Application of Smart contract system for financial lending

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ABSTRACT

Today, fintech is on the rise and creates a strong wave in the financial lending sector. Additionally, its operations are still facing risks, such as illegally accessing, changing information, etc; hence, it needs modern, independent financial technology that can solve security and process issues. Thus, we propose the application of a Smart Contract to create a management information system in the field of financial lending. The main objective of the study is the application of Blockchain technology and smart contracts along with the use of modern programming techniques such as MERN stack technology and Solidity running on Ethereum blockchain technology to build a Hybrid Database system - where centralized data is transparent through Smart Contracts to be stored on Ethereum. Through the Waterfall method along with surveying more than 1000 individuals, the author team has performed requirements by analyzing, designing, programming, testing as well as product deployment and then following the motto "best effort" with some features including centralized storage, decentralization, etc. This research idea contributes to ensuring security and maximum support for customers as well as administrators in accessing and managing enterprise data, helping to reduce risks and unnecessary disputes to enhance the level of trust along with user experience.

Keywords: Personal Loans, Finance, Smart Contract, Blockchain, Ethereum

1. Introduction
The 4.0 industrial revolution is inevitable in human evolutionary history. We live in a "digital era" where the Internet and electronic devices are an integral part of daily activities. Every field today needs the Internet and advanced technological devices, and the financial sector is no exception.

In the past, most financial transactions were performed at banks and required many procedures to make a successful financial transaction. However, that is no longer a problem as today's transactions gradually shift from in-person meetings at banks to online at customers' homes via smartphones. Along with the "New Normal" social

change taking place in most countries around the world after the Covid - 19 pandemic, the replacement of trading methods from traditional trading methods with new Traditional paper contracts have been replaced by modern transactions with smart electronic contracts that seem to have predicted a new era in human evolution and the evidence is the end of the world use more modern technologies.

Applying the modernity of new technology to make human life more developed, flexible, safe, and more beneficial is the motto that people in the industry in general and our group in particular always aim for. By using 'Blockchain' technology, 'Smart Contracts', and developing the decentralized web system 'Web3'; The result of our scientific research group - Cryptology is "Smart contract system in the field of financial lending".

2. Theoretical basis

2.1. Finance

Finance is known as an important field that has existed since ancient times. It is also simply defined as the management and use of money in a scientific way (Orús et al., 2019). Nowadays, the emergence coupled with the strong development of various technologies and new financial products has led to profound changes in the financial market. From student loans to mortgages, credit cards, mutual funds, and retirement income, the scope of financial products that individuals choose has significantly differed from the past, and decisions related to them directly impact personal well-being (Lusardi, 2019). Therefore, having a certain understanding of finances will provide the ability to manage finances effectively, from daily expenditures, maintaining an emergency fund, planning for children's education, to preparing for a peaceful retirement in the future (Goyal & Kumar, 2021).

2.2. Personal Loan

Personal lending is the process of meeting an individual's monetary needs based on their loan application. The borrowed amount can be used for various purposes such as travel, education, event organization, or simply shopping. This process involves the participation of multiple parties, including the lending platform, the lender, the borrower, and a reputable third-party intermediary. Both lenders and individuals in need of funds must go through the intermediary's lending platform to complete the lending process. Personal loans are considered to have relatively low effectiveness, with a low likelihood of timely debt repayment and a high risk of default (Li et al., 2019). According to TransUnion statistics, the balance of unsecured personal loans reached $21 billion in 2018. Furthermore, the highest recorded record was $138 billion. The balance of personal consumer loans in China reached 15.702 trillion RMB in January 2015. And in December 2018, the figure doubled from four years earlier, specifically 37.790 trillion RMB. The reported data shows that the personal loan market is

growing significantly in many countries (Xia et al., 2021). The benefits of personal loans, as outlined by Joseph (2021), include no collateral required, simple procedures, no restrictions on usage purposes, and Large borrowing limits.

+ No collateral required: Typically, other forms of loans may necessitate borrowers to provide collateral, such as homes or other assets. Conversely, personal loans do not involve any collateral requirements from the bank.

+ Simple procedures: Due to the absence of collateral requirements, the process of personal loan approval can be completed in a short period, requiring fewer documents compared to conventional loan types.

+ No restrictions on usage purposes: The borrowed funds can be utilized for any purpose without the need to declare the intended use to the bank. Borrowers only need to answer questions about income, employment, and other factors for the bank to assess whether the borrower has the ability to repay the loan on time.

+ Large borrowing limits: Borrowers can obtain a substantial amount through a personal loan, depending on the evaluation conducted by the bank.

