DEVELOPMENT OF BLOCKCHAIN-BASED COMPUTERIZED TRANSCRIPT PROCESSING SYSTEM

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Abstract— This work introduces a computerized transcript processing system that utilizes blockchain technology to modernize academic transcript management. The system automates the issuance, verification, and retrieval of academic records, addressing inefficiencies and security concerns in the current manual process at Federal University of Technology, Owerrri, Imo state, Nigeria. The key objectives of the system are to reduce paperwork, processing costs, and record retrieval time. It utilizes blockchain and a smart contract on the Binance Smart Chain test-net to ensure transparent and secure payment processing. The system allows staff to upload semester results and grant post-graduation access to students, facilitating account creation and transcript requests. Students can log in and submit requests, and the system integrates with personal blockchain wallets like Metamask for payment processing. Validated transactions are securely recorded on the blockchain. Once payments are verified, students gain access to a personalized dashboard where they can preview and download their transcripts as PDFs. The use of blockchain technology guarantees record security and transparency, revolutionizing transcript management for academic institutions and providing a user-friendly experience for students. This project redefines academic transcript processes, combining blockchain's potential with efficient procedures to alleviate administrative burdens and fortify data security. The future-oriented approach promises enhanced operational efficiency for institutions and a seamless, secure experience for students.

Index Term- Blockchain; Cryptography; Distributed Ledger; Smart Contracts; Transcript,

I. INTRODUCTION

A transcript is an academic record detailing a student's academic performance while at the university or higher institution of learning. The process of obtaining these transcripts can often be challenging and frustrating, especially in universities that rely on outdated or inefficient transcript processing systems. Additionally, there may be instances where facilitators within the university system expect unofficial payments in order to expedite the transcript issuance.

To facilitate the processing of students' transcripts, it is desirable to make the process of issuing, sending, receiving, and verifying grade reports either completely or partly automatic. This could be done by computerizing the procedure. However, there are important considerations that need to be taken into account. Some of those issues include security, or making sure that records are authentic; time used in retrieval of student's files; convenience for students, professors and graduate schools; storage, or ensuring that records are not lost.

This paper discusses a design of such a system. Design goals of this system are as follows: decrease the amount of paperwork for students and graduate schools, reduction in the amount of resources and cost of processing of student's transcripts, easy retrieval of record and reports of students with increased data security, and the reduction in time used in retrieval of student's records.

The system leverages blockchain technology, allowing users to interact with a smart contract deployed on the Binance Smart Chain testnet to make payments for the transcript processing fee. The records are securely stored directly on the blockchain, ensuring transparency and efficiency in handling the payment process for the transcript processing fee. The record of a particular student can be retrieved at any time by simply searching for the record using the student's matriculation number. This record can then be formatted in the form of an official grade report (OGR), Statement of Degree Result or Transcript format and can be viewed on the dashboard or downloaded as a PDF.

This study aims to develop a computerized transcript processing system using Blockchain Technology that is used to store and retrieve students' result data, and process and verify payments for the transcript fee. The system is limited to processing payments, storing and retrieving students' result data. The system only serves as a way to store and retrieve records after result correction and all necessary authorization by the head of the department (HOD) has been done. Meaning that, the record being stored in the system, is a digital version of the record that has already been signed and authorized by HOD.

II. LITERATURE REVIEW

A. Overview of Transcript Processing System

A blockchain is a distributed ledger with securely linked records (blocks) containing cryptographic hashes, timestamps, and transaction data. It forms a chain, each block linked to the previous. The time-stamp proves that the transaction data existed when the block was created. Since each block contains information about the previous block, they effectively form a chain, with each additional block linking to the ones before it [1].

Distributed ledger technology synchronizes digital data across multiple locations without a central administrator. Unlike centralized databases, it avoids single points of failure. where each replicates and saves an identical copy of the ledger data and updates itself independently of other nodes [2].

Web3, or the Distributed web, seeks to decentralize data storage, reducing control by a single entity. It's exemplified by BitTorrent's peer-to-peer file sharing. Web3 transitions from central data to a fully distributed structure. It lacks central servers, gateways, and large storage arrays, distributing data across many devices.

