

The Impact of the Blockchain on Academic Certificate Verification System-Review

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Abstract

Blockchain innovation (BT) guarantees benefits in believe capacity, collaboration, organization, identifying proof, validity, and transparency. These solid suggestions for the long run of how to verify the authenticity of academic certificates because a paper-based certification is fallible to manipulation and susceptible to fraud. This literature review started by collecting a test of basically peer-reviewed sources, as well as an enlightening outline of articles from different other channels to analyse about approximately later approaches, techniques and later patterns on instruction which is being utilized in blockchain innovation on document verification from different sector such as banking , medical records and education system etc. This paper proposes a digital certificate verification blockchain based system employing anowner authentication scheme and time, space of the students are stored as blocks using blockchain technology. A distributed public record with tamper proof and immutable that preserves the state of the document, which creates security in the digital asset. This clearly stated that this technology is required to keep digital assets in secure and any one can access without loss of data and maintained it with minimum cost.

Keywords: Blockchain, blockchain platform, solutions and applications for certificate authentications, Challenges and BT in Education

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1. Introduction

The future internet is blockchain technology. The first blockchain is Bitcoin which is introduces by Satoshi Nakamoto; it is Bitcoin came into existence in 2009. Now the Bitcoin became more popular. Bitcoin is the most popular digital money used on peer to peer network in the case of the blockchain.

Blockchain technology has the abilities that are Decentralized, Distributed, Secure and Faster, Transparent, and non-modifiable. These are more beneficial than the existing technologies. It is a linked list like data structure that maintains details of data and its transactions via a peer to peer network publically. Each movement of data is secured with hashing SHA-256 algorithm and then all the transaction summary will be grouped and kept as blocks of

data. Then the blocks are joined with hash value of previous block and so on and secured from tamper-proof. This entire functionality of the blockchain will produce secure and non-modifiable record of the transactions that happened across the P2P network. The great advantage of blockchain enables most of the author made to implement the educations system. It can store student details such as degree certificates and history of the provider and address of student's data in the network. The feature of cryptography in blockchain technology keeps data secure with tamper-proof which will avoid the intruder to access and fakes the certificates from the blockchain. No can access and modify the certificates other than one who have access rights. So this powerful feature of Blockchain suggests that to implement this blockchain technology to verify the degree certificates and student's details insecure. The blockchain establishes a set of consensus and common operation mechanisms through the general ledger, smart contract, and

cross-chain technology. The mechanism solidifies the data stream formed by time, space, and instantaneous multidimensional overlays by programming to form recordable, traceable, determinable, priced, and tradable technology constraints [2].

The blockchain technology uses the several consensus algorithms and common procedure execution through the distributed public ledger, business logic (smart contract) and cross-chain concepts. These techniques maintain change of the data integrity by keeping the attributes of transactions such as time, space and instantaneous multifunctional overlays with constraints such as recordable, traceable and determinable, cost and tradable procedure etc.,

In this study, this paper shows an exact review by analyzing suitable papers such as journals, white papers and IEEE papers to explore the characteristic and applications. This article has 5 sections and in its first Section 1 is about quickly depicted blockchain innovation and portrayed how this innovation is developing step by step. Section 2 is about writing a survey in which assembled information from notable assets dependent on our examination questions. Besides, a short portrayal of our procedure is likewise introduced in this segment. Just as Section 3 presents basic examination, in this segment is broke down the use of blockchain innovation dependent on the information of the exploration addresses planned in section 2. Segment 4 is about the present patterns and future bearings of BT. Additionally, Section 5 is about the conclusion of the research paper that closes this examination.

2. Literature Review

This exploration comprises of insightful research papers from supposed diaries, gatherings and books which are comprising of 35 notable assets top world colleges articles by IEEE papers, Frontiers of Computer Science - Springer, Frontiers of Computer Science - Springer, Scopus, Journal of NCA, Computer Communications, Transactions on Emerging Telecommunications Technologies, Journal of super computing, ACM, Elsevier and Science Direct. The reason for this writing audit is to distinguish the current instruments, approaches, philosophies, and really understudy's information and squares chains that are reliably working in the industry. In writing audit we watched its most recent innovative patterns and analysts and industrialists who are all the while taking a shot at it and improving this innovation dependent on the current weaknesses. Our examination depends on four basic research inquiries so as to discover the proper research bearings in the space of blockchain and its applications. They looked into writing permits depicting standards and the establishment of blockchain innovation, just as its applications in various genuine use cases. It merits referencing that practically all papers show a requirement for additional exploration in the field. A great deal of creators accepts that blockchain has huge potential, yet at the same time there are a ton of snags and difficulties for genuine execution. For instance, there isn't a single, overall

