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Ensuring Security and Verification of Graduate Credentials Using Blockchain Technology

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ABSTRACT
Traditional methods have always made it hard to check and protect graduate qualifications because they are slow and easy to lie or cheat about. This study says that a blockchain-based system should be able to check that academic credentials are real and reliable. The decentralized and irreversible nature of blockchain is used in this solution to keep academic records safe and make sure they can be easily checked. Smart contracts get rid of middlemen and make it easy to check things. This makes sure that everything is clear. To combine privacy and ease of use, the answer uses a permissioned blockchain network. This lets the right people verify credentials while keeping data safe. Based on the results of the execution, this method boosts trust, reduces down on verification times, and provides an expandable way for academic and professional groups to manage credentials. This study makes a strong case for using blockchain in the process of verifying credentials.

Keywords: Blockchain, graduate credentials, verification, smart contracts, decentralized systems, credential management, data security

1.INTRODUCTION

In order to show that they have completed the standards for their majors, colleges and universities give graduates certificates. Transcripts and degree certificates are important to have when applying for work or going back to school. Fake transcripts and awards are still a big problem, even though schools are giving out more of them every year [1]. Paper graduation certificates are still widely used because electronic ones have some problems. Realising qualifications is important for trust in today's fast-paced digital world, whether it's in healthcare, finance, education, or anything else. It can be slow, expensive, and easy for fraud to happen with traditional ways of verifying credentials, such as through manual processes, papers, and third-party verification.

A revolutionary answer is blockchain technology, which makes it possible to verify digital credentials in a safe, open, and quick way. Then why is it so powerful? How does it work? Trust will be different in the future because of blockchain and digital identities.

What is Blockchain

A distributed network of computers keeps track of events or data in a decentralised ledger that can't be changed. The information in each "block" is encrypted to link to the information in the block before it, making a "chain."

What Makes Blockchain Unique:

1. **Decentralization:** Distributed storage eliminates the need to trust any one entity with sensitive information.
2. **Immutability:** Information stored on the blockchain cannot be erased or changed once it has been recorded.
3. **Transparency:** All nodes in the network can see a transaction, which makes everyone responsible.
4. **Security:** The use of cryptographic methods renders data impenetrable to fraudsters and hackers.

What is a Digital Credential

A digital credential is a record of your skills, accomplishments, or name that is kept safely and can be shared easily online. It's a current alternative to paper credentials that can be checked, is faster, and is easier to get. Professional groups, schools, the government, and other trustworthy bodies can issue digital credentials.

Examples of Digital Credentials:

1. **Academic Degrees or Certificates**: Digital diplomas or awards are given out by schools and universities to show that a person has finished school. These certificates are safe, simple to share, and can be checked by companies or other groups.
2. **Professional Licenses**: Having a digital professional licence, like one for a doctor, engineer, or lawyer, makes it easy to check that someone is qualified and legally allowed to work in that region.

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3. **Government-Issued Documents**: More and more, IDs, visas, and other government records are being replaced by digital copies instead of paper copies. They help with things like proving your identity when you bank, move, or use other services that need legal proof.

Benefits of Digital Credentials:

1. **Efficiency**: Digital credentials, on the other hand, can be shared right away and checked online, which saves time for both the person giving the credentials and the person checking them.
2. **Accessibility**: People who know the password can see it at any time and from anywhere, so they don't have to worry about missing or misplacing paper copies.
3. **Scalability**: Digital IDs are easier to hand out to big groups, which makes them perfect for events like mass graduations or certification programs.

Challenges and Security Concerns:

