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Smart Certificate using Blockchain

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Abstract: The student academic records maintained by the university system manually are vulnerable to easily being modified or tampered with. These academic records of students are proof of the student's performance for all semesters till the degree is completed. They are supposed to be present at the time of the interview or at the university if he wants to continue their studies further. The issue with the conventional approach is that it is simple for a malicious person to alter it so that it affects the student's grade in any way. This study aims to use blockchain to create safe Smart Certificates. It offers a viable alternative for issuing, confirming, and exchanging certificates without fear of their integrity being compromised.

Keywords: Blockchain, Smart Certificate, Firebase, Education

Introduction

Blockchain is a decentralized database, shared across computers a network node that acts as storing information in a digital format. It organizes data into groups, known as blocks, having specific storage capabilities, connected to the preceding block, producing a data chain, known as the blockchain. All additional information added after that newly added block is compiled into a new block, which is then added to the chain after it is full. Blockchain is one of the most well-known technological developments of the twenty-first century. Most people are still unfamiliar with its technology and style of operation; yet, blockchain has enormous potential to take root in a variety of fields (Lamkoti *et al*., 2021). Blockchain plays a significant part in unlocking the finest features technology has to offer in business, financial technology, healthcare, education, business, and even gaming (Chen *et al*., 2021).

Many individuals in the IT sector and academics alike have taken notice of blockchain technology recently as a breath of new air in this industrial transformation. This is largely owing to its unique qualities, such as decentralization, immutability, security, and traceability, from a technological standpoint (Zheng *et al*., 2020). As a result, several applications of blockchain have been developed and addressed a wide range of issues in a variety of industries such as financial services and healthcare. There has been an increase in the number of blockchain-based educational apps, although few have been implemented. Because of this, there's still a lot of uncertainty about its long-term viability in this industry.

There are many technologies in the field to create smart certification but we used only blockchain over other techniques due to its unique characteristics.

Blockchain technology is a decentralized technology that improves security, increases efficiency, and decentralizes any industry in which it is used. All of these characteristics have the potential to elevate the position of company control across the globe (Bashir, 2017). There are already dApp applications that have been developed to give answers for a variety of different businesses. However, several roadblocks prohibit businesses throughout the globe from incorporating these dApp apps into their existing business strategies. At the moment, the majority of firms are still following the blockchain since they are striving to reach a reasonable consensus in their situations. The present position offers severe difficulty for blockchain since, in the current setting, it seems like blockchain needs enterprises, which is the polar opposite of what should be the case. Blockchain technology is still considered a platform of the future (Huh and Seo, 2019).

Certificates are important in both education and resource management since they provide proof of completion. Individual learning records are becoming more important for people's professional growth (Bubb and Earley, 2007). As a result, these instructional materials should be saved in a ledger that is both permanent and cannot be tampered with. Throughout the previous several decades, there have been countless instances of degree fraud committed (Moyes *et al*., 2019) so to reduce the rate of fraud a smart certificate generation with blockchain technology has been the main criterion of the study. With the rapid advancement of technology, it has never been simpler to fabricate a degree certificate that seems to be legitimate or to get one via the use of the internet. It is estimated that there are 3.300 unidentifiable schools of higher education throughout the globe that offer degrees to anybody who will pay for them and that over 50,000

Ph. D.s are acquired from diploma mills each year (Agarwal, 2009). Furthermore, according to a poll done by CareerBuilder.com (2014), 58% of roughly 2,200 human resource managers have found lying on resumes, with one of the most prevalent lies accountings for around 33% of all caught lies being connected to an academic degree (Grasz, 2014). Many remedies have been developed in response to the issue, to reduce the degree of fraud. So far, however, none of these approaches has been successful in completely resolving the problem. Hence this study proposes a Smart Contract blockchain to generate the Smart Certificate that fulfills the purpose of a safety certificate.

The next Section discusses the literature survey of the frauds and the tools and techniques used to remove the fraud.

Literature Survey

This section discusses the literature on Smart certificates and the Blockchain.

