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Blockchain Technology in Donation-Based Crowdfunding Systems

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ABSTRACT

This study discusses the limitations of conventional crowdfunding systems, such as lack of transparency, dependence on intermediaries, risk of fund misuse and fraudulent campaigns, and high operational costs that reduce public trust. It successfully designs and develops a blockchain-based crowdfunding system using Base, and implements secure authentication through wallet addresses as the primary user identity. This system supports key features such as campaign creation, donations, and fund withdrawals. Campaign creation allows users to set fundraising targets and deadlines, donations are recorded directly on the blockchain to ensure transparency, and fund withdrawals can only be made by the campaign owner after certain conditions are met. The implementation of smart contracts plays a vital role in ensuring that all transactions are transparent, secure, and accountable. Additionally, this system effectively eliminates the need for intermediaries, which are commonly found on conventional platforms, by replacing the role of fund escrow through smart contracts. As a result, this system no longer requires high administrative fees, but instead relies on much lower fixed gas fees. This approach increases public trust, reduces operational costs, and strengthens accountability in donation management through a decentralized and tamper-proof system. As a direction for future development, this system can be expanded through multi-blockchain integration and broader support for popular digital assets to increase user reach, donation flexibility, and overall platform resilience.

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1. INTRODUCTION

Rapid technological advancements over the past few decades have driven significant transformations in the business sector, including the shift of financial services from conventional systems towards digitalization [1][2]. Technological developments have created new opportunities in fundraising mechanisms, particularly through crowdfunding platforms.

Although not a new concept, technological progress, especially in fintech, has increased the ease, attractiveness, and effectiveness of fundraising processes by providing faster, more flexible, and wider access [3]. However, conventional crowdfunding systems still face several challenges, such as lack of transparency, potential misuse of funds, and high administrative costs [4], which often range between 3-12% [5]. Moreover, reliance on intermediaries in conventional systems increases the risk of fund misappropriation [6].

Weaknesses in conventional donation management systems have been demonstrated through several real cases, such as the Cak Budi case in May 2017, which highlighted poor oversight of funds that were not managed through official platforms. In this case, the donated funds used did not originate from the Kitabisa.com platform but were transferred directly to personal bank accounts, thus remaining unmonitored by the system. This condition shows the importance of adopting more transparent and decentralized systems, such as blockchain-based crowdfunding, which enables every transaction to be publicly audited and difficult to manipulate, thereby increasing accountability and donor trust.

To address these challenges, a technological approach that guarantees transparency and security is required, one of which is blockchain [5]. Blockchain is a distributed ledger system that documents all participant activities without the involvement of trusted third parties [7][8]. Each node in the blockchain network stores an identical copy of the ledger, with records tracking the amount of funds used by each node. This information is permanently stored on the blockchain [8][9]. By implementing blockchain technology, problems related to transparency and additional costs in fundraising can be overcome. This technology enables decentralized and transparent transaction recording, preventing data manipulation and providing open access to the public [5].

One of the main features of blockchain technology is the use of *smart contracts*. A *smart contract* refers to a digital agreement programmed to be executed automatically when certain predefined conditions are met, without requiring third-party intervention [10][11][12] . This feature can be used to automate and regulate the fundraising process more efficiently, which in turn strengthens accountability and transparency in fund management. Through the use of *smart contracts*, every donation will be permanently recorded in the system, so all transactions are clearly documented and can be verified by all parties involved [13].

Based on previous research [14] the application of blockchain technology in zakat management can overcome issues of trust and transparency. In the context of conventional systems, zakat institutions in Malaysia have faced dissatisfaction from *muzakki* (zakat payers) concerning the lack of transparency in fund distribution. Through blockchain, every transaction is recorded in a distributed ledger that is permanent, immutable, and accessible to all parties. The use of *smart contracts* also automates processes according to established regulations, thereby reducing reliance on intermediaries and minimizing the potential for fund misuse. Thus, this technology has the potential to strengthen accountability and restore public trust in zakat institutions.

The utilization of blockchain technology in crowdfunding promotes transparency, accountability, and efficiency, thereby building trust between donors and fundraisers. With *smart contracts*, the fundraising and fund disbursement processes can operate automatically, quickly, and accurately. This technology serves as an innovative solution to conventional systems and encourages public participation in philanthropy, especially social assistance. Based on these advantages, this study analyzes the role of Base blockchain in creating a fully transparent and auditable donation system, implementing *smart contracts* to automate the donation and fund distribution process without third-party intervention, and evaluating cost efficiency compared to conventional platforms.