Digital passwords have many benefits, but if they are not properly protected, they can be faked, copied, or changed. This makes them vulnerable to risks, like false claims or stolen personal information, which can make them less reliable and trustworthy. It is boring and takes a lot of time to check each graduate's credentials by hand every year as they apply for jobs. It is very hard to keep track of and verify so many records, so it is possible to make fake or copied certificates by changing them. Because of this issue, there are many more dishonest companies that make fake degrees. Thanks to advances in technology, it's getting harder to tell the difference between real and fake certificates [2]. Because of this, validating and checking documents is more important than ever. It is very important to make sure that the rightful owner has the certificates of success. Due to their immutability and ease of forgery, paper certificates take a long time, cost a lot of money, and are often used for scam. Paper-based grade sheets also have some problems, such as being hard to get to, rigid, inefficient, and bad for the environment. The problem of fake certificates has gotten worse since cheap modern technologies are now available. This puts certificate holders and the schools that give them in risk [3] .Degree certificates can be digitally verified using blockchain technology, according to this research. Degree certificates cannot be falsified or fabricated thanks to blockchain technology's immutability [4]. Digital ledger technology known as blockchain distributes and decentralizes the storage and verification of transactions over a network of computers, or nodes. Even while it was built to be the backbone of the Bitcoin cryptocurrency, its uses go well beyond that. Part of the fourth industrial revolution, it allows for the decentralization, synchronization, and validation of transactions as well as the secure, transparent, and securing updating of data through a majority consensus method [5]. Blockchain is an immutable distributed ledger that records information about transactions, including their timestamps, quantities, and participants, in a sequential fashion called "blocks" [6]. When one user starts a transaction with another over a peer-to-peer network, a cryptographic identification technique identifies participants uniquely. After that, the transaction is sent to the storage pool of the blockchain network to be verified. Once the number of authorized nodes reaches a specific threshold, consensus is achieved, and a new block is created. After everyone is in agreement, mining begins, and each node updates its own copy of the blockchain ledger. This process creates a new block. Two popular methods for reaching a consensus are the Proof of Work (PoW) and the Proof of Stake (PoS) [7].

2. LITERATURE REVIEW

The mechanism of blockchain as a distributed ledger operated through hundreds of nodes results in tamper-proof operation which requires attackers to gain control of more than 51% of network ledger nodes [8]. The access to view recorded data by every node within the network provides blockchain with its transparent nature. The system enables follow-up capability through sequential transaction recording and hash function applications which link each block to its adjacent ones. Users can track all transactions through the analysis of block content [7]. The technology can protect educational documents such as diplomas and transcripts together with student qualifications [8]. Students maintain complete ownership of their credentials through blockchain solutions since neither party nor organization is needed to validate these credentials [9,10].A look into blockchain's potential uses in academia may be found in [11]. In this area, specifically in relation to its effect on educational advancement, the researchers examine the pros and downsides of blockchain technology. The study incorporates practical implications; MIT is used as an example. The researchers determine the merits and demerits of blockchain technology in the classroom by employing the multivocal literature review (MLR) method, which incorporates grey literature sourced from mainstream media including newspapers, blogs, websites, and government documents with scholarly works that have undergone peer review. Nevertheless, the report avoids a comprehensive analysis of the technical aspects of blockchain deployment in favour of focusing on its pros and cons. Additionally, it does not thoroughly investigate how blockchain technology could affect the overall educational system. The necessity for an accurate method to validate academic credentials and the issue of fake certificates are highlighted in research by [13].

An analysis [12] demonstrates that blockchain technology forms an appropriate solution which protects educational

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certifications from counterfeiting. The process of checking degree certificates requires straightforward ease-of-use at affordable costs because educational institutions continue expanding their student base and numbers of graduates. The combination of low cost with straightforward verification stands as the main requirement students seek from their degree verification method alongside business needs which focus on swift and dependable service. The purpose of this research utilizes blockchain technology to develop an decentralized system for diploma digital management and authentication. A smart contract controlled by the researcher kept institutions from unauthorized addition to the system. Each certificate gets saved in the Interplanetary File System (IPFS) through the SHA-256 hash algorithm-based hash creation process. Using the proposed method produces lower management expenses as it detects and stops fraudulent documents while delivering precise trustworthy digital certificate information. Using the Interplanetary File System (IPFS) to store the certificates and the Ethereum blockchain network to store the hashes of certificates makes sure that the data can't be changed and is safe. The certificates can be stored safely and checked using this decentralized method, which means that no one has to be involved. Researchers have found that this method can be used in a number of fields where electronic papers need to be timestamped. As stated in the paper[14], the blockchain could be used to create, authenticate, and validate academic certificates.An authentication mechanism of certificates exists within this system to ensure both certificate authenticity and fast responses and secure storage options. The system includes two essential roles which are composed of universities and student and employer users. The system enables institutional users to create new certificates along with editing or certifying them while public users remain limited to certificate examination and authentication checks. Human resources comprise the measurement of individual intellectual capacity together with their capabilities and natural abilities and their talents. The workplace depends heavily on academic credentials which create proof of expertise and aptitude and ability in addition to reliability and responsibility and capacity. People with solid academic results enjoy better chances at future work opportunities and financial stability because of their high graduation rates [15]. Users consider the academic degrees awarded by colleges that endorse data to be official. The research results show Blockchain authentication needs all users to provide authentication. The end users consist of companies together with educational institutions and businesses.

