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# Blockchain Architecture Design On Payment System For New Students of IIB Darmajaya

**Adi Syuman Pahlawan[1], M. Galih Ramaputra[2], Ari Purnomo[3*]**
[1,3] Digital Business, Darmajaya Institute of Informatics and Business, Lampung, Indonesia
[2]Lampung University, Lampung, Indonesia

**Email:** adisyumanpah11@gmail.com, ari.purnomo@darmajaya.ac.id

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**ABSTRACT**

Technology and information that are increasingly sophisticated change human behavior and perspective on technology. Blockchain is a decentralized technology that serves as a digital ledger that is constantly updated and distributed across the network. Each block in the blockchain has a timestamp and information about the transaction that has occurred and also users can make transactions directly with each other without additional fees with high security, each transaction is recorded permanently and cannot be manipulated, The transparency of all transactions made on the blockchain is publicly recorded and open for anyone to see, And the efficiency of blockchain transaction fees is much cheaper because there are no fees charged by third parties. In addition, what needs to be considered in the payment system is the quality of service, Service quality is the totality of the form of characteristics of goods and services that show the ability to satisfy the customer needs, both obvious and hidden. The quality of service to customers is a vital aspect because the quality of service provided to customers must be much better than expected so that customers are not disappointed. Measurement of service quality in general can be done by the servqual (Service Quality) method in the form of: 1) Tangible, 2) Reliability, 3) Responsiveness, 4) Assurance, 5) Emphaty

***Related Authors:***

Digital Business, Darmajaya Institute of Informatics and Business, Indonesia
Email: ari.purnomo@darmajaya.ac.id

## 1. INTRODUCTION

Technological advancements and the rapid evolution of information systems have significantly influenced human behaviour and perspectives on technology. Indonesia, as a country with a growing digital economy, has witnessed the rise of numerous startups, particularly in the financial sector. The emergence of Financial Technology (Fintech) has revolutionized financial services by offering efficient, fast, and economical solutions for

transactions such as digital payments, loans, and investments. This transformation is largely driven by blockchain technology, a decentralized digital ledger known for its transparency, security, and cost-effectiveness.

Blockchain operates through interconnected blocks that record transactions permanently and immutably, making it a reliable technology for financial services. Its advantages, including decentralization, high security, transparency, and cost efficiency, make it an ideal choice for payment systems. However, challenges such as scalability, regulatory uncertainty, and the risk of private key loss must be addressed to maximize its potential. Despite these challenges, blockchain's capabilities can be transformative in enhancing the quality of financial services.

At IIB Darmajaya, current financial services for new student payments rely on third-party systems, which may lack efficiency and direct integration. This study aims to address these gaps by proposing a blockchain-based architecture for new student payment systems. By integrating blockchain, the system is expected to improve speed, efficiency, and customer satisfaction, aligning with the SERVQUAL model, which emphasizes tangible evidence, reliability, responsiveness, assurance, and empathy in service quality.

This research explores the design of a blockchain architecture tailored for IIB Darmajaya's new student payment system. The proposed design seeks to modernize payment processes, combining online and offline methods to cater to diverse consumer needs. Through this study, the authors aim to contribute valuable insights into leveraging blockchain technology in the educational sector, offering a scalable and efficient solution for financial transactions.

## 2. LITERATURE REVIEW

Service quality has been widely recognized as a determinant of customer satisfaction. Parasuraman et al. (1988) introduced the SERVQUAL model, which evaluates service quality through the comparison of perceived and expected services. The five dimensions—tangibles, reliability, responsiveness, assurance, and empathy—highlight how organizations can enhance customer perceptions.

In the context of online systems, network security ensures data confidentiality and transactional integrity, playing a crucial role in building consumer trust (Bakhtiar & Sunarka, 2019). Blockchain technology further strengthens this through its decentralized, immutable ledger system. It allows secure, transparent, and efficient transactions without intermediaries (Efanov & Roschin, 2018).