Malsa *et al*. (2021) the author presented a framework for a robotics-based certificate verification system that may be used with a blockchain. Here, using an Arduino Uno connected to a WiFi device, robotic cameras are being utilized to scan the certificates and store them in the cloud. Later, the same was permanently preserved as blocks on the blockchain. The chapter illustrates a smart contract for storing and verifying a certificate on blockchain since the smart contract is a computational component of the technology. The goals had been accomplished and the smart contract had been built and tested for good operation. The creation and testing of the smart contract were done using the two programs Sublime Text 3 and Remix Ethereum IDE, respectively. This smart contract makes it possible for the employer to see the stored certificate, making it simpler to validate the credentials of job applicants. Students, companies, and academic institutions can all use this smart contract.

Li *et al*. (2019) proposed a blockchain system for e-learning assessment and certification that includes a brand-new network structure built on top of the combination of public and private blockchains, as well as four distinct smart contract schemes for the realization of the e-learning assessment and credit exchange, the issuance and secure storage of digital certificates, the verification of digital certificates and the allocation of e-learning vouchers, respectively. The proposed approach is a viable contender for creating an online learning and e-learning environment that is more equitable, healthy, and open.

Khandelwal *et al*. (2020) suggested and implemented a certificate issuing and validating methodology by utilizing the blockchain's tamper-proof and non-repudiation properties. The high number of fake certificates that are currently in use is a serious issue that has existed for a very long time. The business of issuing these certifications has grown out of people's needs and desires for employment. As a result of this phenomenon, hard-working people with valid degrees and certifications must suffer since the owners of the phony credentials are keeping what should have been theirs from them. In many situations, this can prove to be very risky. For instance, take into account a surgeon practicing based on a phony degree. These kinds of circumstances underscore the necessity for a system that can verify and authenticate the certificates, their issuer, and their holder.

Take and Rokade (2021) described how to generate electronic certificates based on blockchains in a cloud context. In a real-world setting, it is generally difficult to bring significant or educational documentaries. When any resource is penetrated by attackers, some private information should leak from multiple centralized systems. In this method, the author offered strict supervision-based blockchain technology to produce an electronic certificate per the documentation presented by the relevant student and user. The system is broken down into four distinct pieces. The author first clarifies that a user can upload his or her official documents or diplomas and that a middleware authority known as a Third-Party Auditor (TPA) will validate these documents coming from a trusted entity. If all of the documents have been approved, a dynamic e-certificate with a QR code and individual serial identification number is generated. Once this procedure is complete, the data is saved in various data nodes and the student is given a QR code and a UID. Additionally, a student can submit a QR code or be issued a Unique Identification number to the appropriate entity when it wishes to verify their supporting documentation. The blockchain will deliver consistent information following safe authentication when such organizations validate the student's data. The author created an open Smart contract that used the SHA family algorithm for generation, a mining method to create acceptable hashes, and a consensus process to assess the proof of work during the entire execution.

Smart Certificate

Smart Certificate is a collection of technologies that allows educational institutions to securely give credentials to all of their graduates while maintaining complete privacy of their personal information (Cheng *et al*., 2018). Smart Certificate enables educational institutions to provide credentials to their graduates/trainees and alumni in a timely and secure manner. The latter have access to a protected digital version of their credentials that they may share with recruiters and potential employers. Smart Certificates are one-of-a-kind and safe and they protect the issuer's reputation by preventing fraud. Smart Certificate also reduces administrative effort significantly. Duplicates and certificates are produced in small quantities and the number of validation requests from recruiters is kept to a minimum.

S.no.	Aim of the study	Limitation	References
1	Presented a framework for robotics-based certificate verification system that used with a blockchain	Other functions, modules and modifiers can be added to the certificate to make it more versatile and can be added to the CERTbchainIoT decentralized application for achieving the the objective of the certificate verification system.	Malsa *et al*. (2021)
2	Proposed a blockchain system for e-learning assessment and certification	There is a need for improvement and practice of implementations of the proposed system and focus on the implementations of smart contracts for each functional module, providing new application cases for blockchain in online education.	Li *et al*. (2019)
3	Suggested and implemented a certificate issuing and validating methodology by utilizing the blockchain's tamper-proof and non-repudiation properties.	Protection against identity theft cannot be guaranteed, If the user is not present in the system.	Khandelwal *et al*. (2020)
4	Described how to generate electronic certificates based on blockchains in a cloud context.	Working with large data sets and multiple data nodes with custom blockchains should be studied.	Take and Rokade (2021)

Smart Certificate also streamlines the process of creating and disseminating credentials. It also provides graduates with essential services by allowing them to access their credentials at any time and from any location. For both job searchers and recruiters, treating trust as a critical aspect of the job market improves the recruitment process.

