Blockchain- Based Smart Employment Decision Support System

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Abstract— **The primary reason of the existence of Blockchain technology is to develop a platform with features that can secure data from the risk of data modification and the presence of the permission from a third party in terms of data deletion. This will ensure that the data is encrypted to avoid any manipulation of the stored values and that tampering will be difficult. Since Blockchain technology reduces cost, increases transparency and efficiency for the users, it is a better way to consider developing an employment decision support system that uses the advantage of data analytics. The system contains a database of grades and self- assessment test results that will be interpreted to recommend entry- level positions and that the overall evaluation will be converted into a single PDF. A file hash will be generated based on the encrypted contents of the results and later be notarized by the NEM blockchain. The file will have its own unique transaction hash to easily distinguish it to other transactions recorded on the blockchain.**

Keywords— **Blockchain Technology, Employment Decision Support System, NEM Blockchain, Transaction Hash, File Hash, Secured Data Evaluation, Notarization**

I. INTRODUCTION

Blockchain was initially a notable network designed for the application of financial transactions. [1] It was originally use for bitcoin made for providing secured electronic transactions that is based on the framework of coins made from digital signatures or hash keys. [2] Due to its structure, the cryptographic security of Bitcoin is firm that researchers around the world are thinking that Blockchain can be used in other applications aside from cryptocurrencies such as NEM, Ethereum, etc. Resolving security and privacy issues are some of the focus research, however there are points to consider in using the Blockchain such as latency, scalability, storage, computation and energy requirement. [1] The blockchain later developed features where the deletion of data needs permission from the trusted third party (TTP) and build a blockchain-based database system where the blockchain is associated with distributed databases. Blockchain being decentralized and distributed, the nodes have its own copy of the records of the transactions that validates the legitimacy of the data. [3] The main goal of the study is to integrate the Blockchain technology with Employment Decision Support System to use as a security to the data.

This means that a more reliable system for the security purpose is present to avoid the leakage of information from the users. Utilization of blockchain technology will assure that the results obtained in a certain Decision Support System is secured and unaltered. It uses an encryption method that is called SHA-256 to ensure integrity of the data, and to protect it from unintended entities.

The research study is primarily concerned about the integration of Blockchain technology in an Employment Decision Support system. This will not tackle any specific details about Decision Support Systems.

The paper is presented as follows: Section II pertains to the related works associated in the study, Section III defines the methods done by the researchers in recording the results to NEM blockchain, Section IV involves the evaluation results and validation of the information indicated in the certification, Section V declares the conclusion, and Section VI states the recommendation for future works of the research.

II. LITERATURE REVIEW

A. Blockchain Technology

Blockchain is a distributed ledger structure that is made up of *blocks* where the cryptographic hash is being computed and *chain* that links the blocks to be accessed on multiple computers. [4] It also enables the participant to share their data for machine learning and any data manipulations. [5] In the recent years, many platforms are integrated with blockchain like Linux Security, Smart Contracts, NEM Blockchain, etc. These includes the presence of using various tools or programming languages such as PHP, JavaScript, HTML, CSS, jQuery and many more. [6]

B. Advantages of Blockchain

1. Decentralization

One reason why decentralization is an advantage of Blockchain it is because it can maintain data independently unlike with centralized systems that deals with the whole system. [4] Decentralized systems function without mediator or central administration and the absence of the central control and presence of all participants that give consents will guarantee the confirmation and verification of the transactions. [7] [8] Since data is distributed and synchronized, it will increase the difficulty for hackers to intervene in the whole system. [4]

2. Credibility

Since blockchain is made to record and store transactions, it is credible because participants have the access from the past to the final states of the transaction. It means that the existence of

blockchain is to give control to the customers over their data and be processed without third party. [5] Any data being tampered or altered will be automatically reflected to the ledger or transaction record. [7] [8] [9] Another, it reduces the time for processing that makes it more effective to use for validating any transactions. [8]

3. Security

Blockchain contains several mechanisms to protect data and maintain its security. These are: (1) Hash Mechanism- it is a cryptographic technique that has a unique digital signature that cannot be reduced to its origin, (2) Proof of Work of Mechanism- it is used to maintain the process of calculations that undergo in every block, and (3) Peer to Peer Mechanism- since blockchain is buildup of connecting blocks via chains, it ensures that every member will receive the complete copy of the transactions. [10]

C. Benefits of Blockchain Technology in Different Fields

For educational institutions, E- Learning system is already a trend nowadays especially that grades and profiles are an important personal data. Blockchain is necessary in this field because of the following: (1) It has the strategy to protect intellectual property against any claims of copyright infringements, (2) Academic data can be protected against data modifications from certificate tampering, (3) It can improve the reputation of the academe for providing proper authorization and being transparent in terms of the verification of student's records and requirements, (4) It can create fast processing of academic transcripts and transfer of records between institutions, and (5) It will provide verification of credentials and ensure the confidentiality between the students and the academic organizations. [11]