acknowledged meaning of blockchain; in this way, creating normal principles and guidelines (both specialized and legitimate) is profoundly important. Normalization would-be the initial move towards planning bound together methodologies in blockchain programming improvement and security practices, without which a sensible work of blockchain is not feasible.

2.1. Related work

This literature study is analyzed based on some research questions which are formulated as in table 1. So our research is mainly focused on these stated questions, which are evaluated in this paper as follows.

2.2 RQ1: How does blockchain technology impact the certificate authenticate system?

Blockchain is a linked list, replicated, distributed, consistency maintained by consensus cryptographically linked and assured integrity of data.

It used as immutable ledger of events, transactions of time stamped data, tapper resistant log, platform to create and transact cryptocurrency, log of events/transactions unrelated to currency[1].

Table 1. Research Questions and motivation

Research Questions	Motivation
RQ1:	How does blockchain technology impact the certificate authenticate system?
RQ2:	What are the blockchain processes and methodology?
RQ3:	What are the solutions and applications suggested with blockchain technology for educational system?
RQ4:	Discuss the challenges of adopting BT in education system?

Tease features enable the industries to store their data and make transactions on blockchain network to maintain highly secure data for a long time access without the need for middleman.

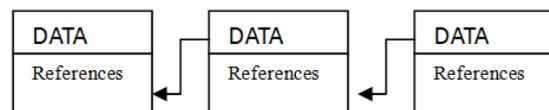


Figure 1. Blockchain structure

Each transaction in the block is approved by the miner (any node on the blockchain network) which confirms the transaction and protects it from altering. Subsequently, the data the advanced block contains is deeply secure.

The blockchain takes a shot at three primary classifications. The first, decentralization which contains no brought together specialists that directs to different blocks. The subsequent one is straightforwardness, which directs simple approved exchanges anyway it permits certain straightforwardness in every system. The last one is permanent which limits to temper the information in light of the fact that once the information has been transformed it will foment the entire chain of information. The permanent column is actually utilized for security reasons in blockchain innovation. Blockchain innovation utilizes a distributed system that permits joining a new block in the chain without influencing different blocks. Each block has an allure for handling and confirming the exchanges [4]. Along these lines, that is the reason these attributes make the blockchain great to keep the records straight and everybody can utilize it [6]. It outlines the innovation of basic ideas such as digital documents are seized instead of duplicated or moved. The advantage is publicly distributed without the middlemen, permitting everyone can access. A straightforward record of changes jams respectability of the report, which makes trust in the benefit. Blockchain is a particularly encouraging and progressive innovation since it decreases the hazards like forgery of certificates, gets rid of overcharge, and produce straightness an adaptable route for heap employments. Finally the overview of the blockchain shows that the certificates are stored as digital assets instead of transferred or copied. So the certificates are available to full real time access without the need of third party. A distributed public record with tamper proof and immutable that preserves the state of the document, which creates security in the digital asset. This clearly stated that this technology is required to keep digital assets in secure and any one can access without loss of data and maintained it with minimum cost.

2.3. RQ2: What are the blockchain process and methodology?

BT is part of a broader suite of technologies called Distributed Ledger Technologies (DLT). Though often used interchangeably, blockchain technology and distributed ledger technology distinguish themselves in their structures of data storage. Blockchain can be considered a subset of distributed ledger technology in which multiple transactions are stored in 'blocks' and cryptographically linked to the previous block by a 'chain'. Blockchain technology, simply stated is the use of distributed databases to store information about transactions between parties. A defining feature of these databases is that they cannot be altered except without concurrence of a significant fraction of the custodians (and users) of the distributed database. The use of cryptographic functions ensures that transactions can be authenticated as originating from a particular identity and transactions completed without the need for any central authority.