Some advantages of the Smart certificate-an educational application based on blockchain technology-are listed below, (Sun *et al*., 2018) based on the four aspects indicated above:

1. Assist the employer in lowering the expenses and time associated with conventional certificate verification by providing evidence of accomplishment and participation
2. Assist the institution in saving time and money when it comes to printing certificate papers
3. Provide long-term storage
4. Prevent the certificate from being tampered with
5. Assist informal learning, such as online learning and boot camps, in becoming safer, trustworthy, and acknowledged, which has lately been underappreciated and lacking in official certifications (Malcolm *et al*., 2003)
6. Students assume full responsibility for safeguarding and sharing their credentials without the assistance of a third party

Some colleges are already using blockchain technology to track and verify academic credentials. The University College London in the United Kingdom and the University of Nicosia in Cyprus, for example, utilize the Bitcoin blockchain to verify academic degrees. On the Bitcoin Blockchain, the MIT Media Lab created a digital academic degree system (Jirgensons and Kapenieks, 2018). Sony Global Education has created a useful educational infrastructure for the open sharing of academic proficiency and progress records.

The smart certificate system is a new age in educational institutions, thus there must be many benefits with this smart certificate based on blockchain, but there are negatives, such as the fact that people are still skeptical of the technology. Some applications and hackers might alter blockchains to introduce new certificates or change the certificates of other students, making them very vulnerable (Poorni *et al*., 2019). Smart certificate authorities, according to the author Malcolm, should update their software regularly to ensure that security dangers like this are kept to a minimum, but security threats remain a problem. Given the value of the information they safeguard, smart certificates have become a prominent target for hackers and other cybercriminals. To safeguard users from cybercrime, the program needs ongoing monitoring. This needs a lot of financial support and skilled employees.

Blockchain

The blockchain contains different blocks which were mentioned below

Block: A block is a place in a blockchain where information is stored and encrypted.

Index block: In this block, all the details of the student were mentioned. Only one student's information should be entered at once.

Hash: A hash is a mathematical function that turns an arbitrary-length input into a fixed-length encrypted output. As a result, its unique hash will always be the same size, regardless of the original quantity of data or file size involved. Furthermore, since hash functions are "one-way," they cannot be utilized to "reverse-engineer" the input from the hashed result.

Hash functions accept variable-length inputs and return outputs of a fixed length. Hash functions are widely used data structures in computer systems for activities like message integrity checks and information authentication. Hash functions add security characteristics to standard hash functions, making it more difficult to decipher the contents of a message or personal information. The hash for each piece of data is unique. If someone attempts to update the data, the hash will change as well.

Nonce: A nonce is an acronym for "number only used once," and it's a number that's appended to a hashed or encrypted block in a blockchain that fulfills the difficulty level limitations when rehashed. In this first, the conditions are to be set for the various runs.

In the block header, the process of guessing the hash begins. The block version number, a timestamp, the hash used in the previous block, the Merkle Root hash, the nonce, and the target hash are all included.

The block is added to the blockchain if the hash fulfills the parameters specified in the target. Proof of work is the process of cycling through solutions to predict the nonce.

Materials and Methods

This study proposes a system for dynamic and safe e-certificate creation utilizing the blockchain environment. The system presents a novel certificate-generating technique based on blockchain that is dynamic in nature. Firebase, an application development program that allows developers to create iOS android, and Web applications, is utilized to create the blockchain database. Firebase offers capabilities for measuring analytics, reporting and correcting app errors, performing marketing and product experiments, and leveraging blockchain to issue smart certificates. The procedure is as follows:

(i) Setting up the university smart contract rules:

1. Only the university creator has access to the list of eligible issuers
2. Only the issuers on the list are allowed to generate certificates
3. Issuers may only be removed from the list by the University System

(ii) Setting up the certificate smart contract rules:

1. The certificate may only be approved by the owner
2. If the issuer does not complete the verification procedure, the certificate is deemed invalid
3. Optional - Only the certificate's owner may share it with others. (Incidentally, the reason behind this regulation is that you don't want anybody to view the information on your certificate without your consent.)