3. THE ROLE OF BLOCKCHAIN TECHNOLOGY:

Blockchain technology addresses these vulnerabilities by making digital credentials more secure and trustworthy. Blockchain provides:

- **Immutability**: Credentials are immutable once stored on the blockchain, protecting the authenticity of data.
- **Transparency**: Blockchain makes it possible to check identities in real time, so anyone who has access to the digital credential can be sure that it is real without having to go through a third party.
- **Decentralization**: Unlike closed systems, blockchain technology makes systems more reliable by distributing data across many nodes. Not a single point of failure is possible.
- **Self-Sovereignty**: Blockchain lets people decide how to share and control their data, which is in line with ideas that value privacy.

How Blockchain Secures Digital Credentials

Blockchain has special features that make it possible to change how digital credentials are made, kept, and checked. Let's look at how it does this:

1. Tamper-Proof Credential Records

Because passwords are immutable, the blockchain makes sure that they can't be changed or removed. After a credential is issued, it is cryptographically signed and added to the blockchain. This makes it hard to change in any way.

Example:

A graduate can get a digital degree based on blockchain from their education. Employers don't have to worry about forgery because they can check its authenticity straight on the blockchain.

2. Decentralized Trust

Blockchain technology gets rid of the need for centralized officials like third-party verifiers by spreading trust across the network. The blockchain can check any credential, which speeds up the process and makes it more accurate.

Example:

A company hiring people to work from home can check their credentials on their own, so they don't have to rely on standard background-checking agencies.

3. Transparency and Traceability

Every credential that is given on the blockchain has a clear record of where it came from. Stakeholders can track the badge back to the person who issued it, which builds trust in the system.

Example:

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When a supplier says they meet a safety standard, the compliance certificate that is kept on the blockchain can be tracked back to the organization that issued it, making sure it is real.

4. Privacy and Selective Disclosure

Privacy-protecting features can be built into blockchain-based identities. Holders can only share the information that is needed for proof and keep other information secret.

Example:

A blockchain digital certificate can be used to prove that a person is over 18 years old without giving out their full birth date or other personal information.

5. Preventing Credential Fraud

Credential theft is a big problem in many fields, but especially in healthcare and education. Blockchain makes sure that identities are signed cryptographically and can be checked, which makes fraud very hard to do.

Example:

With blockchain-secured licenses, medical workers can show that hospitals and patients can trust their credentials without having to check them by hand.

4. METHODOLOGY

Our academic certificate verification system is built on the blockchain. It was made using a method that lets us fully test how well it works, how reliable it is, and how helpful it is to users. To go along with our quantitative method, we have detailed architectural designs and a lot of documentation about the system's architecture.

Research Design

The proposed study uses a mathematical approach to fully evaluate how well and reliably blockchain technology can be used to verify academic credentials. This method can be used to look at the system's speed, how users interact with it, and how secure it is by using numbers. The statistical methods used in the quantitative technique provide strong evidence that either supports or contradicts the study hypothesis. Following these organized steps will help the researcher find out if the blockchain answer works in the real world. The study aims to figure out how much of an effect the method has by setting up accurate performance measures. By taking this method, we can make our results more reliable and pave the way for even more useful research and real-world uses. Full system architectural models will be used in the study to help with understanding and reproducing the results. Assuring that people in the field can easily comprehend and replicate the setup, Figure 1 shows the layout and flowchart for the blockchain system.