Unlike present day networks which depend on trusted intermediaries for security and trust, blockchain create trust organically through the underlying technology of distributed networks. They allow users to exchange digitized assets directly, in a way that is incorruptible (data cannot be changed once added) and transparent (all transactions are logged onto the time stamped ledger, with the identity of the person who committed the transaction). As they effectively reduce the dependency on 'middlemen', blockchain can also generate savings by streamlining processes and reducing inefficiencies typically introduced to systems due to multiple layers of control. Gartner estimates that distributed ledgers and blockchain will create USD3.1 trillion in added business value by 2030, driven by fraud prevention, cost savings, and added transparency [7].

2.4 RQ3: What are the solutions and applications suggested with blockchain technology for educational system?

A variety of blockchain applications since from Bitcoin to research on blockchain could have a huge impact on the way researchers build their reputation and become recognized. These applications have been developed for different purposes. Most of the articles focused on supply chain and digital certification verification to keep up with for long time with secure data. In this paper focus on applications have been developed for educational purposes those are analyzed its aim of the application and implementation mechanism and challenges which are required to resolve in future functionality are summarized as shown in Table2. This review process on different articles and papers depicted the applications for educational system can be classified into different categories such as a decentralized publically distributed system for educational student details, students performance report and reward, a tool for chase and verification of authorized degrees: Enterprise form, accreditation and degree verification system, academic certificate authentication system, issuing and verifying digital certificates, universities can incorporate an efficient blockchain education program, secured university results system, learning outcome and meta-diploma and student data privacy and consent, lifelong learning, protecting learning objects, examination review, enhancing students interactions in online learning. The most of applications were studied in this review were centred on students degree certificates verification management.

The system provides the digital certificate platform by making use of a secret session key. It generates the key and uses it to authenticate the user [8]. This system makes use of private key optimized digital identity for digital certificate generation and authentication [9]. The system can be used by an institution for its official website. The purpose of the system was to design an online certificate system based on verification which can be used by the institution [10]. A unique ID is generated using facial particular region, which is used for one to one verification of documents [11]. The system makes use of QR code for authentication of digital

certificates. The server database is used for the record of all generated QR codes. Using the client-server model, the system is developed which generates the certificates in batches and not individually [12].

Most of the papers enclosed for this literature review conferred the applications which are used to verify the validity of issuing, storing, and sharing students' academic certificates. Still, these artifacts focused on blockchain applications to maintain student details, sharing the degree certificates and mark statements (learning outcomes) which

are earned by students. The concept of applications focuses on student's evaluation and academic abilities [13]. Some of these articles present the blockchain based applications that are used by companies to verify the student's academic achievements and professional skills [14]. The category is concerned with protecting learning objects from destruction and unauthorized change, and it includes articles. The applications found in the reviewed articles are related to the combined learning

Table 2. Sum-up the comparison of various applications, implementation mechanism and challenges