(iii) Initializing certificate contract

1. The certificate's information is sent to the owner by the issuer
2. The information is double-checked by the owner. If it's correct, the owner confirms it by emailing the issuer his address (a unique identifier that's generally a public key or derived from a public key)
3. The issuer inserts the owner's address into the contract and publishes it on the blockchain network. A contract is deployed by submitting a transaction containing the contract's "bytecode," which is known as a contract creation transaction
4. Once the transaction has been added to the blockchain, the issuer gives the contract's address to the owner
5. The certificate is approved by the owner once again to ensure that no errors were made when providing the data to the certificate contract
6. The issuer may complete the verification only once the certificate has been accepted

If the certificate has incorrect information in Step 5, so it is better to reload the contract rather than introduce a new function that enables the issuer to change the information. Figure 1 shows the initialization of the certificate Smart Contract.

Figure 2 shows the confirmation of the smart contract.

(iv) Validating and Sharing Certificate Contract:

Sharing: The owner provides his or her certificate address to the employer, as well as authorization to view the information.

Validation: To ensure that the certificate is 100% legitimate, the employer needs to go through the two processes below:

1. Check to see whether the certificate has been confirmed
2. Look at the certificate's contract formation transaction to identify where it came from. It is legitimate if the contract creator's address matches the university address and vice versa

Figure 3 shows the validation and sharing of the certificate of Smart Contract.

Process of Creating Smart Certificate

Algorithm

Step 1: Get the hash value of the previous file
Step 2: Initiate the nonce value = 0
Step 3: Run the hash generation program until we get a standard predefined hash structure (Proof of work)
Step 4: Note down the number of nonces required. Generate new hash to current file using previous document hash

The next Section discusses the implementation of the Smart Contract of the certificates.

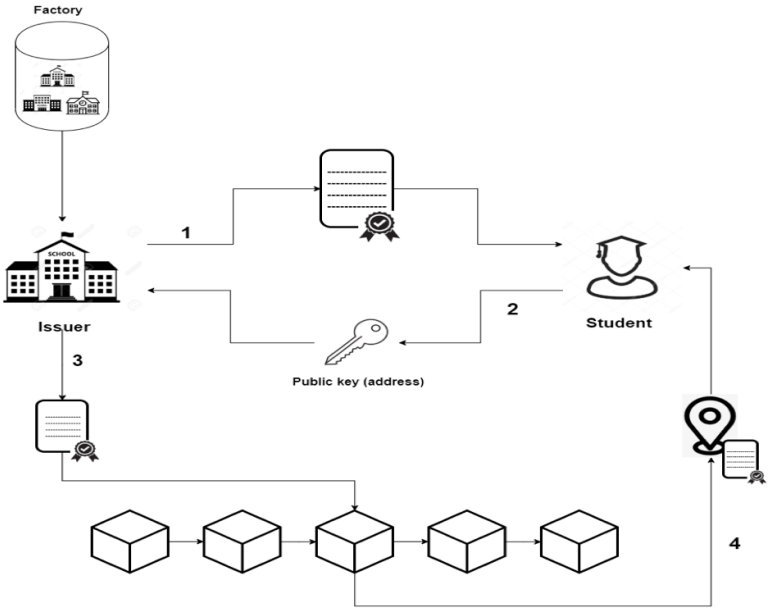

Fig. 1: Initializing certificate smart contract (Source: https://blog.fpt-software.com/smart-certificate-in-blockchain-we-trust#:~:text=Blockchain%2DBase%20Solution%20%E2%80%93%20Smart%20Certificate&text=With%20the%20emergence%20of%20blockchain,the%20concern%20about%20its%20integrity.)

Fig. 2: Confirmation of the smart contract (Source: https://blog.fpt-software.com/smart-certificate-in-blockchain-we-trust#:~:text=Blockchain%2DBase%20Solution%20%E2%80%93%20Smart%20Certificate&text=With%20the%20emergence%20of%20blockchain,the%20concern%20about%20its%20integrity.)

