A Blockchain-Based Crowd sourcing Loan Platform For Funding Higher Education In Developing Countries

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Abstract- *In developing countries, funding is a significant obstacle to receiving higher education. Brilliant but needy students cannot complete their studies since their parents are unemployed and their countries' economies are poor. As a result, the students' talents are not harnessed to their full potential. In order to help students obtain higher education and harness their full potential, governments provide student loans to students in higher education. The government provides loans to students through the ministry of education. The students pay back the loan with interest when they start working. Governments have been the sole funders of student loans. The emergence of COVID-19 and the Russia-Ukraine war have resulted in a global economic crisis. Because of the global economic crisis, the government's spending has increased. In order to help reduce the burden of government and thereby reduce spending, we intend to revolutionize the student loan program through blockchain and crowd sourcing. This work presents a blockchain-based crowd sourcing decentralized loan platform where investors will be brought on board to provide funds for students in higher education. The platform will allow students to apply for loans from investors through registered financial institutions. The students will pay back the loans with interest when they enter the workforce. The proposed platform will allow students to fund their education, investors will get interest on the money they invest, and governments can channel the money they put into student loan programs into other avenues. We perform a thorough security analysis and back the efficiency of our work with numerical results*

Keywords- Blockchain, crowd sourcing, higher education, smart contracts, student loans.

I. INTRODUCTION

University students have many obstacles to overcome to achieve their best academic results [1]. To complete an edu cational programme effectively, much more is required than just studying. Many things can hinder a student's academic success, like not managing their time well, having money problems, not getting enough sleep, social events, and, for some students, taking care of their families. Funding is a sig nificant obstacle to obtaining a higher degree in developing countries. Brilliant but needy students cannot continue their education to the tertiary level because their parents do not have jobs and their countries' economies are bad. Therefore, these brilliant but needy students' talents are not used to their full potential [2]. Student Loan Schemes have been set up in developing countries to help college students pay for their programmes and repay the loans when they start working and making money [3].The sole contributor to the scheme has been the governments in these developing countries through the Ministry of Education. The Students Loan Scheme allows students accepted into and studying recognized programmes at higher universities to get loans to help pay for their edu cation.

For example, in Ghana, the Students' Loan Scheme was introduced under PNDC Law 276 in 1989 [4]. Students apply for this loan through the Ministry of Education (GES) and pay it back with interest when they start working after graduating. The emergence of COVID-19 and the Russian-Ukraine war has triggered a global economic crisis [5], particularly in developing countries. Economic growth in developing countries is subject to significant fluctuations such as high inflation, a lot of state debt, and significant changes in foreign direct investment, all of which hurt the country's economy. The economic crisis has pressured governments to provide social interventions for their citizens in addition to those already offered, such as free senior high school, national health insurance schemes, student loans, etc [6]. To help ease the burden on the government, specific social interventions, such as the Students' Loan Scheme, can be made public through blockchain-based crowd sourcing to invite investors to invest in them. Crowd sourcing is a method for decentralized problem solving based on an open call for remedies [7]. A typical crowd sourcing platform comprises three responsibilities: requestors, workers, and a centralized crowd sourcing unit. Through the crowd sourcing platform, requesters send tasks difficult for machines but simple for humans to complete[8]. Workers willing to solve the task

start competing and sending answers to the crowd sourcing platform. Requesters then choose a good solution (usually the best one that gets the job done) and give incentives to the workers who offer it. A blockchain is a distributed ledger of all peer-to-peer network transactions. A blockchain allows involved parties to validate transactions without the involvement of a centralized entity [9]. Possible uses include money transfers, trade settlements, voting, and many other problems. This work revolutionizes the Students Loan Scheme in developing countries through blockchain-based crowd sourcing. This work aims to present a blockchain-based decentralized crowd sourcing framework for higher education student loan programs that address the positive effects on college students, academic institutions, and possible investors. This platform will allow students (requesters) to apply for funding through registered financial institutions (miners). Investors (workers) who put money into this plan will get their money back in full, plus a percentage of the student's earnings after being out of school for a certain amount of time. The method uses the blockchain's benefits as a dis tributed architecture that provides a reliable long-term invest ment mechanism, authenticity, and accountability to create a trusted funding platform for poor college students who want to continue their education. Using blockchain, the investors and students can be monitored to ensure the data is correct since it is part of the chain that has already been checked because the system is distributed.