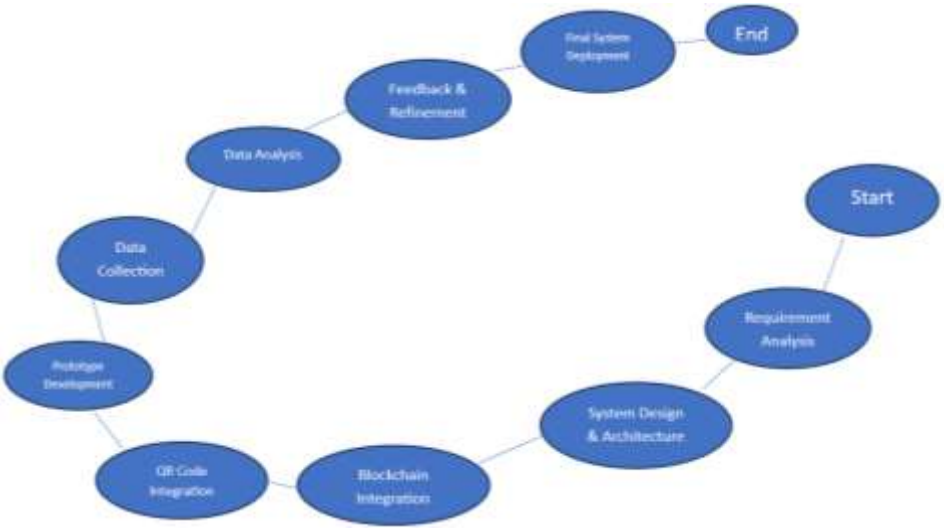

Figure 1. Flowchart for blockchain-based academics credential verification system.

System Development

Requirement Analysis: The first step in development is to do a full study of what is needed. These include finding out what companies and schools need to see to confirm credentials. This step makes the architecture perfect for everyone's wants by laying out the system's layout and features. Once we know what they are, we can change the system to handle passwords better, making sure that the information saved is correct, safe, and easy to recall.

Design and Architecture: To make sure that academic records are kept safely and checked quickly, the structure of our suggested blockchain-based system has been carefully thought out. An essential part of the method is the

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blockchain network. An electronic paper with a credential has several fields. This includes the name of the student, the name of the school, the date the credential was granted, the degree that was given, and a unique number for the credential. Within the blockchain, events are related based on when they happened, and to protect the data, it is encrypted. By keeping the order and validity of the passwords safe, this structure makes a cryptographically strong chain that is hard to change. The simple, easy-to-understand design made the system simple for everyone to use, including schools, businesses, and students. This makes checking passwords quick and simple. Simply scanning a QR code or entering a credential ID makes the process easy and lets people of all levels use the system without putting security at risk.

Blockchain Integration: We added blockchain technology, which is very important to our system, with Python's strong security features and ability to be flexible. When checking a lot of credentials, the Proof of Stake (PoS) agreement method works well because it doesn't use a lot of energy and can be scaled up or down easily. The computer has to do a lot of extra work for Proof of Work (PoW) and Delegated Proof of Stake (DPoS) systems, but this option doesn't have either of those problems. Mostly educational institutions are stakeholders who use their names to confirm transactions. This improves the accuracy and speed of the testing process. To manage passwords on the blockchain, smart contracts are necessary. Issue, verification, and revocation of digital IDs are controlled by these Solidity contracts. They provide a clear and unchanging testing process by running themselves automatically under certain conditions. As long as strict rules are followed, data changes and unauthorized entry are not possible with smart contracts.

QR Code Integration: With QR codes that go straight to blockchain records, we made the system even easier to use. This feature enhances the authentication process and provides quick access to identity verification, allowing users to quickly verify information on their mobile devices.

Prototype Development: It's very important to try and judge how well the system works during the prototype creation stage. This is the point where we can test our idea in real life and make any changes that are needed based on what real people say. The prototype shows how much better it would be to handle and check academic titles, showing that the system is possible.

Data Collection

Data Sourcing: Kaggle is a website with a huge collection of educational datasets and other types of datasets that we will use for this project. The datasets that were picked will have a lot of information about how to verify educational certificates. Without this data, we can't test our blockchain-based approach in a simulated real-world setting. The datasets were picked because they provide a lot of information about academic accomplishments, have been used for verification attempts in the past, and have a lot of different types of data that lets testing be strong in a lot of different situations.

Types of Data: The databases will mostly have records of names, schools, degrees, dates of issue, and efforts to verify them in the past. So, we can test how well the system works with common inputs and complex data sets that are likely to be seen in real-life academic certificate verification.