Efficiency and speed, as part of technological advancement, are central to enhancing user experiences. Efficiency focuses on maximizing outputs with minimal inputs, while speed emphasizes the system's ability to improve user performance seamlessly (Mahmudi, 2019; Dewi Kusuma, 2022). Blockchain, as a distributed database, exemplifies these principles through its mechanisms such as hashing and consensus algorithms, ensuring both reliability and rapid processing (Iansiti & Lakhani, 2017).

## 3. METHOD

This study employs a qualitative research approach, conducting an extensive literature review to explore blockchain technology, its features, and potential applications in the education sector (Jirgensons & Kapenieks, 2018; Fernando et al., 2020; Fedorova & Skoblev, 2022a, 2022b). The Design Science Research Methodology (DSRM) was adopted to structure the research process (R. Umar et al., 2021), focusing on developing an innovative solution that addresses limitations in existing systems (U. Subagyo & F. Santoso, 2022)

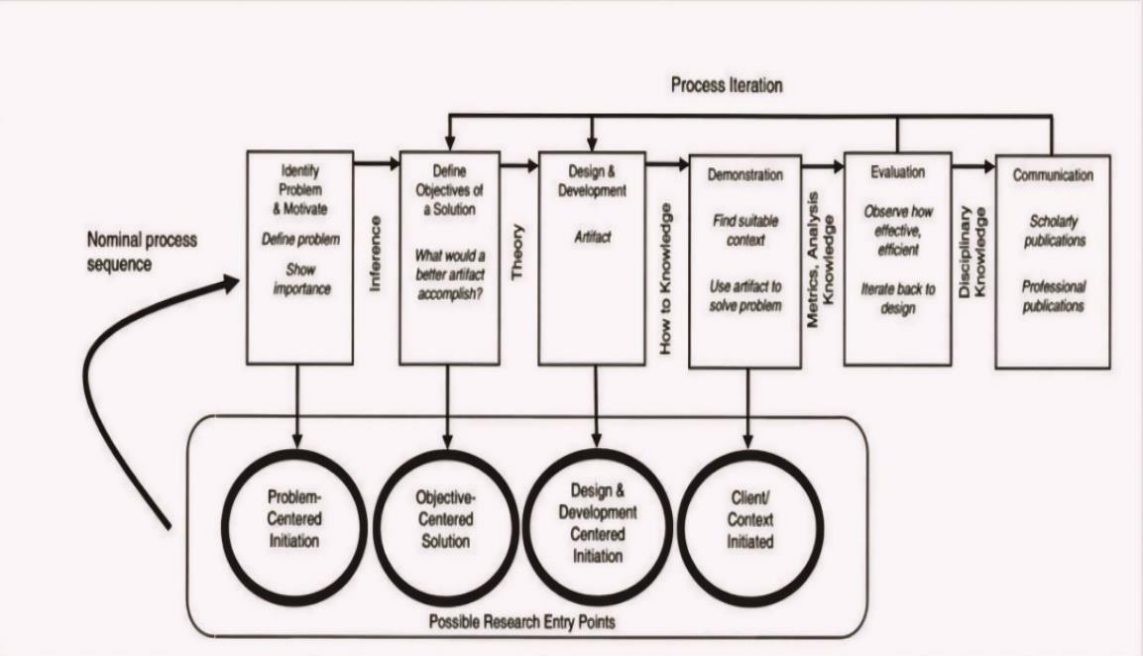


Figure 1. DSR Methodology Process Model
Sumber: Jan vom Brocke, Alan Hevner, Alexander Maedche (2020)

1. Identify problems and motivations

This activity defines the research problem and justifies the value of the solution. Justifying the value of a solution accomplishes two things: motivating the researcher and the research audience to pursue the solution and helping the audience appreciate the researcher's understanding of the problem. The resources required for this activity include knowledge of the status of the problem and the importance of its solution.

2. Setting solution goals

The goal of the solution can be inferred from the definition of the problem and knowledge of what is possible and feasible. Goals can be quantitative, for example, terms that state that the desired solution will be better than the current solution, or qualitative, for example, a description of how a new artifact is expected to support a solution to a problem that has not been addressed before. The goal should be rationally inferred from the problem specification.