For medical fields, processing of health documents that were supposed to be in a form of a paper system and turned into electronic systems. [6]

For the business field, since it involves the monetary system, blockchain can highly gain trust of the users. Many organizations hold fundraising, and it does not ensure that funds are obtained in reliable sources but also it can validate funders that the recipients will also trust the transactions of the funds within the system. [12] In an online system, all legal requirements, design, and documentations of the construction of buildings are being disclosed within the people involved in the project and are integrated in blockchain. [6]

TABLE I
BRIEF COMPARISON FRAMEWORK OF THE RELATED WORKS

Authors	Purpose of Using Blockchain Technology	Target Field
S. Nakamoto 2008 [2]	Peer-To-Peer Cashless Transactions with Digital Signature	Commerce
A. Misha, D. C. Gandhi, Mayank and A. Sharma 2020 [4]	Linux OS Security	Business
A. Thio-ac, E. J. Domingo, R. M. Reyes, N. Arago, R. J. Jorda and J. Velasco 2019 [13]	Adding security to Procurements using Digital Signature and Multi- signature Scheme	Commerce
A. a. M. V. Bahga 2016 [7]	Adding security to Industry-grade Internet-Of-Things Technology	Industry
B. A. Herlambang, R. Triana, Y. Gunawan and Sfenrianto 2020 [10]	Adding security to thesis grading to avoid tampering	Education

Table I shows the comparison of the study to other related works where the purpose of integrating blockchain is to find trusted technologies and to strengthen security.
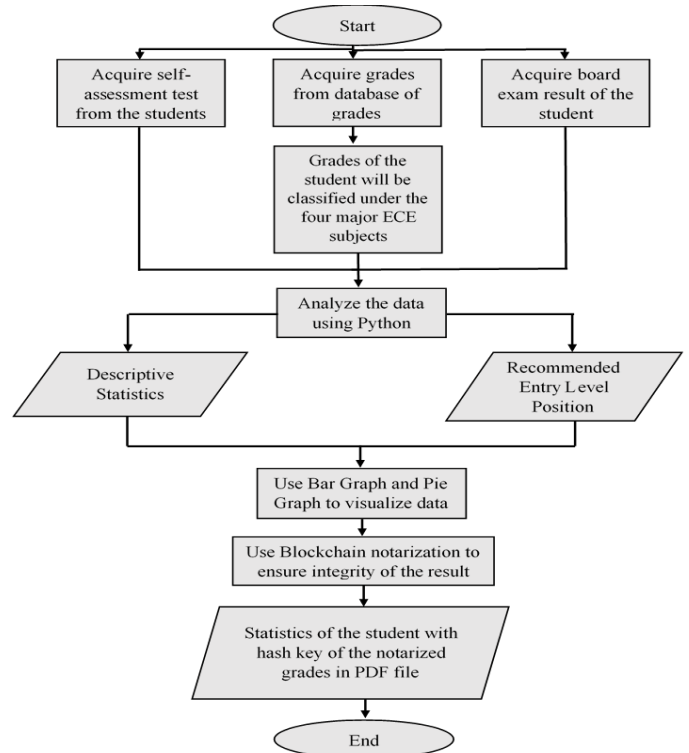
III. METHODOLOGY

Figure 1. System Architecture

Figure 1 illustrates the overall system architecture where the input data represent the grades/ ratings of the student which are encoded on the database found on the system.
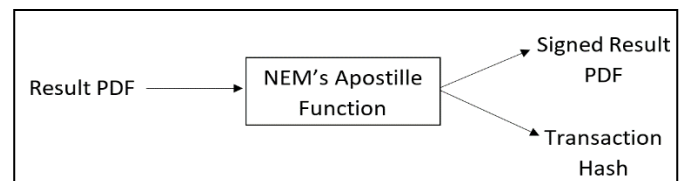

Figure 2. NEM Apostile


```
// import the NEM SDK and File System
var nem = require('nem-sdk').default
var fs = require('fs');
const args = process.argv
// Create an endpoint to a supernode
var url = "https://nistest.opening-line.jp"
var port = 7891
var endpoint = nem.model.objects.create("endpoint")(url, port)
// Create a common object holding key
var privateKey =
var common = nem.model.objects.create("common")("", privateKey);
// Simulate the file content
var fileName = args[2];
var fileContent = fs.readFileSync(fileName, 'hex');
var fileTags = "Grades, Statistics"
// Create the apostille
var apostille = nem.model.apostille.create(
    common,
    fileName,
    fileContent,
    fileTags,
    nem.model.apostille.hashing["SHA256"],
    false,
    "",
    true,
    nem.model.network.data.testnet.id);
```