Data Collection Methods: During the prototype testing stage, both quantitative and qualitative data will be gathered. The blockchain system will collect numeric data like the speed of transactions, the time it takes to respond, and the number of errors. Use of these measures is the only way to judge how efficient and effective the method is. Qualitative data will be gathered from what users say. A lot of different people, like students, school officials, and business owners, will be asked to try out the prototype and let us know what they think and feel about it. We will focus on the system's pros and cons in terms of how well it works and how easy it is to use in this study.

Analytical Methods: Statistical methods will be used to check how well the system works when the data is analyzed. The goal is to find out what factors affect the speed and number of mistakes in transactions. We will use ANOVA testing to look at how fast the system responds in different situations. We will use thematic analysis to find themes and ideas in user input, which is qualitative data, so that we can make the system better.

5. RESULTS AND DISCUSSION

This section of the paper compares blockchain-based academic credential validation with more traditional approaches of validation. The results emphasize the main advantages of blockchain technology: faster verification times, less security breaches, and better scalability when handling large quantities of credentials. Blockchain's distributed and irreversible character assures exceptional security and dependability even if the efficiency of the system remains constant even as the number of credentials processed increases. When tested against more traditional methods, blockchain verification also exhibits almost perfect accuracy. These findings show how blockchain could address security, inefficiency, fraud in the credential checking process, concerns.

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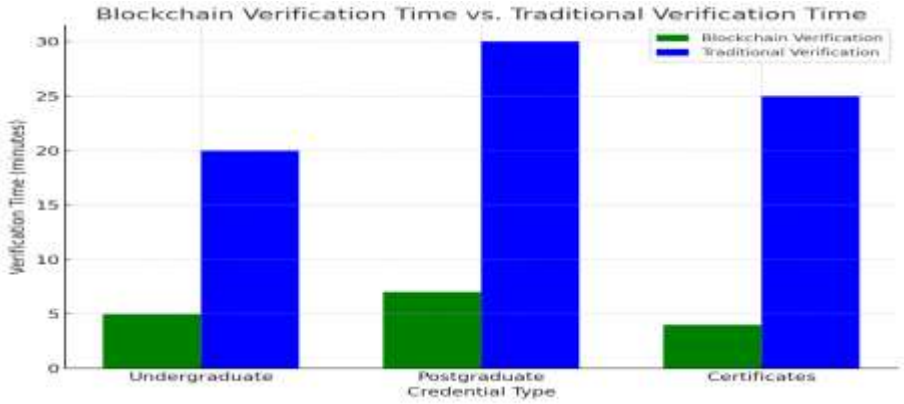

Fig 2: Blockchain Verification Time vs. Traditional Verification Time

This figure 2 compares the time taken to verify graduate credentials using blockchain versus traditional methods. As shown, blockchain verification is much faster across different types of credentials, demonstrating its efficiency.

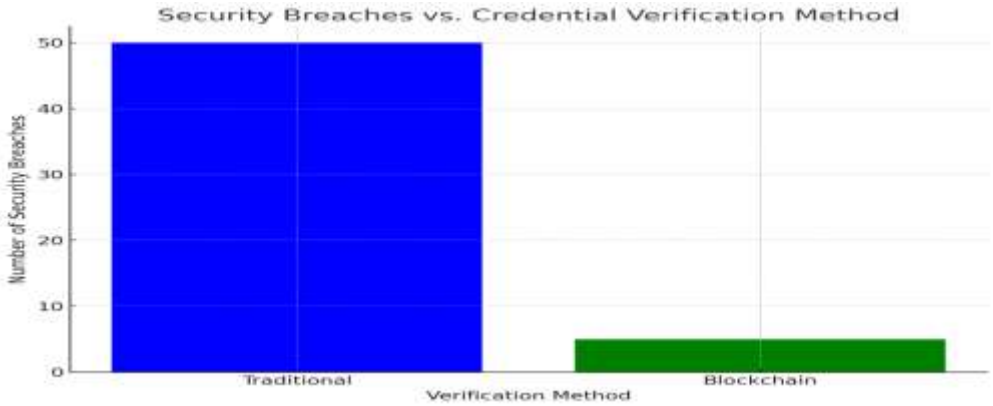

Fig 3: Security Breaches vs. Credential Verification Method

This bar chart of figure 3 illustrates the number of security breaches for traditional and blockchain-based verification methods. Blockchain demonstrates a significant reduction in breaches, highlighting its security advantages over conventional systems.