2.3. Blockchain

Blockchain, also known as Distributed Ledger Technology (DLT), is a system in which all transactions are recorded through cryptography and stored in a decentralized manner. Transactions on a blockchain are shared among their users through a peer-to-peer network without the need for a trusted third party (Yang et al., 2020). Blockchain is a combination of several core technologies including hash algorithm, digital signature and consensus algorithms, etc (Monrat et al., 2019). Some key features of blockchain technology are summarized by Atlam and Wills (2019) such as decentralization, immutability, transparency, security, efficiency, etc.

+ Immutability: Data stored on the blockchain is permanent and immutable as long as the network is still maintained. This is because each block in the blockchain always refers to the previous block.

+ Decentralization: The advantages of decentralized storage are that it can address the challenges that centralized storage is facing, such as single point of failure and scalability. This is because transactions in a decentralized blockchain can be executed by the nodes in the network with each other without the involvement of a third party.

+ Transparency: All transactions on the blockchain are shared across the entire network of users, it provides a high level of transparency without the need for assistance from third parties.

+ Security: Blockchain achieves enhanced security compared to most other technologies, thanks to its consensus mechanism and the use of public key infrastructure to prevent data tampering.
+ Efficiency: The aforementioned properties have enabled blockchain to be more cost-effective than traditional centralized storage models, offering advantages in terms of transaction cost, risk management, and resolution speed.

2.4. Smart contract

Smart contracts are programs deployed on the blockchain platform that work similarly to traditional contracts but without the need for a trusted third party to participate (Sayeed et al., 2020). Smart contracts operate based on simple "if/when…then…" statements written in programming languages. It can automatically perform "then" actions when "if/when" conditions have been met. Thanks to the immutable nature of blockchain, smart contracts once deployed on the blockchain cannot be controlled, modified or stopped by anyone (Bauk, 2022). One of the advantages of smart contracts over traditional contracts is that smart contracts can operate without the need to rely on a third party. Therefore, it can reduce the costs of transactions and the time required to pay for the verification and execution of the contract (Shahab & Allam, 2020). Specifically, the benefits of smart contracts mentioned by Khan and Naz (2021) include: speed, efficiency, and accuracy; trust and transparency; security; and savings.

+ Speed, efficiency, and accuracy: When the conditions are met, the smart contract will execute the transaction immediately and accurately according to the agreed terms.
+ Trust and transparency: Information about the transaction is encrypted and only known to the parties to the contract.
+ Security: Transactions are all encrypted and stored on the blockchain, making it almost impossible to hack or modify information.
+ Savings: Because smart contracts are automated, the cost and time of paying third parties is not necessary.

2.5. Ethereum

Ethereum is currently the second-largest blockchain platform, only behind Bitcoin, and is the largest blockchain platform supporting smart contracts. Ethereum provides a cryptocurrency called Ether (ETH), which is used for transactions on cryptocurrency exchanges and various fees, including transaction fees and fees for maintaining the Ethereum network. The Ethereum Virtual Machine (EVM) within the Ethereum network is a runtime environment used to execute smart contracts (Hu et al., 2021). In addition, the Ethereum DApps and smart contracts can be combined. Ethereum aims to create decentralized applications by establishing an alternative protocol (Taş & Tanrıöver, 2019). DApps, also known as decentralized applications, are built on a blockchain platform with the support of smart contracts. The special feature of DApps is