Figure 3. Code Snippet of the Apostille Function

With the use of the NEM's Apostille service, the records from the self-assessment test, grades, board exam results are unalterable making it secured and authentic. [13] An Apostille is an official certificate from NEM that authenticates the result's origin. [14] Figure 2 illustrates how the Apostille function is utilized and, Figure 3 shows a snippet of the actual code of the apostille function.
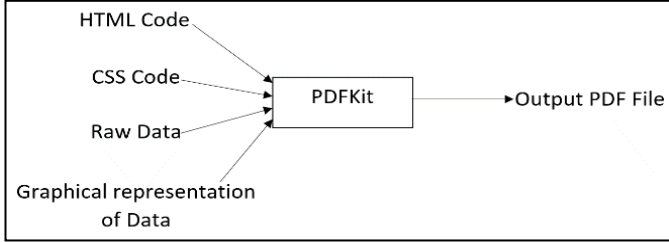

Figure 4. PDFKit Operation

Figure 5. Code Snippet of PDF File Generation

The PDF result was generated by Python's PDFKit Library. It uses an HTML file as a canvas, then renders it to a PDF file. Figure 4 illustrates how PDFKit works and Figure 5 shows a snippet of the actual code of the generation of PDF file.

Figure 6. Code for Blockchain Integration

Finally, Figure 6 shows the actual code for blockchain integration where the generation of private/ hash key, file name, apostille and records of transactions are being accomplished.

The NEM Blockchain uses an API Gateway server called "NISTest" that receives a request and responds to the system. The system sends the result, and the API Gateway server responds with the signed result and the transaction hash. If the results are to be tampered, the API Gateway server will respond "Invalid" to the request. The API gateway server also

has logging wherein it records the exchange of transactions. Every transactions and data were transferred to the nodes. When the data is already embedded into the Blockchain, there will be a program that will analyze and sort the data converting it into descriptive statistic and graphical representation. The converted data will be forwarded into website, making it visible to the users.
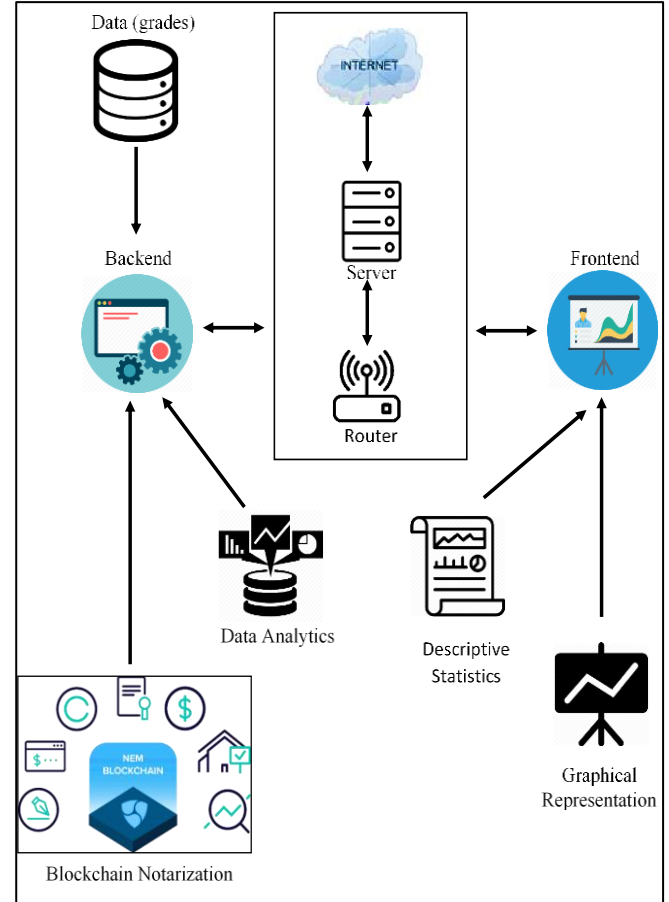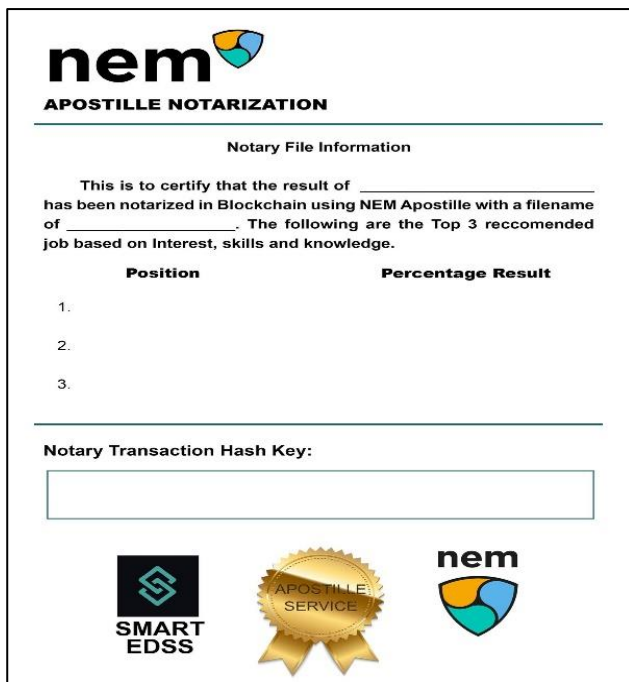