MongoDB is a distributed NoSQL database that stores data in BSON format with unique Object IDs acting as a primary key for that specific data entry. It partitions data across nodes for speed and reliability. Collections organize related data efficiently, allowing easy retrieval and manipulation. Within the blockchain ecosystem, smart contracts

are self-executing contracts with predefined rules and conditions. These contracts automatically execute when specific conditions are met, without requiring intermediaries or manual intervention. Smart contracts are usually written in programming languages like Solidity and deployed on the blockchain, enabling trustless and efficient execution of agreements [3].

B. Review of Related Works

Several studies, academic papers, and research projects have explored the potential of blockchain technology for transcript processing in tertiary institutions. Study by Alsalamah identified several benefits of using blockchain technology for academic records, including increased security and transparency [1]. Another study in [2] demonstrated the feasibility of using blockchain technology for academic credential verification. [3] proposed a Secure and convenient computerized transcript system. The paper discusses the design of a system that replaces paper transcripts with computerized records that are secure, safe, convenient, and practically impossible to falsify. A blockchain-based system for secure and efficient transcript management in higher education institutions is proposed in [4]. In [5], the work proposed a design framework for blockchain-based digital credential systems and discusses their implementation in the context of higher education. Similarly, the Open University's researchers have developed the OpenLearn system on the Ethereum public blockchain, granting OpenLearn badges upon completion of course sections and assessments [6]. Furthermore, the creators of this system are actively engaged in a blockchain project aimed at establishing a permanent distributed record of intellectual effort and associated reputational rewards [7], effectively democratizing educational reputation beyond the academic community.

Blockchain helps to solve this problem by utilizing smart contracts for processing the payment of the transcript processing fee. Users will interact with the deployed smart contract, which runs on the blockchain, to initiate the payment transaction securely and transparently. The smart contract will handle the payment verification process, ensuring efficient management of the payment system for the transcript processing fee. The authors in [8] proposed a platform EduCTX, which is an ambitious project for the development of a higher education credit platform based on the concept of the European Credit Transfer and Accumulation System (ECTS), a framework which has been approved by the EU. The decentralized higher education credit and grading system can offer a globally unified viewpoint for students, higher education institutions, and other potential stakeholders such as prospective employers. A more theoretical investigation of blockchain-based student records is presented in [9].

The study outlines the architecture for the Disciplina platform for student records and analyse the main issues related to storing student records on a blockchain. The platform integrates both private blockchains maintained by individual institutions of higher learning and public blockchains, managed by "Witnesses" who verify the legitimacy of private blocks produced by valid institutions. The paper provides a thorough discussion of the problems of privacy, provability, and data disclosure in this context.

III. SYSTEM DESIGN AND IMPLEMENTATION

To effectively meet the research objectives, a mixed methods of research design was used. This method combines both qualitative and quantitative data to offer a holistic insight into the technical aspects of the proposed system and its influence on the transcript processing work-flow. The research began with a qualitative examination of the current

manual transcript processing system and the issues encountered by students and administrators. Subsequently, a quantitative survey was administered to collect input from stakeholders regarding their anticipations and choices for the automated system. Below is the data collected methods used

A. DATA COLLECTION METHODS

a) Literature Review

A qualitative literature review was conducted to examine existing research, academic papers, and publications related to blockchain technology, transcript processing systems, and educational record management.

b) Interview

A semi-structured interview was conducted with some lecturers who has significant expertise in academic records and transcript processing. Some of the interviewed lecturers also served as a class adviser, which makes them well-informed about the manual process of requesting transcripts and the appearance of the transcript document. A quick interview was also carried out with two schedule officers who are responsible for transcript processing in Federal University of Technology, Owerri, Imo State, Nigeria.

B. DATA REQUIRED

Student information: To generate a transcript, students must log in using their matriculation number and password. They can request a transcript after successfully logging in, but only if they've graduated. After the request, students must pay the transcript processing fee. Once the correct payment is verified, they can instantly view/download the transcript as a PDF file.

Staff Information

The following is the information about staff. The staff (class adviser) can register on the website and the information about the staff will be saved in the database. The class adviser can now log in to the website to upload results for the students the moment semester result is released.

Result Information: This is the information about the student's result. This information is saved in the database when the staff uploads the students' results.