II. PRELIMINARIES

This part presents the various technologies employed in the blockchain-based crowd sourcing platform. Furthermore, this section concisely describes blockchain technology, a crowd sourcing platform, and smart contract.

A. CROWD SOURCING Crowd sourcing is outsourcing tasks to a large group of individuals through a public request for contributions [7]. In crowd sourcing, a group called requesters sends jobs to a crowd sourcing system, and a second group called workers contributes to the task's completion. The outcome of com pleting a task is referred to as an output. When requesters entrust quality control duties to the crowd sourcing platform, outputs can be evaluated and compensated directly and spon taneously by the crowd sourcing system. The compensation can be monetary, material, or reputational [10]. In principle, there are two different kinds of platforms for crowd sourcing: (1) a hiring method in which workers apply for specific tasks. Following the completion of the appli cation procedure, the requester who posted the task selects workers from the pool of applicants to complete the assignment.

B. BLOCKCHAIN TECHNOLOGY A blockchain is a distributed ledger of all peer-to-peer net work transactions [9]. With this technology, participants can confirmtransactions without a central clearing authority. The method is designed to timestamp digital documents so that they cannot be altered or backdated. Blockchain aims to address the double-records issue without requiring a central ized system. The blockchain enables the security and con f identiality of items such as money, assets, and contractual arrangements without needing a third-party such as a govern ment or a bank. Once data is stored on a blockchain, it is nearly impossible to alter it. It is easy to understand the working principles of blockchain technology by comparing them to a Google Docs file. A Google Doc is not duplicated or transmitted whenever it is shared with a number of people; rather, it is simply distributed. Consequently, a decentralized, distributed network is created, enabling everyone to access the basic file simultaneously. All changestothefileareloggedinreal-time, making them completely visible and ensuring that no one is locked out while awaiting modifications from other parties. One thing to note is that, unlike Google Docs, it cannot be altered after writing data to the blockchain,

C. SMART CONTRACTS Smart contracts are blockchain-based applications that exe cute when specific conditions are met [13]. The contract's code and negotiations are disseminated across a decentral ized blockchain network. The code controls the execution of transactions, which are easy to trace and immutable. Smart contracts enable trusted transactions and agreements between different, unknown participants without requiring a central body, legal system, or external enforcement agency. Most of the time, they are used to keep track of how terms and condi tions are being followed so that everyone knows the outcome right away, without the need for a third party or wasted time. They can also automate a workflow by automatically making the next step happen when certain conditions are met.

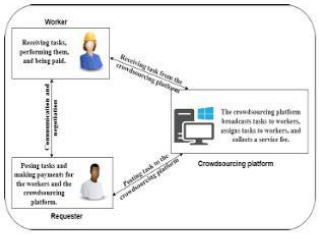

FIGURE 1. A model of a typical crowdsourcing platform.

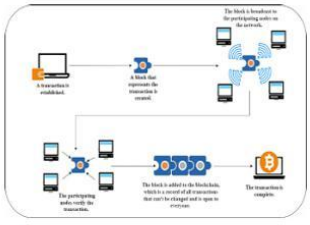

FIGURE 2. A working principle of blockchain technology.