Title	Authors	Aim of the application	Implementation of the application benefits	Challenges in future process
A Distributed System for Educational Record, Reputation and Reward	Sharples, M., Domingue, J	Storing educational records as Distributed ledger to resolve forgery of certificate	Smart contracts mechanism Micropayments Kudos -educational reputation currency to access records	No separate verification service Vulnerable to proofing attacks
learning outcome and meta-diploma	Bin Duan, Ying Zhong, Dayu Liu	Evaluation system of certified profession is verified	POA Consensus Mechanism (Prove of Accreditation)	Lack of consensus mechanism. Not clear picture of authenticity
Using blockchain as a tool for tracking and verification of official degrees	Miquel Oliver, Joan Moreno, Gerson Prieto, David	Blockcerts platform with an easy interface.	Back-End service for making easy the management of titles through the key	Lose of key need a new wallet Student will be responsible to save in a secure vault
How Universities Can Incorporate an Efficient Blockchain education program	Rajarshi Mitra	Give out blockchain courses is via certification.	Blockchain Education Network (BEN) to establish the Kerala Blockchain Academy (KBA)	Universities curriculum only via partnerships Not clear picture about authenticity
Blockchain for Student Data Privacy and Consent	Gilda, S., & Mehrotra, M.	Solves the problems of nested authorization and granular consent for data release	Hyperledger Fabric & Hyperledger Composer framework of nested authorization	Lack of consensus mechanism The certificate is vulnerable to manipulation
Certificate Verification System using Blockchain	Nitin Kumavat Swapnil Mengade , Dishant Desai	Solve the problem of counterfeit certificates.	(IPFS)unique hash generated by SHA-256 algorithm Ethereum platform	University can be added only by the owner of the smart contract Not clear method of authority of experts
EUniCert: Ethereum based digital certificate verification system	Trong Thua Huynh1, Dang-Khoa	solve the problem of counterfeit certification	EUniCert based on UniCoin a digital currency built on the blockchain	Requirements for an employer to verify the certificate A student cannot authorize Not clear method of authenticity
A Blockchain-Based Accreditation and Degree Verification	Aamna Tariq, Hina Binte Haq , Syed Taha Ali	Accreditation and Degree Verification System	Permissioned blockchain	Not for students or employers Need a partnership with multiple universities Not clear method of authenticity
Secured University Results System using Block Chain Features	Prashik Thul, Tushar Raut, Kunal Yadav	Secure the university results using Block-chain	Administrator has control of the system. modules used Administrator & Student Administrator	Not for the employer and hides the privacy of student Lack of consensus mechanism
Degree Verification over Blockchain	BlockchainTech Private Limited, Karachi, Pakistan	Certify.pk Pakistan's first platform to verify the authenticity of academic	Proof of Existence (PoE) consensus mechanism. Verify Digital Certificate by scanning QR code on Digital Certificate.	Vulnerable to proofing attacks Need for basic information security measures No clear method of authenticity of parties

the job and higher education. These applications benefit from the high security and less cost and credit transfer

[15]. This paper is concerned with bring off academic competitions and deepen the degradation and clearness of

these competitions and also related to copyrights management and protective the ownership rights of learning materials [16]. However few of the reviewed papers focus on e-learning process to enhancing students' interactions by rewarding them with virtual currencies. This paper deals about auditing and sharing of exam papers to validate the student's academic achievements.[17].This review shows that the out of thirty five papers stated education based applications that have been already formulated and are now being used. This study clearly mentioned that the student's degree certificate and other performance abilities are stored in blockchain which definitely provide high security and real time access those data within minimum cost.

In spite of the truth that blockchain has come out its possible in an instruction set; on that point there are contrasting situation that got to be reasoned when apply blockchain conception within the education system. This study compared different platforms allow the development of blockchain-based applications. They can either be permissioned or permission less. Among these the Ethereum is the public blockchain , Hyperledger , R3, Ripple are the private blockchain , and EOS are a few names that have built blockchain frameworks, allowing people to develop and host applications on the blockchain. In this survey article, Table3 is summarized into a few essential categories availability of the blockchain platform [26] to develop the applications is listed as Table2.

2.5 RQ4: Discuss the challenges of adopting BT in education system?

Table 3. Availability of Blockchain Technology platforms for various applications

Features/ blockchain platform	Ethereum	Hyperledger Fabric	R3 Corda	Ripple	Quorum	Hyperledger Saw tooth	EOS	Hyperledger Iroha	Stellar
Industry focus	Cross-Industry	Cross-Industry	Financial Services	Financial Services	Cross-Industry	Cross-Industry	Cross-Industry	Cross-Industry	Financial Services
Type	Public	Private	Private	Private	Private	Private	Private	Private	Both
Consensus Algorithm	Proof of Work	Pluggable Framework	Pluggable Framework	Probabilistic Voting	Majority Voting	Pluggable Framework	Delegated Proof-of-Stake	Chain-based Byzantine Fault Tolerant	Stellar Consensus Protocol
Smart Contract	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Governance	Ethereum	Linux	R3 Consortium	Ripple Labs	Ethereum & JP Morgan Chase	Linux	EOSIO Core Arbitration Forum	Linux	Stellar Foundation
Programming language	Solidity , Vyper	Golang, JAVA	Kotlin,	C++ JavaScript	Java , Kotlin	Python, C++, Go, Java, JS	C++, Web Assembly	C++	C++, Go, Java, JS, Python, Ruby