2. RESEARCH METHOD

2.1 System Development Method

The Prototyping Method is an approach in software development that begins with the system requirements gathering stage (requirement analysis), aiming to assist developers in understanding and visualizing the initial system idea through the creation of a simple prototype. According to Pressman, the stages in this method include requirement analysis, quick design, prototyping, and evaluation and refinement, which are performed iteratively until the resulting system meets user needs [15]. These research stages are illustrated in figure 1.

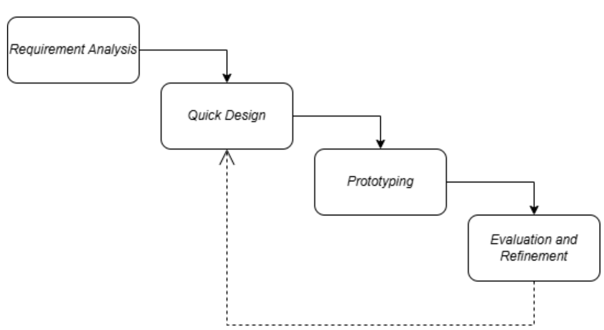

Figure 1. Diagram prototype

2.2 Analysis and Design

2.2.1 Requirement Analysis

This stage aims to identify and analyze what the system needs to achieve by gathering relevant information from users and understanding the context in which the system will operate. The results of this phase serve as a foundation for developing the initial design, ensuring that the final product meets user expectations and project goals.

2.2.2 Quick Design

Based on the analysis results, initial designs were developed, including the application structure, database schema, and user interface layout. These preliminary designs provide a foundational overview that guides the development process before moving into the prototyping stage.

2.2.3 Prototyping

Building upon the initial designs, this stage focuses on developing a working prototype that highlights the system's main features and functions. The prototype facilitates early user interaction, allowing developers to gather valuable feedback and validate system requirements. This iterative approach helps identify necessary adjustments before advancing to full system development.

2.2.4 Evaluation and Refinement

Following prototyping, the system undergoes thorough evaluation to identify any deficiencies or inconsistencies. Feedback collected during this phase serves as a critical basis for ongoing improvements and refinements. By addressing observed issues iteratively, developers enhance the design to ensure the final system effectively meets both functional and usability requirements.

2.2.5 System Implementation

The proposed system is implemented using *JavaScript* and *Solidity* as the main programming languages. *Smart contracts* are developed and implemented on the Base blockchain network using the *Remix* development environment. The frontend application is built with *React* to provide an interactive user interface integrated with Web3 wallet authentication, while the backend services are handled using *Node.js*. System data related to campaigns and transactions is primarily stored on the blockchain to ensure transparency and immutability. In addition, an off-chain *PostgreSQL* database is used to manage additional application data that does not require on-chain storage.

3. RESULTS AND DISCUSSION

3.1. System Requirement Analysis

In this project, the author develops a web application intended for use by multiple users. The system is designed with specific roles and activities, which are described as follows.

3.1.1. Donor

Donors play a crucial role as active participants in the fundraising ecosystem. After logging into the platform, donors can browse and select specific campaigns they wish to support. They can then send donations directly through the platform and continuously monitor the transparency of fund usage to ensure accountability. Additionally, donors have the capability to create their own campaigns by providing clear descriptions and objectives, enabling them to initiate fundraising activities for causes they care about

3.1.2. Campaign Owner

Campaign owners are users who create and manage fundraising campaigns. After logging in, they can submit campaign proposals with clear descriptions and funding goals. They are also responsible for ensuring transparency by monitoring the use of funds collected through their campaigns. This role allows individuals or organizations to initiate and oversee fundraising activities in a trustworthy and accountable manner.

3.1.3. Admin

Admins are responsible for maintaining the platform's integrity and quality. Their duties include monitoring all campaigns submitted by users to ensure compliance with platform guidelines and standards. Based on their evaluation, admins can approve campaigns for publication and deployment or reject those that fail to meet the required criteria. This oversight ensures a trustworthy and well-regulated fundraising environment.

3.1.4. Guest

Guests access the platform without registering or logging in and have limited privileges compared to registered users. Their main role is to view the list of available campaigns, allowing them to explore ongoing fundraising initiatives and understand each campaign's purpose. This exposure may encourage guests to register and participate as donors or campaign creators in the future.