3. Design and development

An artifact is created. Conceptually, DSR artifacts can be designed objects in which research contributions are embedded in the design. This activity involves determining the functionality of the desired artifact and its architecture, and then creating the actual artifact.

4. Demonstration

This activity shows the use of artifacts to solve one or more example problems. This can involve its use in experiments, simulations, case studies, proofs, or other appropriate activities.

5. Evaluation

Evaluation measures how well the artifact supports a solution to the problem. This activity involves comparing the objectives of the solution with the results of the actual observed from the use of artifacts in context. Depending on the nature of the problem place and the artifact, the evaluation can take many forms. At the end of this activity, the researcher can decide whether to return to the third step to try to improve the effectiveness of the artifact or proceed to communication and submit further improvements to the next project.

6. Communication

All aspects of the problem and the designed artifacts are communicated to the relevant stakeholders. The exact form of communication used depends on the purpose of the research and the audience, such as professional practitioners.

**Design and Development**

**1. Blockchain Architecture Design**

The design proposed by the author is in the form of a theoretical prototype where there must be shortcomings in every detail proposed. Next, the author wants to create a basic node that will later be used as a transaction block of the node type itself divided into 3: Node types based on roles can be categorized into:

1. Node Admin institusi:
    1. Read/write basic information notes without detailed information from students and staff members of darmajaya.
    2. Read/write student payment information.
    3. Read/write institutional rule settings such as removing or adding backup admins, etc. This rule setting governs the block chain.

2. Create a block.
    1. Node Admin Staff IIB Darmajaya:
    2. Read/write student payment information.
    3. Read payment information.

Next, the author will create transactional data because each design provides a ledger-based system. The author focuses on transactional data as the most important data. The transaction lifecycle begins when a node makes a request to write a transaction. The sending node undergoes the following steps:

1. The sending node creates a transaction token (T) that represents the new transaction. It digitally signs transactions using a set private key. Then send it to the full node.
2. A full node authenticates the received transaction using the public key of the sending node and accepts it if valid data is found.
3. A complete node that has a complete list of blocks, tries to add transactions to the selected block.
4. The block version is incremented.

The modified block is still unconfirmed until the consensus protocol completes its task. For example, if a transaction is sent through node A, it must be verified by the nearest full node as per the rules. Node A will only accept users with security privileges that are precisely to change the sign according to its role type. Then the nearest full node will check for higher-level rules such as value submission deadlines. The verified block will then be published to other node peers to confirm and accept its validity. If it receives the block, then it is deployed to the blockchain.

Each transaction contains information that identifies the creation node and the creation time. Each block has a cryptographic hash of the previous block, and the other blocks have transaction data. In this way, the records of data posted on the blockchain cannot be changed once a consensus has been reached.

On the registration of a new node, a key pair is generated using a public encryption key algorithm for privacy considerations. Then users can start adding transactions using the private key received by the blockchain. Fake nodes/accounts will never be able to add transactions because the private key will never match any public key stored on the

blockchain. The new node can then request to publish the transaction into the blockchain network. The private key can also be used as a node identifier such as the IP on the network.

Step 1: Setting the registration key of staff members or students on the blockchain, authorized users need to set their nodes with private keys in order to be accepted on the blockchain. Whenever an authorized user wants to operate a block of data, a registration private key is required to sign an outgoing transaction, this key is authorized to read, add or update the data.