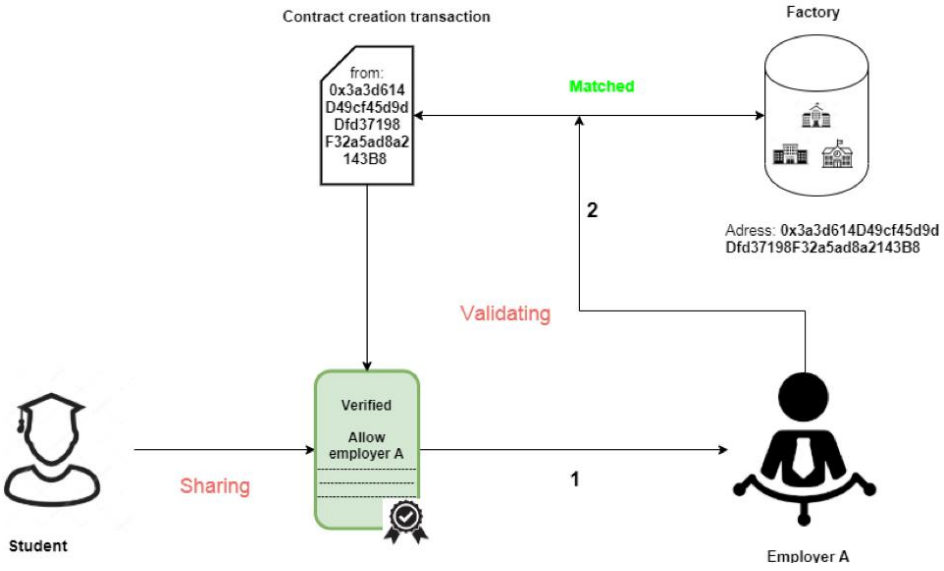

Fig. 3: Validating and Sharing Certificate Contract (Source: https://blog.fpt-software.com/smart-certificate-in-blockchain-we-trust#:~:text=Blockchain%2DBase%20Solution%20%E2%80%93%20Smart%20Certificate&text=With%20the%20emergence%20of%20blockchain,the%20concern%20about%20its%20integrity.)

Results

Table 1 shows the Ethereum-based Smart Contract results. The details of the student stored in the blockchain are as follows. Column-1 shows the previous hash value of the block whereas the column-2 shows the current hash value of the block third column represents the name of the student whose information is stored in the block, next columns represent the course, degree, and year in which the student enrolled and the last column represent the grade of the student.

When these credentials were entered into the blockchain it provides the respective hash individually for each person after corresponding runs.

The data stored in blocks of Blockchain are saved in JSON format in google firebase and it is presented below:


```
{

"000091cfecf53c1ddfb3309ad85348f2778852cd3e43c7e
e97c771f9a95330eb": {
 "data": {
 "Course": "Electical Engineering",
 "Degree": "PG",
 "Grade": "D",
 "Name": "AKRAM",
 "Year": "2022"
 },
 "hash":
"000091cfecf53c1ddfb3309ad85348f2778852cd3e43c7e
e97c771f9a95330eb",
 "index": 4,
 "nonce": 1558720,
 "prev_hash":
"00009e558f439fd6dd9b0d4ee8f269d09c5df9799a0d28e
f07aa7b58a6ae35e5",
 "timestamp": "2022-04-13 17:38:59.182007"
 },

"000091ee63ffbecad0657409a3a546a380dc32ec60a1281
e4c5894763f2f13b7": {
 "data": {
 "Course": "Electical Engineering",
 "Degree": "PG",
 "Grade": "A+",
 "Name": "Rasheed",
 "Year": "2022"
 },
 "hash":
"000091ee63ffbecad0657409a3a546a380dc32ec60a1281
e4c5894763f2f13b7",
 "index": 1,
 "nonce": 788557,
 "prev_hash": "0000000000",
 "timestamp": "2022-04-13 17:22:46.283767"
 },

"000092328099202bfbc66012471dbad59f714f294af6d6
c9959c4c1db9cf5107": {
 "data": {
 "Course": "Electical Engineering",
 "Degree": "PG",
 "Grade": "Fail",
 "Name": "Ayesha",
 "Year": "2022"
 },
 "hash":
"000092328099202bfbc66012471dbad59f714f294af6d6
c9959c4c1db9cf5107",
 "index": 2,
 "nonce": 1306342,
 "prev_hash":
"000091ee63ffbecad0657409a3a546a380dc32ec60a1281
e4c5894763f2f13b7",
 "timestamp": "2022-04-13 17:28:49.840793"
 },

"000093d95689a510f1a768af326c31576876ab41a3e36c
3b93b9836cf8b0643e": {
 "data": {
 "Course": "Electical Engineering",
 "Degree": "PG",
 "Grade": "C",
 "Name": "KHADIR",
 "Year": "2022"
 },
 "hash":
"000093d95689a510f1a768af326c31576876ab41a3e36c
3b93b9836cf8b0643e",
 "index": 5,
 "nonce": 227758,
 "prev_hash":
"000091cfecf53c1ddfb3309ad85348f2778852cd3e43c7e
e97c771f9a95330eb",
 "timestamp": "2022-04-13 17:41:09.096791"
 },

"00009e558f439fd6dd9b0d4ee8f269d09c5df9799a0d28e
f07aa7b58a6ae35e5": {
 "data": {
 "Course": "Electical Engineering",
 "Degree": "PG",
 "Grade": "B",
 "Name": "Imran",
 "Year": "2022"
 },
 "hash":
"00009e558f439fd6dd9b0d4ee8f269d09c5df9799a0d28e
f07aa7b58a6ae35e5",
 "index": 3,
 "nonce": 156902,
 "prev_hash":
"000092328099202bfbc66012471dbad59f714f294af6d6
c9959c4c1db9cf5107",
 "timestamp": "2022-04-13 17:35:58.278989"
 }
}
```