3.2. Quick Design

3.2.1. System Design

At this stage, the results of the system analysis are translated into *Unified Modeling Language (UML)* modeling, which includes the *Use Case Diagram*. The modeling results are presented as follows.

3.2.1.1. Use Case Diagram

Use Case Diagram is used to illustrate the interactions between actors and the developed system [16]. Figure 2 below shows the three main actors involved: Admin, User, and Guest.

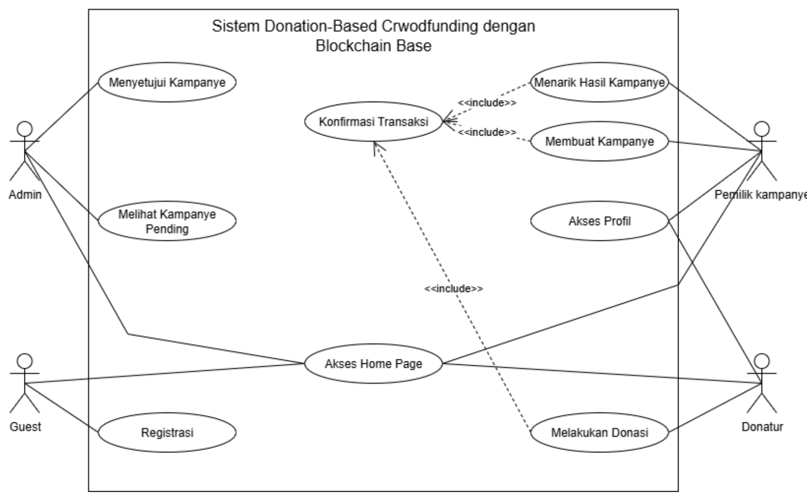

Figure 2. Use case diagram

3.2.1.2. Component Diagram

The *component diagram* presents a four-layer architecture consisting of the client layer, backend layer, blockchain layer, and data layer. Each layer has a distinct role in handling user interaction, application logic, *smart contract* execution, and off-chain data storage, ensuring a modular and well-structured system. Figure 3 illustrates the component layer structure in the system design.

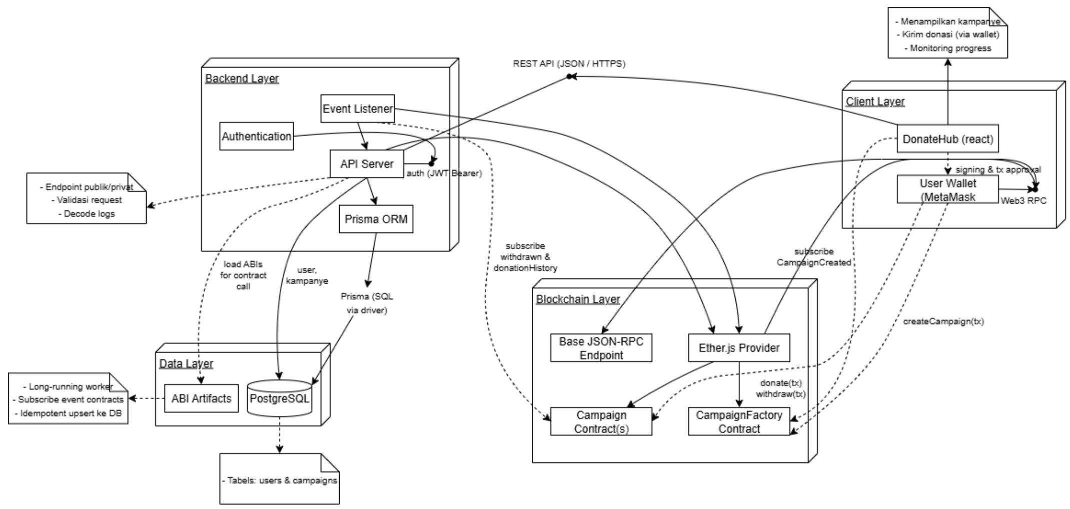

Figure 3. Component diagram

3.2.2. Database Design

The database design in this final project consists of two main tables, namely users and campaigns. The users table has a one-to-many relationship with the campaigns table. The *Entity Relationship Diagram (ERD)* in figure 3 illustrates the design of the system's database as presented below:

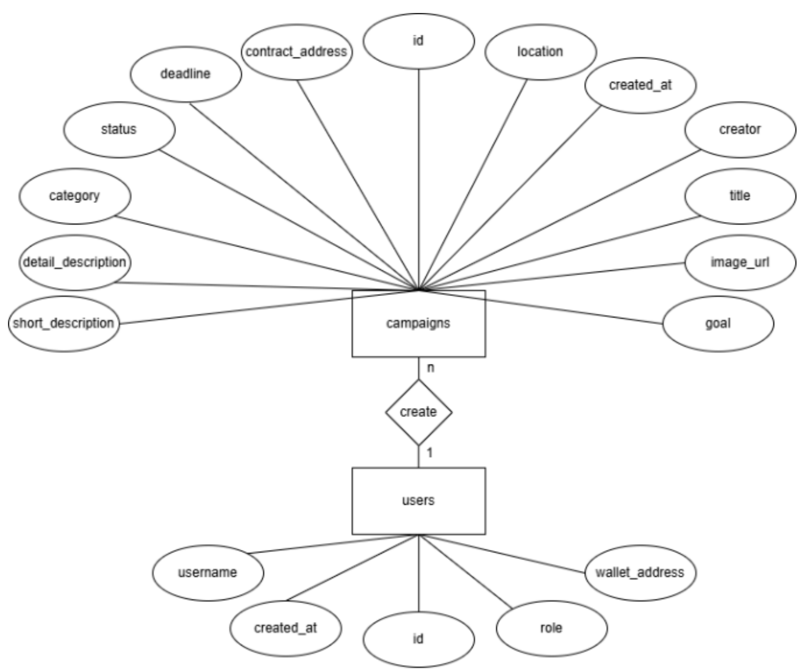

Figure 4. Database design

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3.3. Prototyping

3.3.1. Registration Page

The user registers by entering a username and connecting their *MetaMask* wallet. As shown in figure 4, clicking the Register button triggers a *MetaMask* popup for digital signature verification.

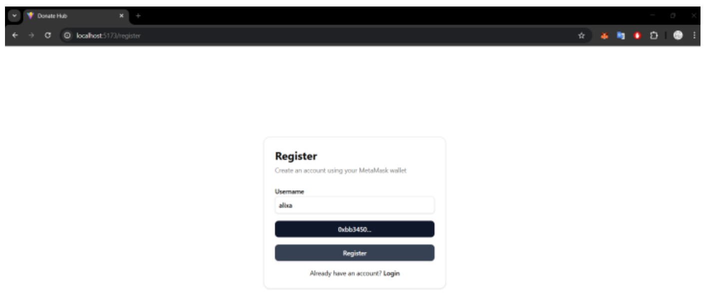

Figure 5. Registration page

3.3.2. Login Page

The user logs in by clicking the Connect with MetaMask button to retrieve the wallet address and verify their identity via digital signature. As illustrated in figure 5, successful authentication redirects the user to the main page.

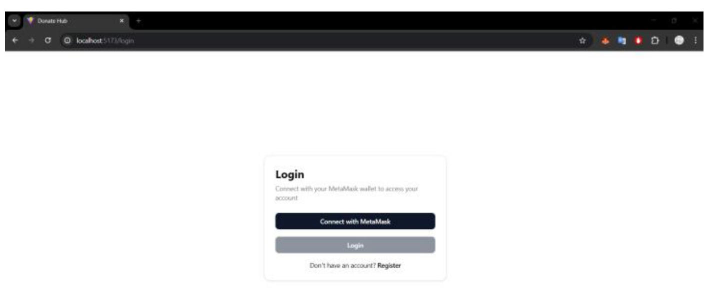

Figure 6. Login page

3.3.3. Main Page

The main page, illustrated in figure 6, displays a navbar and a list of active campaigns presented as cards containing key information and a Donate Now button. It is accessible to all visitors without requiring login.

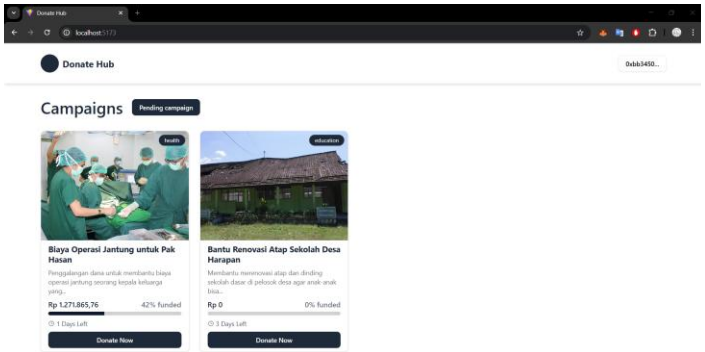

Figure 7. Main page

3.3.4. Campaign Detail Page

This page displays the selected campaign's details, including photos, description, location, list of donors, and donation features similar to the main page, are shown in figure 7.