C. SYSTEM ARCHITECTURE OVERVIEW

The computerized transcript processing system employs a multi-tiered architecture, consisting of the frontend, backend, database, and smart contract layers, each with distinct roles contributing to a cohesive user experience.

Frontend Layer (Presentation): The front-end provides an intuitive user interface for interactions. It enables students and administrators to request transcripts and access various features seamlessly.

Backend Layer (Application): The backend handles business logic and data processing, serving as an intermediary between the frontend and other system components, ensuring efficient data flow.

Database Layer: Responsible for storing and managing data, including student information, course details, and transcripts. It serves as the central data repository.

Smart Contract Layer: Deployed on the Binance blockchain, this layer securely handles transcript processing fee payments, ensuring transaction integrity.
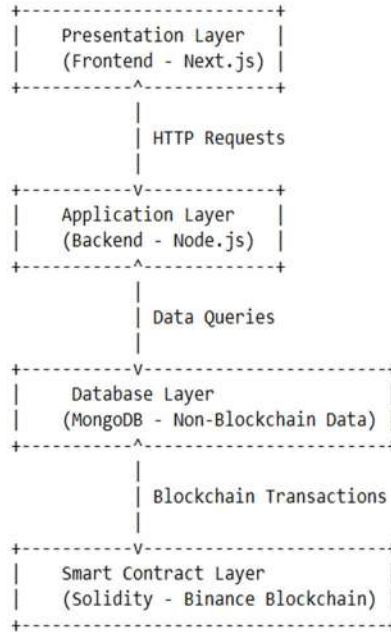

Fig. 1. System architecture

D. STUDENT TRANSCRIPT REQUEST

Below is a simplified data flow diagram for the student transcript request process in the computerized transcript processing system:
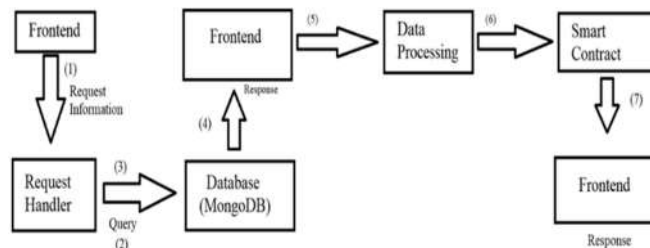

Fig. 2. Student transcript data request diagram

IV. RESULTS AND DISCUSSION

A. Results

a) Website Overview

The TPS website offers an intuitive and user-friendly interface designed to enhance the user experience. The main pages include the Homepage, Staff Login, Result Upload, Student Login, and Transcript Request pages, accessible to staff members and students based on their respective roles.

Fig. 3. Website home page

b) Staff Registration Page

The Staff Registration Page is designed to allow new staff members to join the TPS system. It provides a secure and straightforward registration process. Staff members can fill in their necessary information, such as name, email, and role within the institution.
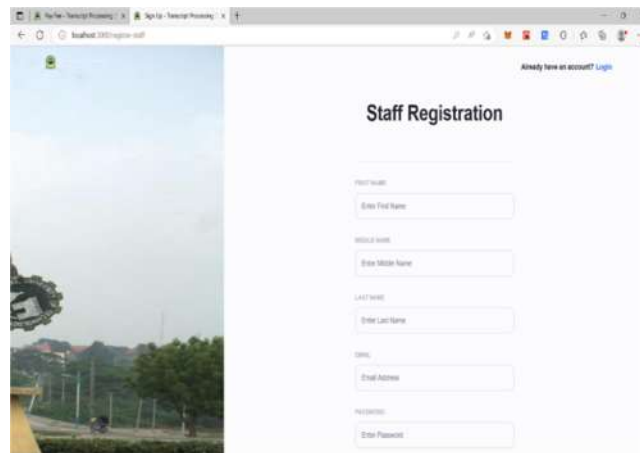
Fig. 4. Staff registration page