that they operate on a peer-to-peer network (P2P) and do not have any central agency or organization to manage them. DApps use smart contracts to perform functions and manage data (Wu et al., 2021). Smart contracts can be written in many Turing-complete languages, with Solidity being the most widely used language. During the compilation process, the smart contract's Solidity code is converted into bytecode to be executed on the EVM. The interfaces of a smart contract can be called through transactions after it has been deployed on Ethereum. This process requires the consumption of a certain amount of gas. Gas is the unit used to measure the amount of energy consumed for the operation of transactions on Ethereum (Li et al., 2020). When a smart contract receives a message/transaction, it activates and automatically executes the code written within it. The accompanying payload in that transaction serves as input data for the contract execution process. To create a new smart contract on the blockchain, a special transaction called contract deployment must be performed (as described in Figure 1). In this transaction, the compiled contract code is sent as part of the payload and permanently stored on the blockchain. After a successful deployment, the new smart contract will have its own address on the blockchain and can be interacted with like other contracts (Pinna et al., 2019, Figure 1).
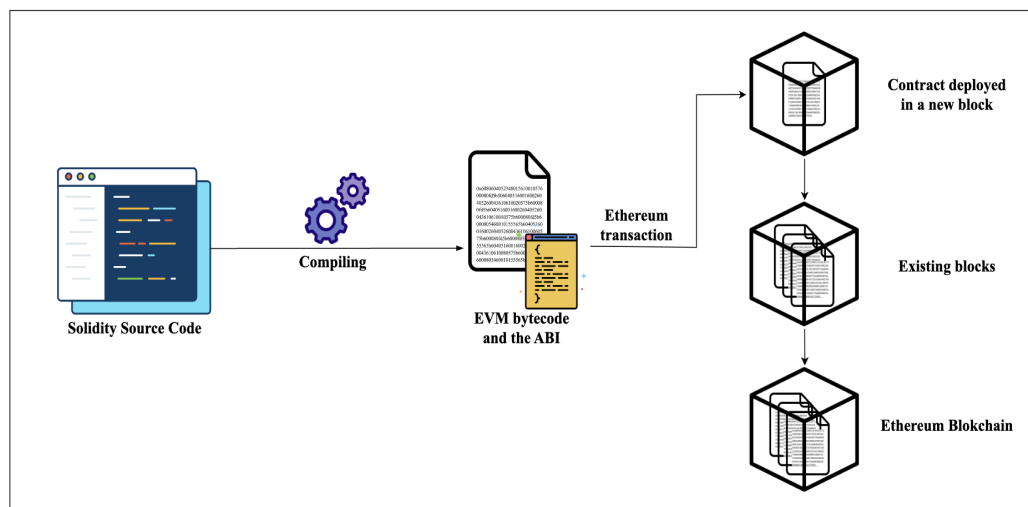

Fig 1. The interaction of Ethereum Smart Contracts and Blockchain through transactions.

3. Methodology

In the pursuit of advancing the transparency and reliability of financial lending transactions, our research endeavors to employ a hybrid database, which combines the attributes of centralized and decentralized databases, as the foundational framework for transaction record-keeping. Our investigative focus revolves around pioneering a novel approach to store transaction histories in tandem with conventional methodologies. The integration of smart contract technology constitutes a pivotal facet of our methodology, serving as a linchpin in bolstering the security and integrity of the stored data.

Consequently, our paramount objective revolves around enhancing users' trust and overall experience within the domain of financial lending.

In the realm of data acquisition, we conducted an extensive survey targeting individuals aged 18 to 30, residing in both Ha Noi and Ho Chi Minh City. Our survey aimed to gauge their familiarity with Blockchain technology, Smart Contracts, as well as their awareness of prevailing financial lending and borrowing practices. The survey instrument primarily sought insights into exceptional cases within financial transactions and the respondents' corresponding attitudes toward such occurrences. Most responded cases show a negative attitude toward the transaction records in the traditional finance system. Hence, we received positive responses in the survey after applying the hybrid storage and indicating related information about the transaction such as transaction address, date time, transaction value, etc.

4. Proposal model and implementation

In terms of reminding the customer, we apply the push notification technology and email sending automation provided by Expo and Zapier respectively. The calculation of extra fee will be processed in the backend, which will make a new transaction of smart contract. Moreover, we use the Alchemy to get an url that allows us to write the Smart contract on Ethereum blockchain. Every process should be implemented in the back end for safety and security, while the front end just be used for showing information and sending a form. To illustrate, we propose React Native for front end and Express Js for back end. NodeJs is a friendly environment that can run on many systems and it is easy to implement. MongoDB is considered to be used as a centralized database due to its speed, NodeJs friendly property and no-cost in hosting for testing.

To facilitate users' access to loan services in the easiest way possible, the lending process has been designed to be simple and optimized by consolidating essential steps and eliminating unnecessary ones.