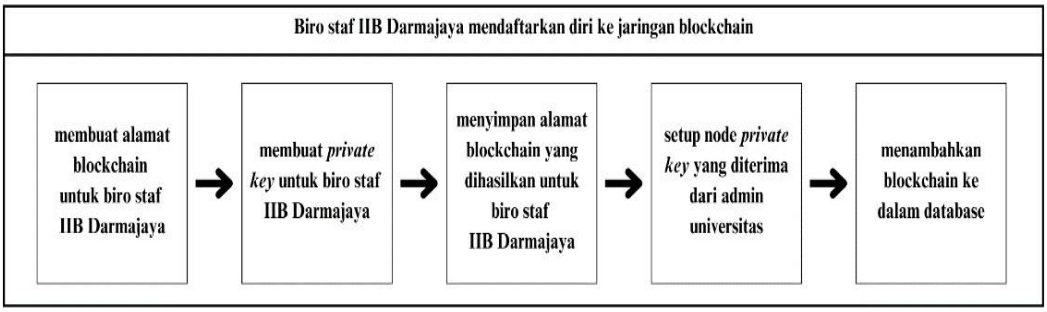


Figure 2. User/staff register for the blockchain network

Step 2: A transaction can be accepted using the protocol on the nearest full node

1. Decryption of incoming transaction requests uses the public key for the sender node requesting the transaction. If a valid request is received, proceed.
2. Add transactions to the list of transactions and count a new node stating all the list of transactions in the current block. The transaction is added to the new node.
3. The transaction token can be a registered code.
4. The sender's lightweight node performs first-level verification by only accepting authorized requests according to the security level rules embedded in it. For example, a staff member is not authorized to change his or her student payment information.

**The verification process will involve two steps:**

Decrypts each transaction using the sender's public key. For that purpose, a hash table that maps each node's address to its public key is stored in the header of the transaction list. If the transaction is in the transaction list, then proceed.

Use the decrypted transaction token to build a new node. If the same hash value is calculated, then a valid block is signaled and broadcast.

If the request that comes in accordance with the university's global rules such as submitting the application within the deadline, then go ahead.

Calculate the hash value of all the request block tokens on the blockchain via hash token =h(hash token$_1$, hash token$_2$,..., hash tokenI).

If the hash value of the requested block is the same as the hash value of the requested block, it means that the user can be authorized to access the data in question, otherwise the full node must deny the access request.

The current version of the block is increasing.

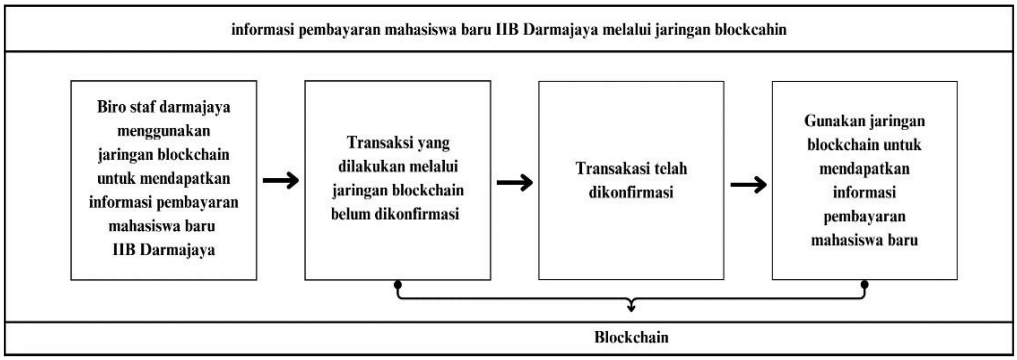


Figure 3. User/staff using a verified blockchain network

Step 3: The result is a validated blockchain and added to the database. The implementation of blockchain design is carried out using blockchain networks and databases. All transactions store information in a blockchain system that cannot be changed or deleted.