III. LITERATURE REVIEW

Due to their promising features, crowd sourcing and blockchain have been used in several domains, such as software engineering, healthcare, marketing, computer vision,

government, education, etc. This part reviews some blockchain-based crowd sourcing frameworks in the literature. Kamali et al. [17]. presented a blockchain-based method for spatial crowd sourcing in which workers approve or disap prove of the accuracy of tasks. Tasks that include a type and location are uploaded to the system by requesters. In the proposed system, all involved participants receive compensation. The system considers both spatial and non-spatial incentive factors to encourage people to work together to collect accurate spatial data. To promote student participation in higher education, Horta et al. [18] presented a study on crowd fund ing in higher education and suggested that crowd funding is a plausible method of obtaining financial assistance for learning activities to supplement funding from other sources.

However, the authors voiced concern regarding crowd funding as a burden on academics and students to search for resources for their educational experiences that academic institutions should make available. In [19] Bit Fund global crowd funding platform was proposed. In the system, investors and developers serve as net work nodes. The investors can ask for a specific project and submit their opening offer value regarding time, cost, and maintenance needs. Several developers may submit bids with varying values for the same project parameters to be awarded the project. The developers participate in numerous rounds of bidding till the optimal solution is attained. A smart contract is implemented to ensure the investors get the best solution. Rashid et al. [20] proposed a blockchain-based platform that provided sponsorship for students in higher education. Investors provided the sponsorship in many ways, such as through scholarships, donations, loans, etc. A group of competing agents raises funds and organizes and maintains them. In 2019, Li and Han [21] proposed a work demonstrating the educational utility of blockchain. Students' records were stored using blockchain technology. The blockchain's purpose was to ensure that the information was safe and trustworthy. Further, data was shared using smart contracts. The evaluation of the work center edondemon stratingthatthe solution presented was secure and computationally efficient. certificates. The solution presented to handle the sharing of certificates relied on a key provided to the graduate. The students were fully accountable for the key's security. The suggested method's primary objective is to be economically sustainable and cost-effective. In [22], research was con ducted on how college students' crowd funding websites for business projects have changed over time. The goal of this work was to address the practical needs of crowdfunding in China. Hip-crowdfunding services can increase the number of people who visit the website and give existing customers high-quality service. Most of the aforementioned research in higher education relies on confined concepts and rarely discusses specifics. Some of the associated research is offered only to a selected group of entities. In contrast, the idea described in this work tries to include people and groups from all over the world who are interested in the plan. It is, therefore, open to the cooperation and inclusion of individuals and organizations worldwide.

IV. SYSTEM MODEL

This section gives a description of the system architecture of the blockchain-based crowd sourcing platform for providing funds for tertiary education students in developing countries. A brief description of the various entities employed in the system is presented.

A. SYSTEM COMPONENTS

1) STUDENTS Students seek financial assistance for their higher education through study loans. If the students are given loans, they must repay them according to the terms and conditions. Students interested in the system must first sign up for the platform through the registrar. After success ful registration, they are added to the blockchain net. A student on the platform is represented as Si = {sid, loc, schName,natID,KSpk}

where

- *sid* is the ID of the student.
- *loc* is the location of the student.
- *schName* is the name of the school that the student attends.
- *natID* is the student's national ID.
- KS_i^{pk} is the public key.
- KS_i^{sk} is the secret key.
- KS_i^{ad} is the wallet address of the student.
- KG_i^{ad} is the wallet address of the guarantor.
- t_{reg} is the time of registration of the student.

It should be noted that students are the loan requesters on this platform, so the terms students and loan requesters will be used synonymously.

2) BROKERS (MINERS) The brokers are registered businesses that act as inde pendent third-party agencies to raise funds for students and then maintain their records. The brokers act as rep resentatives for the students and bring investors on board on their behalf. When the total amount required by a student has been raised, the brokers also serve as min ers and create a contract between the student and the investors. The brokers are very important because they ver ify,

approve, and keep the information and applications of students safe. A broker on the system is denoted

Where

$\{bid, busid, busName, loc, KB_j^{pk}, KB_j^{sk}, t_{reg}\}$, where:

- *bid* is the ID of the broker.
- *busid* is the business identification number of the broker.
- *busName* is the registered business name of the broker.
- *loc* is the location of the business.
- KB_j^{pk} is the public key of the broker.
- KB_j^{sk} is the secret key of the broker.
- t_{reg} is the time of registration of the broker.

is the time of registration of the broker. Brokers serve as the miners on the platform, so the terms brokers and miners will be used interchangeably.