Selecting a blockchain platform for education from the Table3 for specific education or academic postulation may be difficult because there is a broad range of technical dimension that are faultfinding for its acceptance in education applications. For example, there are some solution that take up blockchain would go through too much drive, unexpectedly [18]. This is not about the blockchain itself instead the lack of experts on understanding the process of different consensus protocols such as Proof of work (PoW), Proof of State

(PoS), Proof of Authorization (PoA) etc. that can be selected for a particular blockchain platform. The first application of the blockchain Bitcoin used a PoW consensus algorithm to validate the block and user who have access the data. But it required more energy compared with other consensus algorithms. Another situation involve the open source of a blockchain network as public or privatee, ability to change the code and sharing it (e.g., licenses), and demand for specific hardware (eg, SGX-enabled processors). Too many availability of blockchain platform as mentioned in the

table 3 will increase the level of implementing blockchain technology in and out real time applications. Now a day a blockchain platform should be general but not stick on only for financial applications. It is very popular in technical and support high level of security where ever avoid the forgery there it can be placed.

Still, to adopt and implement this blockchain technology required very high cost. And also other than this execution cost, the exchange, or process expense of numerous strategies of BT is additionally more [19]. As mentioned above this shows that to store huge data which understudy information, as block size increase with the raise of clients, also will develop the cost [10, 20]. In order to implement the blockchain based application need to dealing with this turn of events and operational cost, it is not easy to utilize this method in customary instruction frameworks [21, 23]. However some of the blockchain based platforms are not used in the education application domain indeed. But they should be advised for upcoming days due to its specialized characteristic that is an energy-efficient consensus algorithm.

3. Discussion and Analysis

This section discusses about the impact of the blockchain in the use case of the academic certificate verification that ensures high level of security and avoids fake certificates.

3.1 Blockchain in the education system

Throughout the years, colleges have expanded in sizing to have an enormous development in the understudy base, workforce base, and another related to substances. This has brought about functional difficulties for college authorities, teachers and staff offers types of assistance to huge understudy and graduated class networks have become a huge errand. It can improve the educational system in many ways. The blockchain technology is perfect for secure education information storage, sharing, and networking.

3.2 Maintaining Student Academic Records

The use case chosen to analysis is the universities and educational institute. Who has the responsibility to maintain all the students' academic records that have passed out from the universities and institution? Even in company the employer authority have to do the background verification of a particular student at the time of job requirement. It will take time. So there is no consensus mechanism which can help the institute to verify the records in an electronic or automated way to validate the certificate and speed up the process. Current challenges Existing solutions of educational certificates verification thus have the following challenges:

- a) Centralized-completely dependent on certificate issuing authority
- b) Manual-verification is usually done through emails, phone calls, or web forms
- c) Time-consuming could take weeks or months
- d) Easy to breach and tamper -need for a decentralized trust system that is verifiable and tamper-proof is automatic, real-time, and is fraud-proof.

From this literature review, Table2 clearly illustrated that the technology is nowadays realizable to store medical, real estate bonds, insurance policies, academic certificates, birth certificates, and other important certificates digitally and access them securely and independently anyplace across the world. Most of the organization and institutions have realized the possibility of blockchain and are grasp the technology for storing different kinds of official documents. A hashing algorithm and digital signature strategy and timestamp solve most of the possible problems with forged and frauds in academic certificates. But it is through two technologies that are a public and decentralized blockchain combined enhancing their traditional implementations. The result stipulates greater clarity, let down maintenance, and less costs than whatever other existing alternative.

3.3 Hyperledger based certificate verification system

Based on the analysis of the various BT platforms Table-3 to implement the certificate authenticates system on the blockchain that this paper proposes a private Hyperledger fabric blockchain architecture [24, 25]. Hyperledger Fabric provides distributed ledger solutions on private networks for a wide range of industries including educational institutes. Its modular architecture maximizes the privacy, flexibility, and elasticity of blockchain solutions. Hyperledger Fabric support for safeguarding and managing digital keys for strong verification[25, 26]. This involved decentralization, intelligent identity encryption, and identity interlinking for issuance of educational certificates. The process involved: i. Creation of student identity and verify the certificate based on digital signature along with the hash value of the record. The key features of this permissioned blockchain include i. Data privacy: data stays with the entities that own them. ii. Real-time, automated verification from anywhere in the world. iii. Tamper and fraud-resistant. iv. Permanence: the certificates will survive beyond organizations – removes dependence on the issuing authority for future verifications. v. Scalable to the national and global levels. The following steps illustrate the flow of process in student record verification on permission blockchain structure.