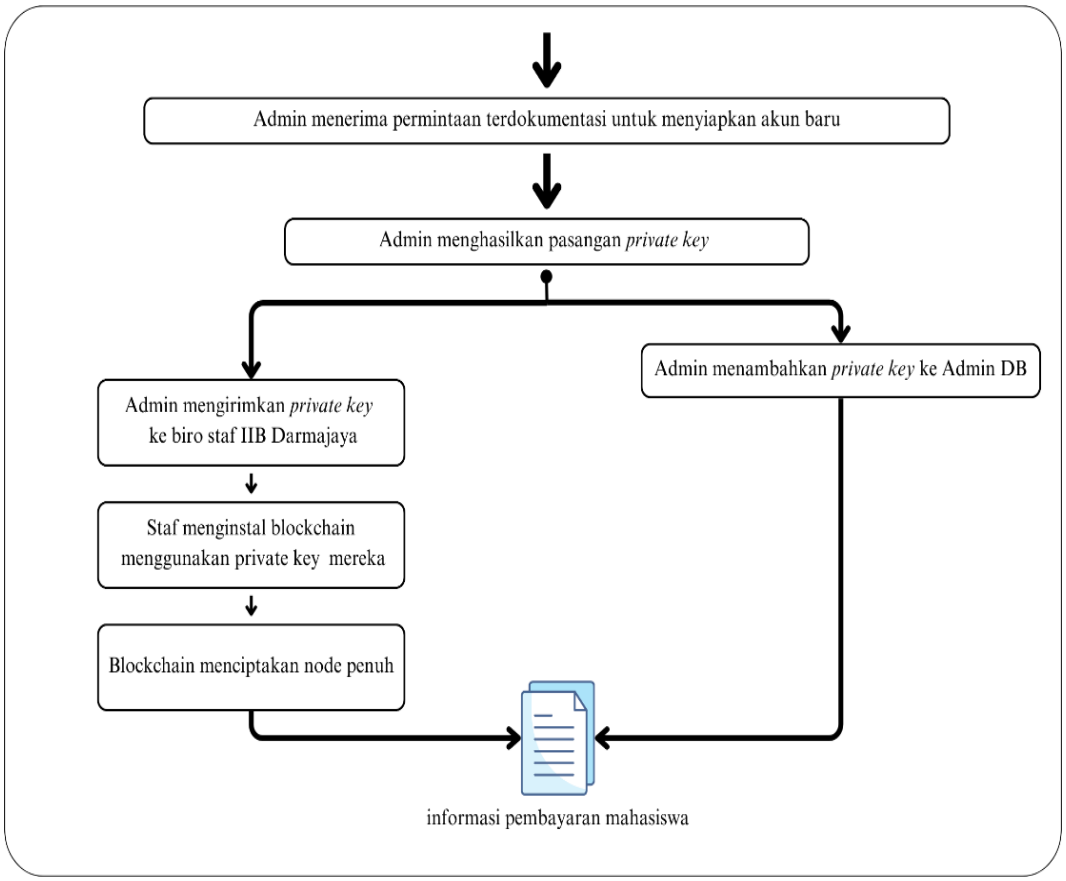


Figure 4. Node activity diagram for IIB Darmajaya User/staff

**Blockchain Architecture Development**

The study uses a hybrid blockchain model, which combines the power of public and private blockchains to meet the specific needs of IIB Darmajaya new students' payment information. Public components built on top of Ethereum allow the use of mature smart contract functionality to manage transparent processes such as application tracking and decision auditing.

Meanwhile, Hyperledger Fabric was chosen because of its personal components due to its improved performance and privacy features, suitable for handling sensitive student information and internal administrative processes. This design ensures a balanced approach, leveraging Ethereum's community and developer support, as well as Hyperledger's modularity and enterprise-level capabilities (Chen et al., 2018; Sun et al., 2018).

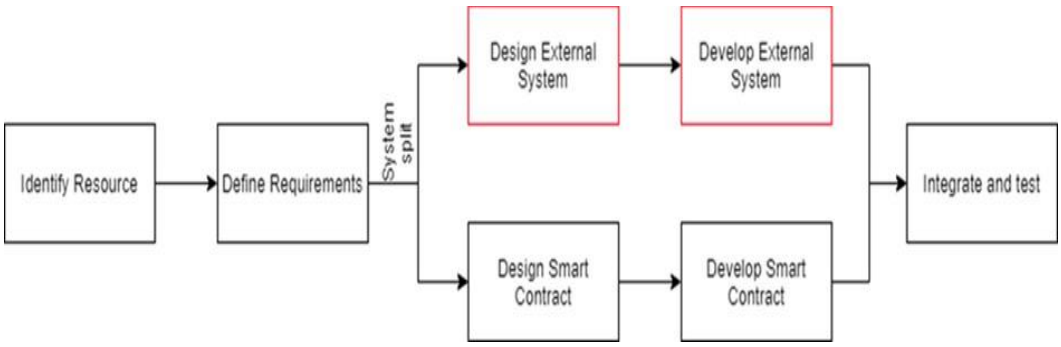


Figure 5 System Development Methodology

## 4. RESULTS AND DISCUSSION

**Blockchain Architecture Design Explaination**

This stage contains the design design that will be discussed in the previous chapter, and to find out whether the design built can meet the information needs and can produce outputs according to the user's desired goals.