Table 1: Details of the students

Previous hash	Hash	Name	Course	Degree	Year	Grade
0000000000'	000091ee63ffbecad0657409a3a546a3 80dc 32ec60a1281e4c5894763f2f13b7	Rasheed	Electical Engineering	PG	2022	A+
000091ee63ffbecad0657409 a3a546a380dc32ec60a1281e 4c5894763f2f13b7	000092328099202bfbc66012471dbad5 9f714f294af6d6c9959c4c1db9cf5107	Ayesha	Electical Engineering	PG	2022	FAIL
000092328099202bfbc66012 471dbad59f714f294af6d6c99 59c4c1db9cf5107	00009e558f439fd6dd9b0d4ee8f269d0 9c5df9799a0d28ef07aa7b58a6ae35e5	Imran	Electical Engineering	PG	2022	B
00009e558f439fd6dd9b0d4ee 8f269d09c5df9799a0d28ef07 aa7b58a6ae35e5	000091cfecf53c1ddfb3309ad85348f2 778852cd3e43c7ee97c771f9a95330eb	Akram	Electical Engineering	PG	2022	D
000091cfecf53c1ddfb3309ad8 5348f2778852cd3e43c7ee97c 771f9a95330eb	000093d95689a510f1a768af326c315 76876ab41a3e36c3b93b9836cf8 b0643e	Khadir	Electical Engineering	PG	2022	C

The uniqueness of each piece of information in the database is shown in the text above. As can be seen, the hash value for each item is unique, indicating that the smart certificates are secure.

Discussion

From the above json file extracted from firebase, it is understandable that each block of data is assigned with a unique hash and it is very particularly generated for the given set of data. If any manipulations or corrections are done by the non-authorized parties will raise the change of hash. This will allow authorities to take preventive measures. The hash is generated with the desired nonce using the proof of work concept. This can help to generate a hash of a specific format. Hence this technology is implemented in the certificate system to avoid manipulations and duplications of any educational system-based certificates.

Conclusion

According to certain surveys, millions of students are graduating and continuing their education. It was discovered during this conception that there is an anti-forgery system in use worldwide, therefore smart certificates are being created to make it safer for students. The students' smart certificate creation has been detailed in this current research, which was done using blockchain and data from Firebase. As a result, it generates a secure code known as a hash for each piece of data and stores it safely in a database. As a result, it can be inferred that by creating a smart certificate in blockchain, a level of security for the certificates can be achieved and any adjustments may be recognized. This blockchain may be useful in a variety of industries and may achieve a significant milestone in the future.

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Author's Contributions

Krishna Bihari Dubey: Contributed in conceptualization, formal analysis, methodology part, coding, validation, original draft writing.

Mukta Goyal: Conceptualization, supervision, reviewing, editing and administration work.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

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