3) INVESTORS The investors comprise individuals or businesses in differ ent parts of the world dedicated to funding higher edu cation through fundraising events. Each investor is given a virtual wallet, and the balance is adjusted based on the investor's dedication to sponsoring a particular student. An investor on the system is denoted as, INm =

$\{inid, natID, loc, KIN_m^{pk}, KIN_m^{sk}, KIN_m^{ad}, t_{reg}\}$, where:

- *inid* is the ID of the investor.
- *natID* is the national identification number of the investor.
- *loc* is the location of the investor.
- KIN_m^{pk} is the secret key of the investor.
- KIN_m^{sk} is the secret key of the investor.
- KIN_m^{ad} is the wallet address of the investor.
- t_{reg} is the time of registration of the investor.

is the time of registration of the investor.

4) REGISTRAR The registrar is a trusted server that generates keys, signa tures, and certificates for all the system entities. It is a crucial entity on the network because no other entity in the system is allowed to perform these actions. Each entity on the system receives encryption keys and signatures from the registrar. The registrar also performs credential validation.

5) LOAN REQUEST A student Si requests a loan on our blockchain-based crowd sourcing platform by posting a request. This request is termed a loan request, denoted as LRSi = LRid,sid,le,Gid,amntrequested,tneeded, tcrt

- LRid is the loan request ID.
- sid is the ID of the student.
- le is the level of study of the student.
- Gid is the guarantor's ID
- am requested is the amount of money needed by the student.
- tneeded is the time the student needs the loan.
- tcrt is the time of the creation of the request.
- sid is the unique ID of the student who sent the request.
- inid is the unique ID of the investor who funded the request.

6) CROWD SOURCING PLATFORM This is a platform that links the various actors in the system together, denoted as CSP The plat form that allows the brokers to receive loan requests from the students. The brokers then look for investors willing to provide funds for the students.

7) BLOCKCHAIN A block chain is a decentralized transaction ledger that uses a chain to store a group of blocks. A block in our suggested architecture holds details about a loan that has been completed and includes them in the blockchain network. A block is denoted as BCN ={bcnidn,bcnidn−1,bcntn,cspr,sid,inid}

- bcnidn is the unique ID of the block. The block's hash value is used as the block ID.
- bcnidn−1 denotes the previous block. The hash value of the preceding block is used as the prior block's ID.
- bcntn is the time of creation of the block.
- cspr is the crowdsource loan request.

8) SMART CONTRACT A contract with predefined contractual terms written by the blockchain network is called a smart contract. A smart contract in our system is represented as, sct = {sctid, cspr, sid,inid,sctpt,sctac}.

- sctid is the unique smart contract ID for the loan request.
- cspr is the crowdsource loan request.
- sid istheunique IDofthestudent whosent the request.
- inid is the unique ID of the investor who funded the request.
- sctpt is the terms and conditions used to create the smart contract.
- sctac is the account balance of the smart contract.

B. USER REGISTRATION

The crowdsourced platform is mostly operable by approved users. A user must first sign up for the platform using a smart device. After completing registration, the crowdsourced plat form will issue the user with a unique user

identifier (User ID). Nevertheless, some users may turn malicious and try to get around the system by making up false user identities, as in the Sybil attack. In a Sybil attack, a single node runs many active fake identities (called ‘‘Sybil identities’’) simul taneously in a peer-to-peer network. This attack is meant to weaken the authority or power of a well-known system by taking over most of the network’s power.