Figure 7. System Architecture

Figure 7 reveals a more detailed system wherein the transfer of information is given using the internet. Also, the system architecture represents all data that pass through the back- end and front- end.

The PDF file will be downloaded to the user together with a certificate where hash keys are written. The transaction hash can serve as a key to check if the document is altered. It is written in the certificate that is included when the PDF result is downloaded. The certificate is made of image that certifying the result is notarized. It is coded in python using Pillow module. The Pillow module is the one responsible in writing the hash and other important information in certificate.

IV. RESULTS AND DISCUSSION

A PDF file consists of different result from the system is generated together with the Blockchain Hash Key Certification. The file has undergone notarization process to confirm the users that their information is secured using blockchain technology and cannot be manipulated. The sample certificate is shown on Figure 8. It consists of the user's name and transaction hash key.

Figure 8. Blockchain Certification with Hash Key

Figure 9. Checking of Validity

Figure 8 shows that the transaction hash is embedded in the certificate to verify that the file is recorded in the blockchain. The hashing algorithm can detect any changes the file that is already present in blockchain. In Figure 9, The file is first checked if it is registered and it returns a statement that the Apostille is valid. After altering the content, the file is checked again with the same file name and hash key, and the result is the Apostille is invalid.

Figure 10. Data Privacy Evaluation

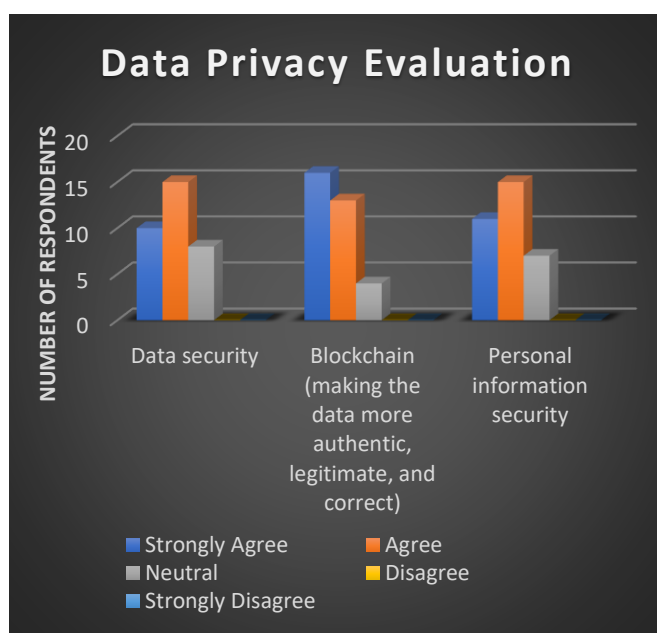The summary of evaluation on the data privacy of the system is shown on Figure 10. There are 31 respondents that tried the Employment Decision Support System and gave a response on security feature of the system. Factors to be considered are (1) the data security, (2) using of blockchain, making the data more authentic, legitimate, and correct, (3) the security of the users' personal information. The average rating is "agreed" in all the factors given. Evidently, the data show that the graduates have their trust with the system's security feature for their personal information and they evaluated that the blockchain technology will make their results unique and legitimate.

V. CONCLUSION

The result from the system were authenticated and cannot be modified by someone who tries to manipulate the information presented. The respondents feel secured when using the website and certain that their information will not be leaked. The users agreed that the blockchain technology made their data secured, legitimate and authentic.

VI. FUTURE WORKS

This research may be developed into more advanced programming where data gathered may be used in different evaluations and purposes. Conducting this research will be better if there are more participants using the system to check more the accuracy of results that have been recorded in the blockchain.

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