Step1: University administrator issue the certificate with a public key

Step 2: Generate a private key for the certificate owner along with the public key

Step3: Hash key generated for each certificate

Step4: Now record will go to the third party who authenticates university digital signature and if the university is recognized then it will add its signature. And push this certificate to the blockchain (public repository) so that anyone can verify.

Step5: Check the validity of the certificate based on hash value if it is valid stored in block else reject that certificate, go to step 7.

Step6: Students are recorded certificate on the blockchain and go to step3.

Step7. Digital signature and public key are invalid.

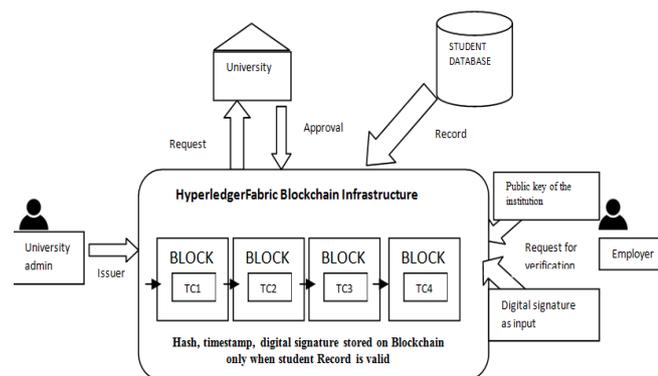


Figure 1. The proposed model to authenticate the digital certificate

One of the main concerns is this approach still leads to a centralized approach that's why this paper proposes the private blockchain [24] to implement this application. Among the education and maintain student record applications that shows the awareness of , the blockchain platforms few of them are proposed and some are implemented are noted in this paper especially public and private blockchain such as Ethereum, R3 Corda, Hyperledger Fabric, and MultiChain [Table3]. The fast growth of the Blockchain technology demands more and more applications such as government policymaker, e-voting supply chain management and education system etc., It is more important that they follow up to standards that the education information science ownership has been encouraging for a long time.

4. Current Trends and Future Directions

In this study, it is identified a maintaining student details, verify the forgery of the degree certificates, students performance skills based applications developed in blockchain and also analyse various platforms that are suited or using by the progressive education blockchain studies. From the Table-3, realize which blockchain

platform may be more practicable for educations or maintaining student record based on the analysis of a regular examination of six characteristics for ten fashionable blockchain platforms. This helps to assists in the selection of the most suitable blockchain platform for their information processing adhoc postulation. And also analyzed hypercritical blockchain enforcement features, enclose suited blockchain platforms, and distinguish the technical diagnostic that are most applicable to maintain student records in blockchain network.

Over the final little a long time, the unused innovative advancement within the tech industry is Blockchain innovation. It was created to boom cryptocurrency forms initially, but that doesn't sense that it isn't reasonable for other applications. The following a couple of patterns that set shape in 2018 and past. i) Internet of Things: Internet of things interface gadgets extending from wearable gadgets to any sort of inter-connected gadget merely can envision. ii) Smart contracts: Increased utilize of smart contracts Using shrewd contracts will bypass third parties and make air proof assertion. These contracts give a high level of straightforwardness and security.

5. Conclusion

This paper reviewed 35 distinct papers of various authors and gathered information from familiar sources and analyzed about the concepts and applications of blockchain especially in the education system. Blockchain is one of the most popular and recent growing technology that is under-use in different sectors such as health care, insurance, banking, e-voting, supply chain management and certificate verification and digital identity etc. Blockchain is considered secure technology, which stands in publically distributed and peer to peer networks. Blockchain allows storing excessive amounts of data due to complex network architecture. Most of the papers depict the implementation of blockchain technology in education system based on Ethereum blockchain with coins. This is clearly shows that the requirement of private blockchain Hyperledger fabric without coin to implement the education system to authenticate the degree certificate.

It's a perfect source for further research using this in education. Blockchain is also used in carry off big data in education system, banking, health care system, supply chain management and much other application with the confidence of security and is easy on open source ledger for researchers and analysts.

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