C. ACQUISITION OF TOKENS ON THE PLATFORM

Tokens are bought either from the platform or from other users. To purchase tokens from the platform, a user just has to quote the number of tokens he or she wants to purchase and provide the equivalent in Ether to the platform. System users can also sell their tokens to other system users. In managing the buying and selling of tokens on the platform, a smart contract transfers the tokens from the seller’s wallet address to the buyer’s wallet address. The transaction can take place only if the buyer has a sufficient amount of Ether and the seller has enough tokens in her wallet. When these terms are met, the Ether is transferred to the seller’s account, and the tokens are transferred to the buyer’s wallet.

D. TERMS AND CONDITIONS OF THE LOAN SCHEME

For investors not to lose too much money if the loan requester doesn’t pay it back, they must agree to the rules of the loan scheme listed on the platform.

- The person who wants to borrow money must have a guarantor who can put up tokens worth 80\% of the amount he or she wants to borrow.
- 0.5%daily interest on the loaned amount. This rate can be modified using the smart contract, and the periodic ity can be changed from daily to monthly.
- A daily increase of 0.5% is applied to the collateral price.

Additionally, this rate and structure of increase are modifiable

E. COMMUNICATION DESIGN

This part presents the communication flow of the proposed platform. Users (students and investors) who want to be part of the system first send a registration request to the platform, and the registrar receives this on the platform. The registrar acknowledges the reception of the request. After that, the registrar generates the users’ credentials, including crypto graphic keys and a unique identity. The registrar sends the credentials to the corresponding user and sends a copy to the blockchain network for storage on the blockchain. When users get their credentials, they join the platform and can make a request.

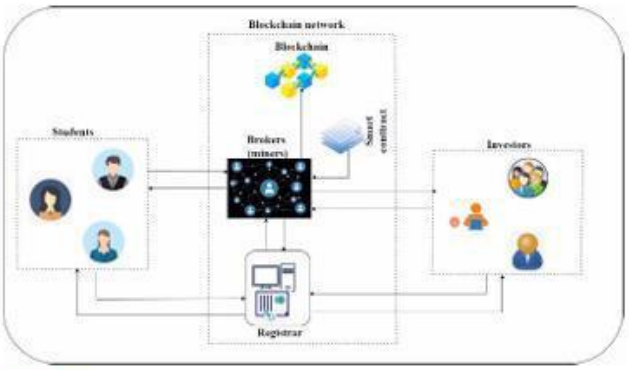

FIGURE 3. System architecture.

Algorithm 1 Loan Request Submission

Input: $\{sid, KG_i^{pd}, amnt_{requested}, t_{needed}, t_{crt}\}$
Output: LR_{id}
Check whether sid is a valid ID
if sid is valid **then**
  if $KG_i^{pd} amount \geq 0.8 * amnt_{requested}$ **then**
    $availInvestor = checkAvailableInvestor()$
    if $availInvestor > 0$ **then**
      Record $amt_{requested}$
      Record t_{needed}
      Record t_{crt}
      Create loan request (LR_{S_i}) with a unique ID
      LR_{id}
      add LR_{id} to β
    else
      "No available investor at this time"
    end if
  else
    "Guarantor's reputation is not accepted"
  end if
else
  return "Loan request placement was rejected"
end if
return "Loan request created successfully with ID LR_{id}"

USER INTERFACE

TABLE 1. Symbols and meanings.

Symbol	Meaning
λ	List of investors
γ	Total amount due for payment
ω	Money received from the requester
β	Loan request table

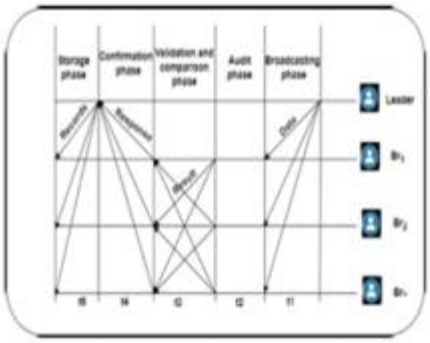

FIGURE 6. The process of carrying consensus on the blockchain network.

