASH <b>0x81ba21ffe70d586b3d7faf5932917055f91b19f0e0d3f3422e48db8f0df59119</b> <span>CONTRACT CALL</span>									
FROM ADDRESS 0x57f9b44C0b42FE18e501Fafe87c544424AE758b1			TO CONTRACT ADDRESS 0xc0723b02E650F05a2ed06Ede79Da21487209A977			GAS USED 41671		VALUE 0	

Fig 5. Block Transaction with Gas Used

CURRENT BLOCK	GAS PRICE	GAS LIMIT	HARDFORK	NETWORK ID	RPC SERVER	MINING STATUS	WORKSPACE	SWITCH	⚙️
5	2000000000	6721975	PETERSBURG	5777	HTTP://127.0.0.1:7545	AUTOMINING	PERFECT-KNOWLEDGE		
<b>← BACK TX 0x4074b62edaff790d0ea253357521e6cac6ac895f722a42603c569c9833b9583c</b>									
SENDER ADDRESS 0xBA508D384e3E7f7f45AaF84Eca62b28Ed6Ca4C84			CREATED CONTRACT ADDRESS 0x57609f0f1DBC13330aFAf20f28e0E5efeFc7D80a			<span>CONTRACT CREATION</span>			
VALUE 0.00 ETH		GAS USED 154537		GAS PRICE 4100000000		GAS LIMIT 154537		MINED IN BLOCK 5	
TX DATA 0x6080604052600805534801561001457600080fd5b50610166806100246000396000f3fe08060405234801561001057600080fd5b50600436106100415760003560e01c8063a5f3c23b14610046578063b93ea81214610092578063cb31926e146100de575b600080fd5b61007c6004803603604081101561005c57600080fd5b8101908080359060200190929190803590602001909291905050506100fc565b6040518082815260200191505060405180910390f35b6100c8600480360360408110156100a857600080fd5b810190808035906020019092919080359060200190929190505050610112565b6040518082815260200191505060405180910390f35b6100e661012565b6040518082815260200191505060405180910390f35b6100e661012565b6040518082815260200191505060405180910390f35b6000818301600081905550600054905092915050565b6000818303600081905550600054905092915050565b6000805490509056f5a265627a7a7231582093e01be0e3e9efc05c0c623703ef29eefb463d661ed976f54c95d3ff3b58eb3d64736f6c634300050b0032									

Fig 6 Contracts hash value while creation

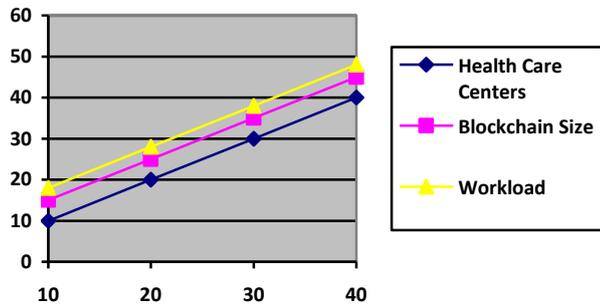


Fig 7. Overhead and Blockchain size as per workload

#### IV. CONCLUSION

The main aim of this work was provide sustainable computing proof of evidence in medical field for the users. eHealth is holding sensitive personal medical information which requires protection. Our proposed model using block chain technology designed for that purpose that depends on contracts among the providers and data consumers/users. This paper clearly mentioned that block creation, contract creation, gas used for every transaction and test results for workload increases how blockchain and overhead will affect. In addition, multi signature scheme is to be used in future where certificates are required to be singeing by designated authority from hospitals, thus allowing for multi-level checks on certificate contents before being successfully deployed on Blockchain. Proof of Concept in Ethereum Blockchain has to provided and evaluated its performance in terms of cost, security and scalability

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