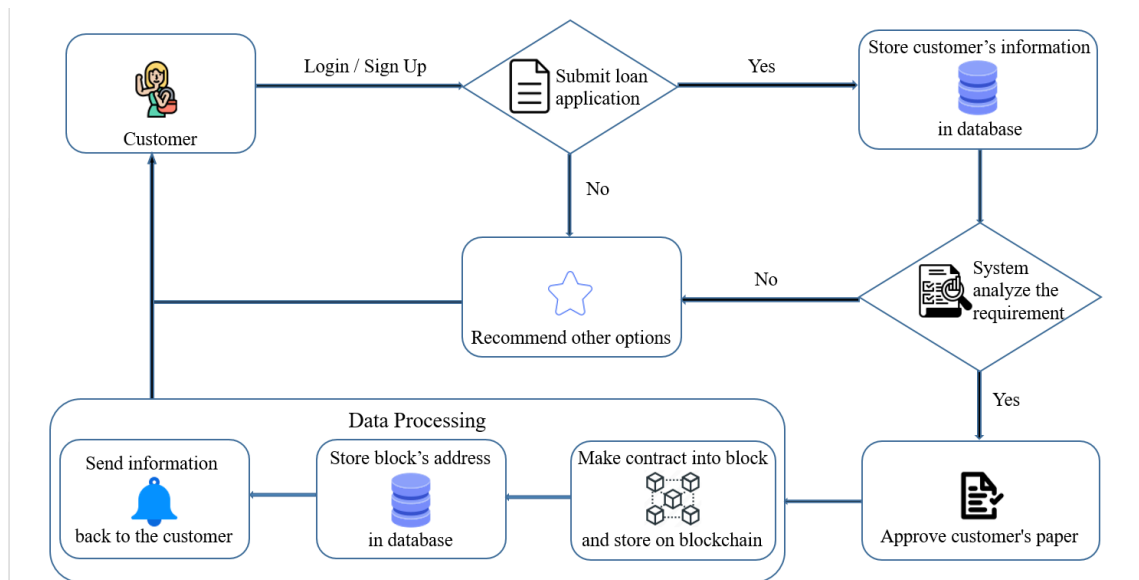The loan process follows the steps and the graphical abstract below:

Fig 2. Proposal model for the loan process

Initially, customers will have to log in to the system by using their account. In case they are new customers, they have to sign up, and the system will automatically store their personal information in the system database. Secondly, the customer will decide if they want to make a loan contract or not right after they have already logged in. The system will recommend some other options so that they can decide which kind of contract is suitable for them in case they don't have any intention of making one. On the other hand, if they decide to make a loan contract, the system will send the customer a paper to fill out with their personal and loan information. After that, the admin will analyze the customer's conditions in payment to decide whether they can afford to pay the monthly fee and pay off the loan on time. If the customer's form can not fulfill the system's requirements, it will recommend other options and repeat the whole process from the beginning except for the logging-in step until the customer's conditions meet the loan package requirements. If the customer's paper can fulfill every requirement then it will be approved and move on to the data processing stage. In the data processing stage, the blockchain system will make an update block with every information about the transaction that the customer has made to store it on the blockchain. After that, the system will insert the block into the chain after finishing hashing. Lastly, the customer will be announced when the process is done.

Similar to the loan process, the repayment procedure is also streamlined and modernized for the convenience of the majority of users. In this process, storage technology through the blockchain system will continue to be utilized to demonstrate the transparency of the information management system.

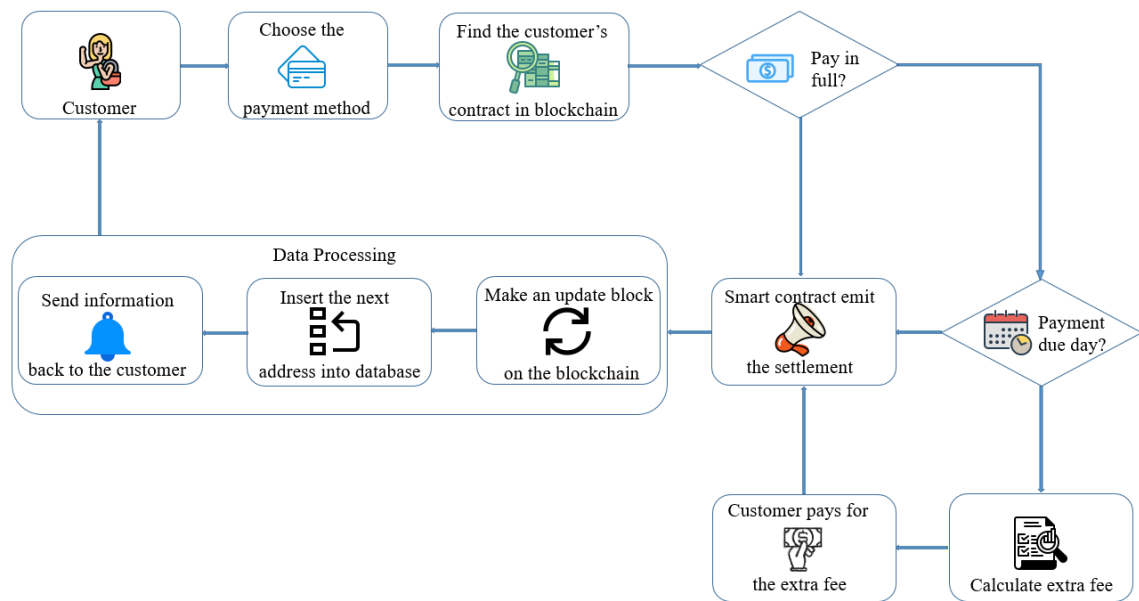The payment process follows the steps and the graphical abstract below:

Fig 3. Proposal model for the debt repayment process

After logging in, customers will choose the payment methods. Then the system will find the customer's contract on the blockchain system through their contract ID stored in the database. The customer will have to tell the system whether they want to pay in full or not. In case of paying in full, the system will check if it has met the due time of the contract or not. If the required time has come, the smart contract will emit the settlement event to the system and then we will move on to the data processing stage. On the other hand, if it is not the due time, the system will calculate the extra fine fee for paying sooner than the expected time. Customers will have to pay that extra fee to have the right to pay in full and move on to the next step, which will be the smart contract emitting the settlement event to the system and then moving on to the data processing stage. If the customer chooses not to pay in full, they will just repeat the emitting step by smart contract and the data processing stage. The data processing stage has been described in the paragraph above.

To ensure that customers can meet loan repayment obligations in accordance with the terms of the loan agreement, the system will undertake the task of reminding customers when the payment deadline approaches. In the worst-case scenario where a customer disagrees with the repayment, the business will take appropriate measures for resolution.

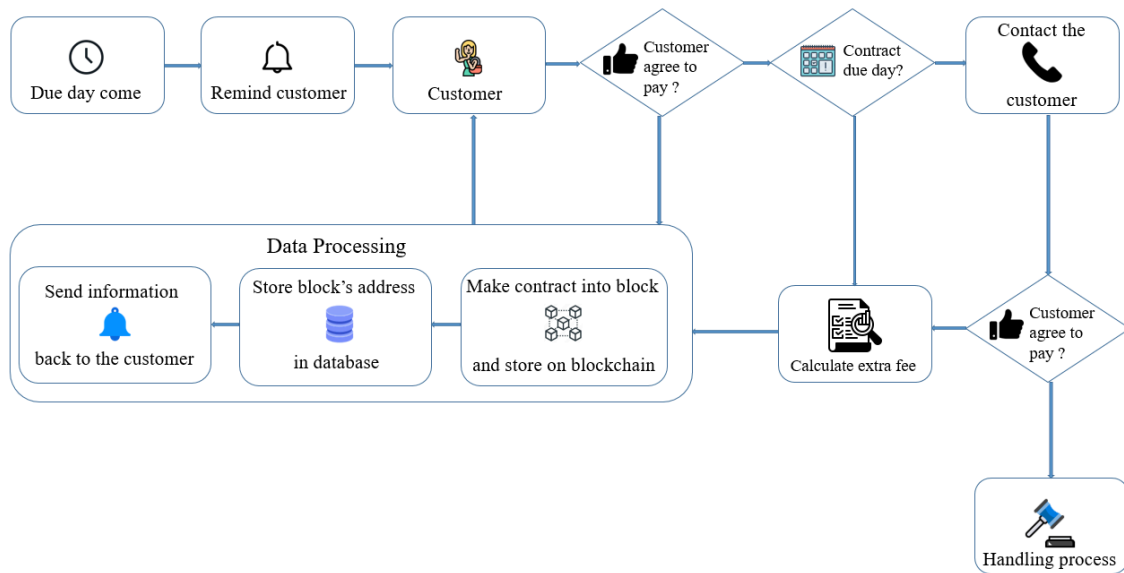The handling of late or non-payment debt follows the steps and the graphical abstract below:

Fig 4. Proposal Model for handling late or non-payment of debt.

At first, we send notifications through the app and reminder emails to remind the customer that the due date has come. If the customer is not willing to return the money and is not beyond the contract's due date, the system will calculate the penalty fee and then update the fee to the contract. In case the customer doesn't accept the extra fee, we will move on to the handling process, which belongs to the enterprises' services. Unless the customer pays lately, the payoff process will be the same as the aforementioned flow.