Before continuing the next discussion, the author would like to inform that IIB Darmajaya user database/staff bureau has been created by the institution admin and the student payment information database is already in the campus database so that the next explanation is the theoretical discussion that the author has outlined in the previous chapter.

This explanation is a blockchain architecture design design to obtain payment information for new students of IIB Darmajaya whose information can be seen by other agencies at IIB Darmajaya in addition to the finance department, because this design design is made on where if a payment information is needed quickly so that it does not go through finance to check the payment information of new students of IIB Darmajaya.

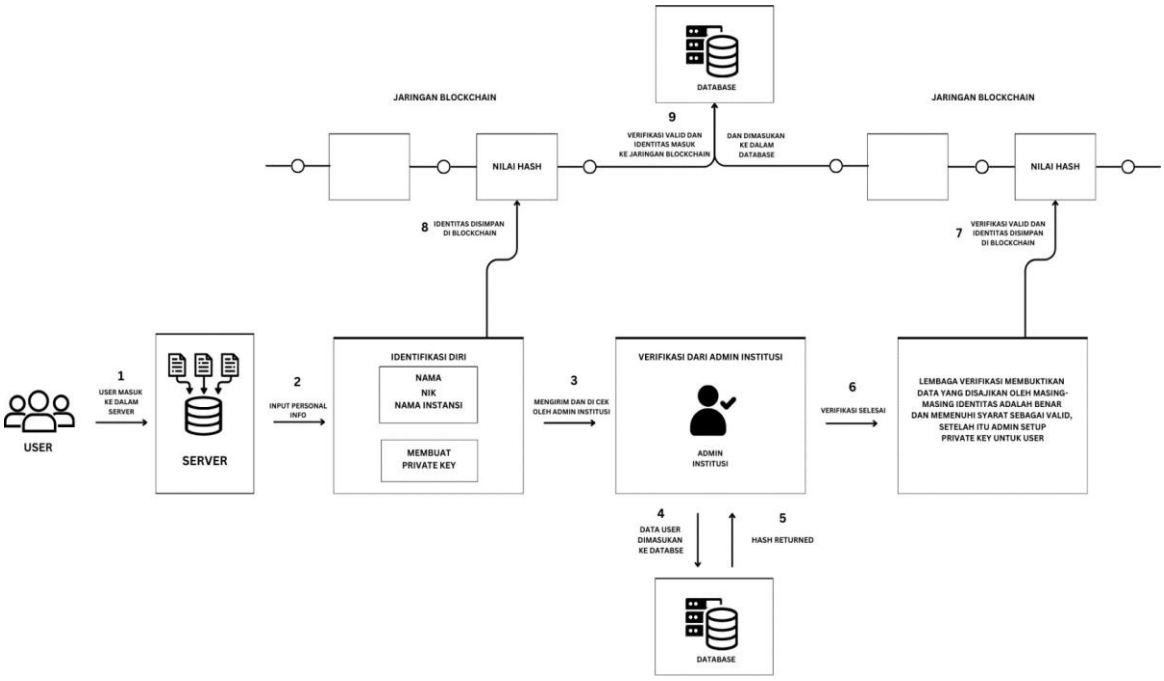


Figure 6. User verification architecture to enter the blockchain network

At this stage, where the user/bureau of Darmajaya staff who is trusted to register to the blockchain network and create a private key which aims to determine whether the user/bureau of staff is a staff registered by the administrator of the institution through verification by the administrator of the institution.