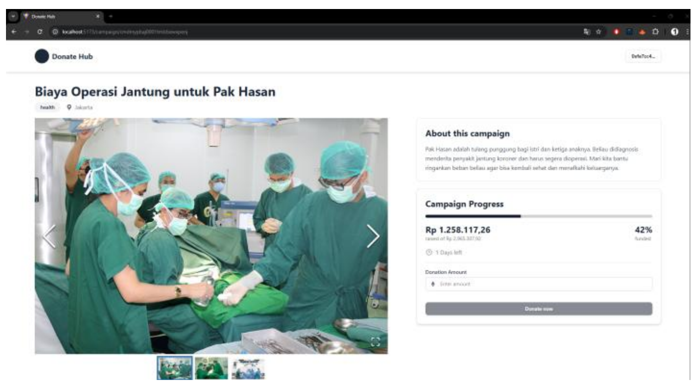

Figure 8. Campaign detail page

3.3.5. Campaign Creation Page

Users can create a new campaign by filling in the required details. As depicted in figure 8, once the user clicks the Submit Campaign button, the campaign data is stored in the database and awaits review from an admin.

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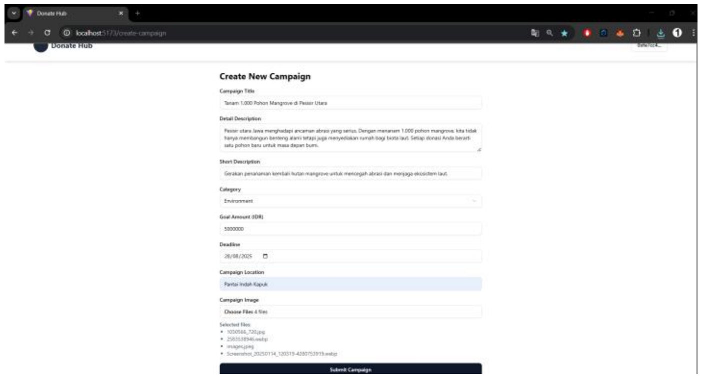

Figure 9. Campaign creation page

3.3.6. Pending Campaigns Page

Admins use the pending campaigns page, seen in figure 9, to review submitted campaigns. They can either approve or reject each submission. Once approved, the campaign status is updated and the user can proceed with deployment.

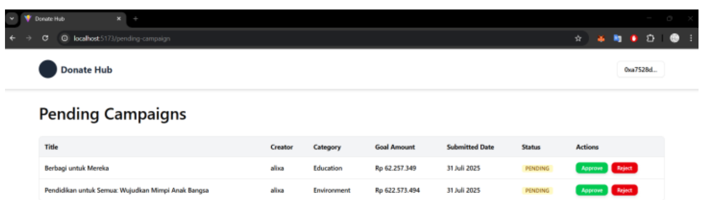

Figure 10. Pending campaigns page

3.3.7. Profile Page

This page displays detailed information of the logged-in user, including profile data such as name, wallet address, join date, total donations, and deployed campaigns on the left side. On the right side, there are two main tabs: My Campaigns, showing the list of campaigns created by the user along with their statuses (as shown in figure 10), and Donation History, containing the user's donation records (as shown in figure 11).

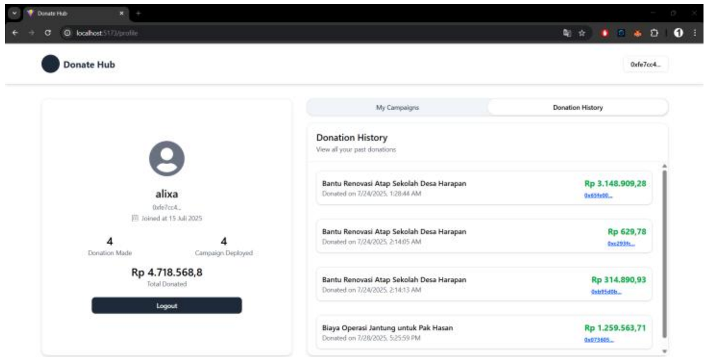

Figure 11. Profile page (tab donation history)