5. Experiment and Results

5.1. Analyze survey results

We have conducted a survey on lending/credit needs through smart contracts with 101 individuals ranging from students to working professionals in two major cities, Ho Chi Minh City and Hanoi, where there is a high economic density and demand for lending/credit. Through this survey, we have gathered important numerical data to provide a brief assessment of the adoption of new technologies such as Blockchain, Smart Contracts, and related activities in the financial lending sector.
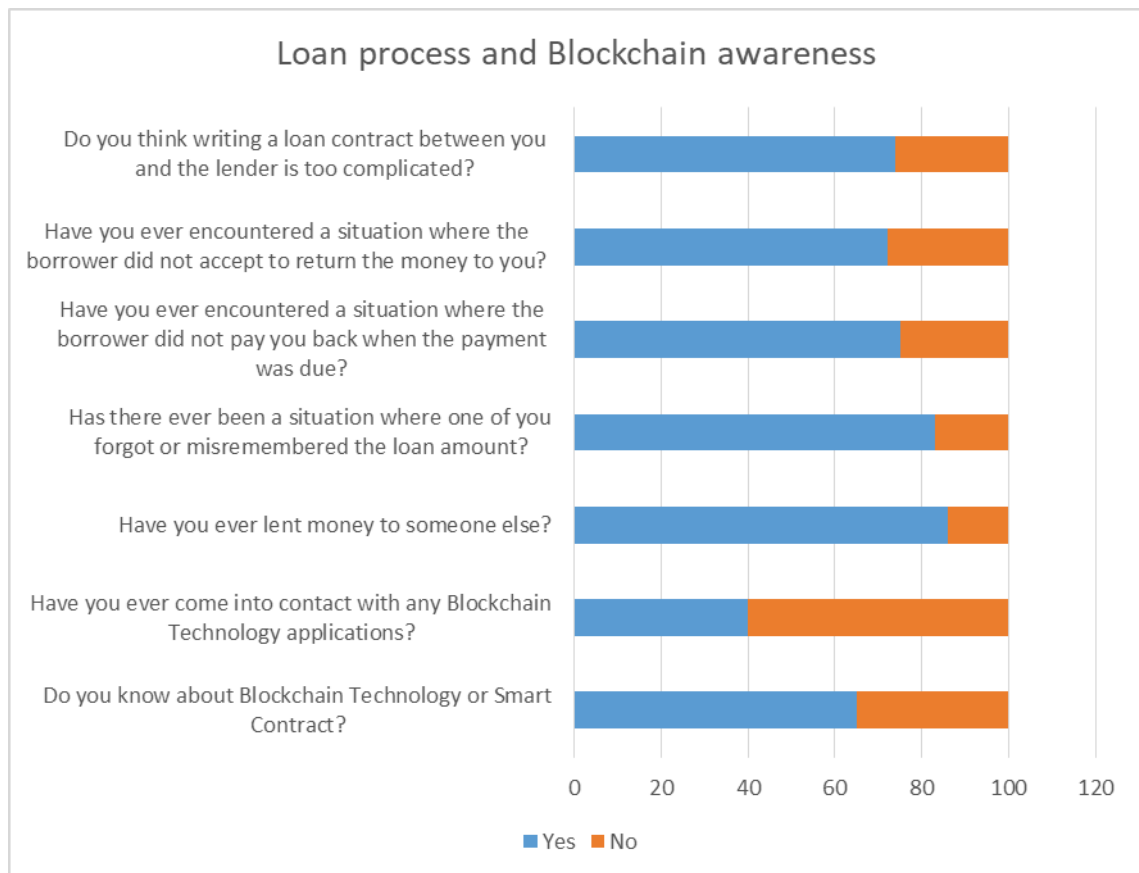
Fig 5. Form results

65% of the surveyed individuals were aware of or had heard about Blockchain and Smart Contract technology, but only over half of them had actually interacted with these technologies in their daily lives. These figures somewhat indicate that these technologies are still relatively new to the general public and not widely known, resulting in a limited understanding of the potential power of both mentioned technologies.

The execution of transactions without a clear information management system can easily lead to undesirable situations. For example, in the survey, it was found that 86% of the participants had previously engaged in lending activities, but 83% of them experienced disputes due to one party forgetting the borrowed amount. Particularly alarming is the percentage of situations where the borrower did not repay the loan on time (74,7%) or refused to return the money to the lender (72%). It is evident that the absence of proper contracts in financial lending transactions poses significant concerns.

The lack of a robust information management system increases the risk of disputes and non-compliance with loan agreements. Implementing technologies like Blockchain and Smart Contracts can address these challenges by providing a transparent and immutable record of transactions. These technologies enable the creation of secure and automated

lending processes, reducing the likelihood of misunderstandings and disputes between borrowers and lenders.

All the aforementioned issues share a common characteristic: the majority of participants in lending transactions primarily rely on verbal agreements rather than clear loan contracts. This unintentionally exposes legal vulnerabilities. They choose this informal approach due to its simplicity, ease of implementation, and the fact that the loan amounts involved are generally not substantial. Consequently, we can observe that the level of detail required in a comprehensive loan contract, which ensures the interests of both borrowers and lenders, would demand a significant amount of time and effort to complete. This is evident from the fact that 74% of the survey participants considered writing a loan contract between themselves and the borrower as overly complex, leading them to explore alternative options.