c) Staff Log In Page

The Staff Login Page serves as the secure gateway for authorized staff members to access the TPS. Upon entering their credentials, staff members gain access to their personalized dashboard, enabling them to manage student records and upload results.
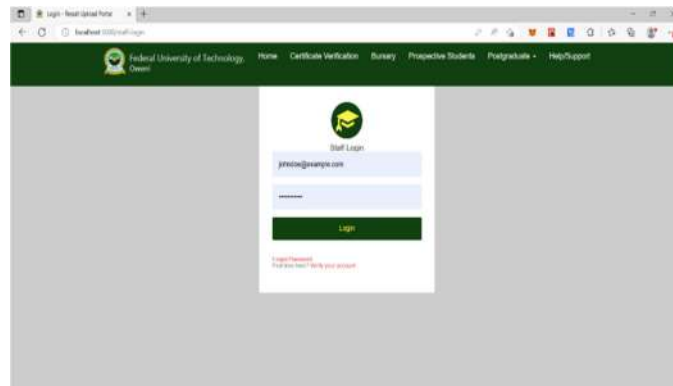
Fig. 5. Staff log in page

d) Result Upload Page

The Result Upload Page empowers staff members to submit student grades and examination results efficiently. Through a straightforward upload process, staff can verify data accuracy before confirming the submission, ensuring data integrity throughout the system
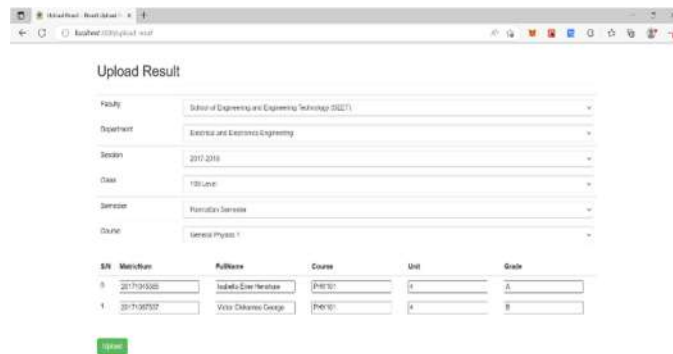

Fig. 6. Result upload page

e) Student Registration Page

The Student Registration Page facilitates a smooth and secure registration process for new students joining the TPS system.   Students can create their accounts by providing essential information such as their full name, date of birth, contact details, and student ID (if applicable). The page ensures the privacy and security of the students' data during the registration process.

Upon successful registration, students will receive their login credentials, granting them access to their personalized dashboard. Within the dashboard, students can view their academic records, request transcripts, and pay the transcript processing fee securely. Once the payment is verified, they can immediately download their transcript, streamlining the transcript-related services for a seamless user experience.
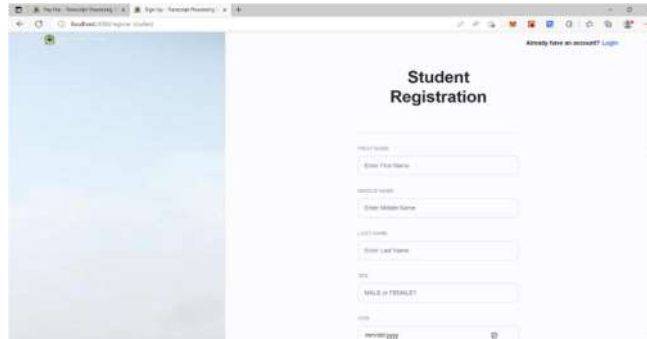
Fig. 7. Student registration page

f) Student Log In Page

The Student Login Page enables students to access their academic records and transcript-related services securely. By entering their login credentials, students gain access to their personalized dashboard, where they can request transcripts, pay the transcript processing fee and download the transcript immediately once payment has been verified.
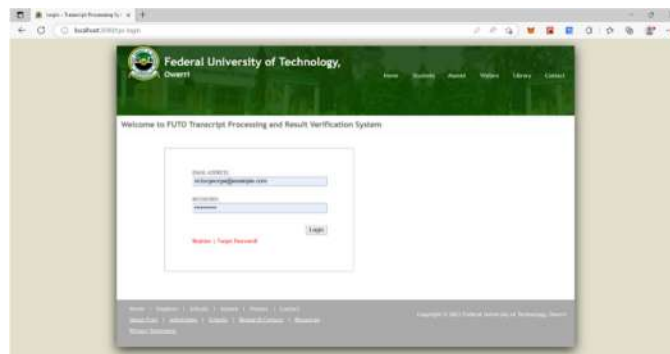