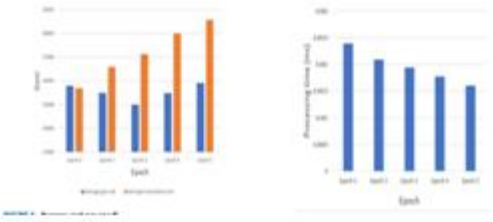

TABLE 2. Comparison between our proposed system and other related systems.

Metric	[23]	[24]	[25]	Ours
Decentralization	NO	YES	YES	YES
Integrity	YES	NO	NO	YES
Privacy	YES	YES	YES	YES
Security	YES	YES	YES	YES
Concuss	YES	YES	YES	NO
Anonymity	YES	YES	YES	YES

V. SECURITY AND PERFORMANCE ANALYSIS OF THE PROPOSED SYSTEM

This section presents a security analysis of the proposed blockchain-based crowd sourcing loan platform. An evalua tion of the system performance is further presented.

A. SECURITY ANALYSIS The blockchain-based crowd sourcing platform employs a private blockchain to provide security and privacy protection for loan requests. Listed below are the blockchain-related security results.

1) PRIVACY For large-scale implementation and acceptance of crowd sourcing platforms, both task requesters and contributors must consider privacy issues. In the proposed platform, as loan requesters and investors sign up for the system, they are given a unique identifier, which provides anonymity and privacy for requesters and investors. The system users are given cryptographic keys that are used to encrypt transac tional messages before sending them on the platform.

2) TRANSACTION AUTHENTICATION Transactional data is publicly checked and verified by all brokers. Due to the high cost, it is impossible to compromise all brokers on the platform. When a broker is compromised, a block with am is take will be found and fixed before forming the block.

3) CONCUSSION A concussion issue can occur with decentralized systems, especially blockchain-based systems. This issue occurs when multiple miners attempt to create a block simultaneously. In this step, each miner selects the same block's hash as a parent hash and generates a block. These blocks are not permitted on the blockchain system. The proposed platform eliminates concussions by managing all loan-related transactions in smart contracts. Consequently, each block's information will be sent to the miner following a predetermined time interval.

4) DATA UNFORGEABILITY The blockchain network is decentralized, and all transactions are cryptographically signed. This makes it impossible for an attacker to pose as a system user and break into the network. This is because an attacker cannot forge the digital signature of any broker (miner) or take possession of the more significant part of the platform's resources. Encrypted with the system's keys, an attacker who controls one or more brokers in the blockchain network cannot discover anything about the actual data. The attacker cannot falsify the saved and validated data in the blockchain

5) SHARING THE CONTRACT INFORMATION When matching the students and the investors, the details are compiled into a file and transmitted to the corresponding student and investor(s) through the email address they signed up with for reference purposes. NB: The file hash is also saved in the block, similar to the conventional legal document signed by the parties. The broker generates it after mining. It contains information such as the program cost, program duration, student and respective investors, the amount each investor contributed, and rewards to the investors after the student obtains employment.

VI. CONCLUSION AND FUTURE ENHANCEMET

After graduating from high school, exceptional students should not be denied the opportunity to pursue postsecondary education due to a lack of financial assistance from their relatives. This work presents a blockchain-based crowd sourcing loan platform to provide financial assistance to students in tertiary institutions to fund their tertiary education. The blockchain employed in our work enables us to monitor the students and the investors, knowing that the information is correct as it is part of the chain, which has been verified due to the distributed system. This platform would provide chances for poor students by outsourcing funding for tertiary education that they would not otherwise be able to afford. We next intend to extend our idea by expanding the platform's functionality to include teaching and non-teaching staff.

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