Then, store the network of blockchain addresses generated from the registration carried out, then the private key received by the institution's admin will be taken which will then be processed at the next stage. After the entire verification process has been completed and the registration of the blockchain network is added to the institution's database, the next stage is how to get the payment information file for new students of IIB Darmajaya.

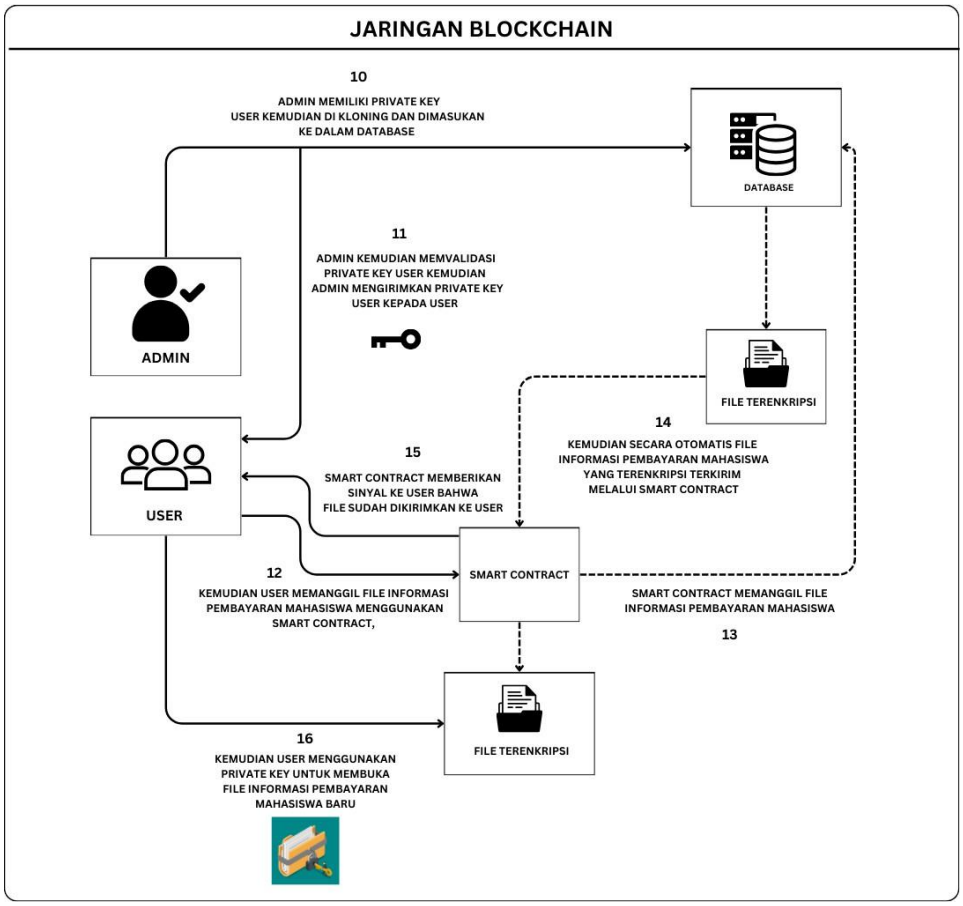


Figure 7. Blockchain architecture to obtain student payment information files

At this stage, the institutional admin has a private key user which is then cloned and then the private key is entered into the database and sent back to the user, namely the IIB Darmajaya staff bureau. Users or staff can use the blockchain network to make transactions, after confirmation, the staff can use the blockchain network to get payment information for new students of IIB Darmajaya.

Before that, there is a stage to get a student payment information file where the staff as a user calls the student payment information file from the database through the smart contract network, then automatically the encrypted student payment information file is sent back to the user through the smart contract network, which the user can then use private key to view student payment.

## 5. CONCLUSION

The conclusion of this study is that the design of this blockchain architecture was made to make it easier for institutions and students if there is a problem such as needing payment information data for new students of IIB Darmajaya. This study is still lacking because this study relies on theoretical studies using qualitative research methods and this study has also not been able to conduct direct trials using existing tools).

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