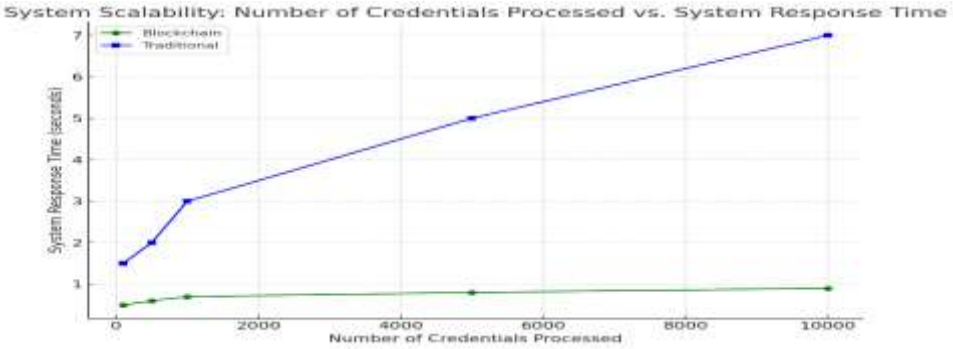

Fig 4: System Scalability: Number of Credentials Processed vs. System Response Time

This line graph of figure 4 shows the scalability of blockchain-based credential verification as compared to traditional systems. As the number of credentials processed increases, blockchain maintains consistent response times, while traditional systems experience noticeable delays.

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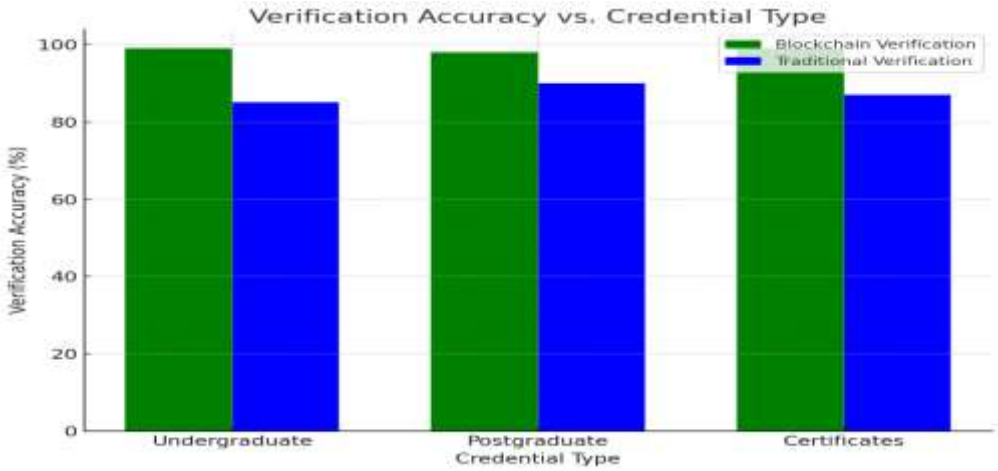

Fig 5: Verification Accuracy vs. Credential Type

This bar chart figure 5 compares the verification accuracy between blockchain-based and traditional verification methods for different credential types (Undergraduate, Postgraduate, and Certificates). As expected, blockchain verification demonstrates near-perfect accuracy (close to 100%), while traditional methods show a lower accuracy, highlighting the effectiveness of blockchain in ensuring reliable verification.

CONCLUSION

In conclusion, traditional verification methods are still having issues. A strong and effective solution is to use blockchain technology to check graduate credentials. Many important benefits of blockchain were found in the study. For example, it can prove things faster, is safer, and can grow better. Standard methods often depend on human steps and third-party middle-men. Verification times show that blockchain-based systems are much faster than these. Aside from that, since blockchain is autonomous and can't be changed, degrees can be checked right away and can't be changed. This makes it much less likely that protection will be broken. Companies and schools will be more likely to think that credentials are real because of this. Another finding from the scalability study is that blockchain can handle a lot of identities without slowing down too much. Because of this, it can work for both small and big school systems. Blockchain can also protect privacy, security, and openness. This means that students and schools can still be in charge of the proof process while theft is reduced. At the end of the day, the findings show that blockchain technology is a safe, scalable, and all-around way to verify graduate credentials. The world could never check and believe academic credentials the same way again if blockchain technology is used. As the need for faster and more effective credentialing systems grows, this is becoming more and more important.

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