However, it is important to recognize that despite the perceived complexity, having a well-structured loan contract with all the necessary legal elements is crucial for safeguarding the interests of both parties. Such a contract provides clarity, establishes clear expectations, and helps mitigate potential disputes. Exploring simplified and user-friendly contract templates or utilizing technologies like smart contracts can bridge the gap between a comprehensive loan agreement and the need for convenience and efficiency in lending transactions.

Currently, issues related to document verification and legal compliance consume a significant portion of resources, including manpower and time, for both lending institutions and borrowers in the financial lending sector. A considerable number of survey participants, approximately 25%, feel that the lending procedures at lending institutions are overly cumbersome and complex. Additionally, 28% of respondents find informal lending methods easier due to their simplified procedures. Therefore, it is evident that employing a complex and multi-step lending system in certain lending organizations can make borrowers feel overwhelmed.

This is a matter of concern, as users are willing to trade off the level of information security when engaging in loan transactions, favoring a more streamlined process over a clear and structured lending procedure. This can be observed through the data, where 52% of survey respondents express concerns about transparency regarding loan contracts in informal lending.

Finding a balance between convenience and transparency is crucial in the lending process. Implementing technologies like blockchain and smart contracts can offer a secure and transparent framework for lending transactions. By automating certain steps and ensuring the integrity of loan agreements, these technologies can simplify the

lending process while maintaining transparency and security. This can help address the concerns of borrowers and lending institutions alike.
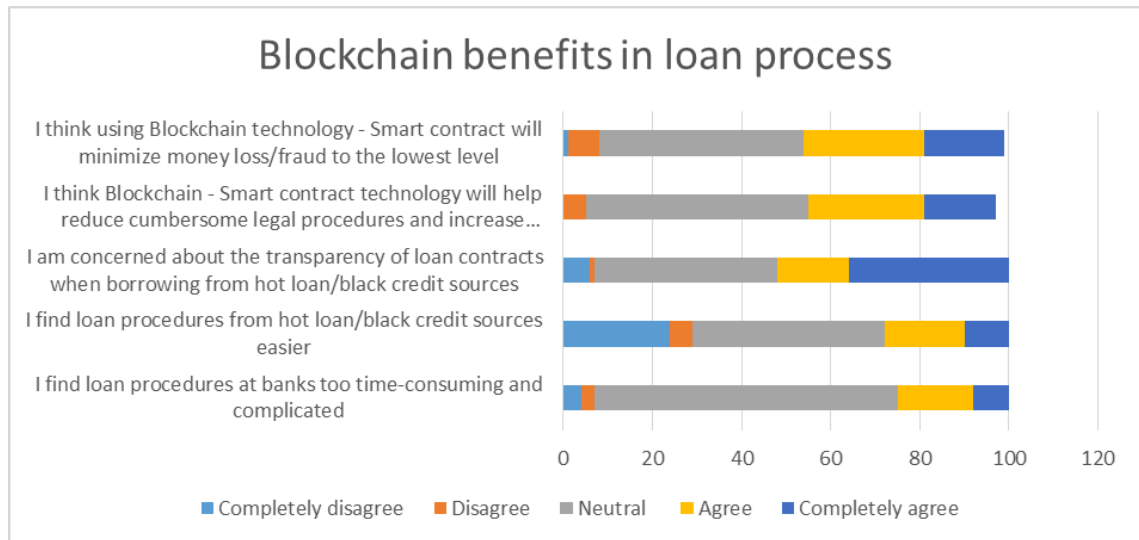

Fig 6. Form results

5.2. Results

From the results collected from the survey, we can see that applying Blockchain technology and Smart Contracts to the lending/credit sector has great potential to solve the problems present.

Specifically, problems such as disputes due to forgetting the loan amount, not repaying on time, or refusing to repay can be significantly reduced if Smart Contracts are used. This technology creates a transparent and immutable information management system, helping to reduce misunderstandings and disputes between lenders and borrowers.

However, this implementation needs to go hand in hand with increasing public awareness and knowledge about Blockchain technology and Smart Contracts. As the survey results show, although 65% of survey participants knew or heard about this technology, only a little more than half of them actually interacted with this technology in their daily lives.