Fig. 8. Student log in page

g) Transcript Request Page

The Transcript Request Page enables students to request official transcripts from the institution with ease. Graduates can request for transcripts, pay the processing fee and then they can login to their dashboard anytime to download the transcript after successful payment. After paying the fee you can download the transcript multiple times in case you misplaced the first file you downloaded.
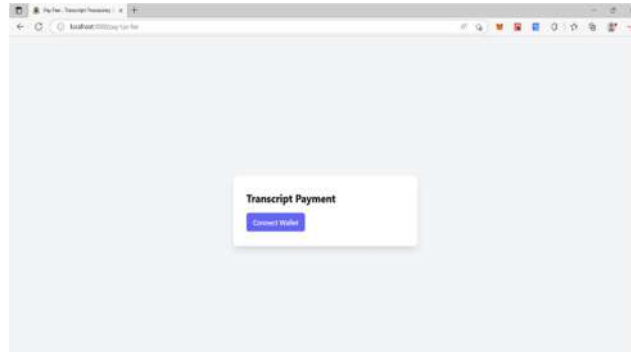
Fig. 9. Transcript request page
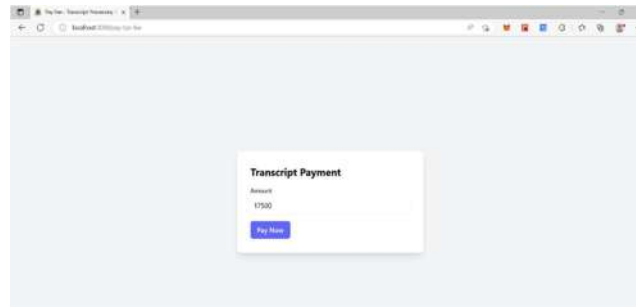

Fig. 10. Payment page (connect your wallet)

Fig. 10. Payment page (wallet connected)

h) User Feedback Testing

We conducted user testing to gauge the system's user-friendliness, functionality, and responsiveness. Feedback from staff and students highlighted the system's ease of use and its ability to streamline the transcript processing workflow. Valuable insights from user feedback informed minor interface refinements to optimize user interaction.

i) System Performance

To evaluate the system's performance, we conducted rigorous testing for data retrieval, processing and blockchain interaction. The TPS demonstrated satisfactory response times and data accuracy during peak usage. Moreover, the blockchain integration exhibited the expected tamper-resistant properties, enhancing the system's overall security.

B. DISCUSSION

The successful implementation of the computerized transcript processing system using blockchain technology reaffirms its potential to revolutionize traditional transcript management. By leveraging blockchain's immutability and decentralized nature, the TPS ensures data integrity and security, instilling trust among users. The positive user feedback further validates the system's user-centric design and its ability to simplify transcript-related processes. The

seamless interaction between staff and students and the real-time access to academic records contribute to an improved educational experience.

By leveraging blockchain's immutability and cryptographic properties, the computerized transcript processing system provides a robust and secure platform for managing student records and transcript-related services. The system offers an innovative approach to address the challenges faced by conventional transcript processing systems.

The achievements of the computerized transcript processing system include enhanced data security, efficient transcript requests, and real-time verification mechanisms. Through a user-friendly interface, the system empowers staff and students to interact seamlessly with the platform, thereby improving the overall user experience.

However, the system's limitations include the dependency on blockchain network performance for transaction processing speed. Additionally, as with any emerging technology, blockchain adoption requires careful consideration of scalability and implementation costs. There's need to investigate the opportunities for integrating the computerized transcript processing system with other educational platforms to promote interoperability and seamless data exchange.

V. CONCLUSION

The successful implementation of the computerized transcript processing system demonstrates its effectiveness in streamlining the transcript management process. The utilization of blockchain technology has introduced a decentralized and tamper-resistant framework, ensuring that academic records are reliably managed and accessible to authorized stakeholders. The design and implementation of the computerized transcript processing system using blockchain technology represents a significant step forward in transcript management and educational record security in FUTO. The system's successful development underscores the potential of blockchain to revolutionize various aspects of the education sector. By combining blockchain's unique features with a user-centric design, we have created a secure, efficient, and transparent transcript processing system. The findings of this research contribute valuable insights to the broader field of educational technology and highlight the immense potential of blockchain in modernizing record management.

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