In terms of technology used, we used the following structure as the main Solidity source code to create Smart Contracts. We have carefully researched to create a simple and user-friendly contract. The research team has realized that financial lending is an important aspect of the Finance industry in particular and the Economy in general. And to optimize financial lending, we propose a combined system for storing loan data, including storage in the database and in the Smart Contracts System on the Ethereum platform . This greatly enhances data transparency and security compared to current storage methods. By leveraging smart contracts and blockchain technology, the research

aims to revolutionize financial lending by introducing automation, transparency and security to the process.

```solidity
Algorithm: Source code Solidity
1    pragma solidity ^0.4.22;
2
3    contract Customer {
4        // amountOfMoney: string of 12 characters
5        // age: unsigned integer of 10 characters
6        string public amountOfMoney;
7        uint public age;
8
9        // Events
10       event FinancialInformationStoredSuccessfully(address indexed _from);
11
12       // Functions
13       function storeFinancialInformation(string _amountOfMoney, uint _age)
14   private {
15           amountOfMoney = _amountOfMoney;
16           age = _age;
17           emit FinancialInformationStoredSuccessfully(msg.sender);
18       }
19
20       // Utilize block.number and msg.sender
21       function getBlockNumber() public view returns (uint) {
22           return block.number;
23       }
24
25       function getSender() public view returns (address) {
26           return msg.sender;
27       }
28   }
```

6. Discussions

The research findings indicate that the implementation of smart contract systems can offer several benefits to financial lending, including:

- **Enhanced transparency and trust**: Since all transactions are recorded on an immutable and distributed database, it helps diminish fraudulent, deceptive, or manipulative behaviors during the operating process. As a result, it increases transparency and trust among the participating parties. Additionally, parties can easily and accurately verify the status and history of transactions.

- **Increased efficiency and flexibility**: Automation of contract terms and enforcement eliminates the human intervention needed while streamlining the lending process. This saves time and costs for both parties and reduces the potential errors or disputes. Moreover, contract terms are customizable according to parties' needs and preferences, such as interest rates, repayment terms, payment conditions, or risk factors.

- **Reduced costs and risks**: By eliminating unnecessary intermediaries and minimizing the ability of disputes or errors, smart contracts reduce lending costs and risks. Intermediaries often impose high transaction fees, increasing borrowing costs and

decreasing lending profitability. Moreover, they can also slow down the processing time or compromise transaction security. Through the use of smart contracts, parties can avoid these complications and increase the success rate of lending transactions.

These research findings highlight the potential of smart contracts in transforming the financial lending landscape by introducing efficiency, transparency and cost reduction.

Comparison with previous research:

The first is Lending models and scenarios using smart contracts, such as direct lending, lending through intermediary platforms or lending in peer-to-peer networks. Next are the Benefits and challenges of using smart contracts for financial lending, including aspects such as security, transparency, efficiency, flexibility, costs, risks, considerations legal and regulatory. And finally Platforms and tools that support the development and deployment of financial lending smart contracts, such as Ethereum.

Compared to previous research, this study presents the following differences and contributions:

This research examines and categorizes existing smart contract solutions based on various criteria such as blockchain type, programming language, flexibility, compatibility, and feasibility. This provides readers with a comprehensive and further understanding of the advantages and disadvantages of smart contract solutions for financial lending.

The study also highlights the challenges and open issues that need to be addressed in future research, such as security threats, vulnerabilities, and legal issues related to smart contracts. This helps readers become aware of the risks and limitations of using smart contracts for financial lending and proposes directions for further research and development.

7. Conclusions and future works

In summary, this research endeavors to explore the application of Smart Contracts within financial lending systems, addressing the enduring issues of transparency prevailing in today's financial domain. Consequently, it presents a novel perspective on the integration of Blockchain technology into traditional databases, coupled with the utilization of Smart Contracts to mitigate risks inherent in every transaction.

Transparency within each transactional contract has been a paramount concern since the inception of our research in this domain. Therefore, the application of Smart Contracts stands as a fitting choice to fulfill the group's objectives. Thanks to this application, the financial sector, in particular, and overall enterprise system management, gain access to innovative approaches to enhance transparency in each signed contract and minimize

disputes that traditional storage methods tend to foster. Moreover, the effective application of Smart Contracts to augment transparency yields the most favorable outcomes when employed within a Blockchain infrastructure characterized by a substantial and uninterrupted network of nodes. Thus, widely adopted Blockchain technologies such as Ethereum or Binance are recommended when implementing the model under study.

Ultimately, the objective of this research is to enhance transparency in financial lending contracts through the utilization of Smart Contracts. By reducing lingering transactional risks prevalent in the present-day financial landscape, this research aims to make financial transaction contracts increasingly lucid and transparent within the financial sector

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