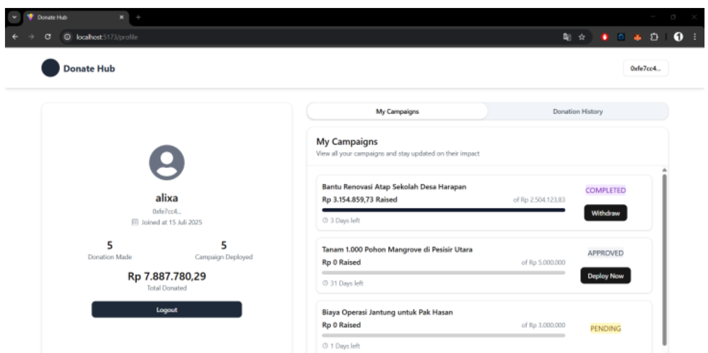

Figure 12. Profile page (tab my campaigns)

3.4. System Testing

Testing was conducted on seven main application pages, each with 3 to 5 test scenarios. All scenarios produced results as expected, indicating the application runs stably and all main features function according to specifications. The tested features include:

- Authentication (Donor, Campaign Owner, Admin)
- Campaign creation
- Campaign approval (Admin)
- Campaign deployment
- Donation process
- Campaign fund withdrawal

Gas fee testing was performed to determine the transaction costs incurred by users when interacting with the *smart contract*. The ETH value was calculated using an exchange rate of 1 ETH = IDR 63,000,000. The testing results per feature are as follows:

- Campaign Deployment: 0.0000641–0.0000698 ETH or equivalent to IDR 4,038 – 4,397
- Donation: 0.000002 – 0.0000034 ETH or equivalent to IDR 132 – 176
- Withdrawal: 0.0000014 ETH or equivalent to IDR 88

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3.5. Discussion

The result of this research is a functional web application adopting a hybrid architecture, combining blockchain technology with conventional web systems to achieve efficiency and reliability. Based on testing results, core principles of blockchain technology such as decentralization, transparency, and immutability were successfully implemented in the system. This implementation demonstrates that the approach can meet the needs for an open and trustworthy donation system.

All transaction activities, from campaign initiation, donation contributions, to fund withdrawals, are permanently recorded on the blockchain and can be publicly verified via a block explorer using transaction hashes. This level of openness enhances accountability and significantly reduces the risk of fund misuse commonly found in conventional donation systems.

Figure 13. *On-chain* campaign detailed data

As shown in figure 12, system transparency is reinforced by storing critical campaign data *on-chain*, including owner address, title, donation target, deadline, and total funds raised. The *smart contract* also logs withdrawal events as proof of fund disbursement. With logic ensuring funds can only be withdrawn when conditions are met, the entire process is publicly verifiable, thereby establishing strong accountability and preventing fund misuse.

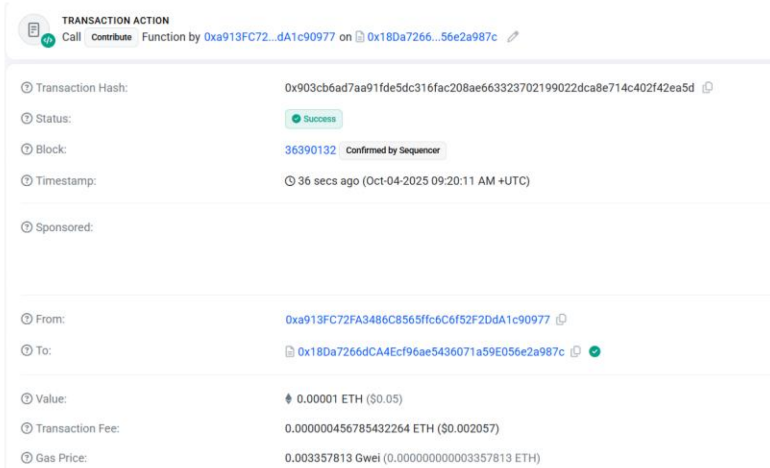

Figure 14. Example of transaction details

Figure 13 shows the donation transaction details via the block explorer, including the sender's address, the recipient *smart contract* address, and a donation amount of 10 ETH. This information is public and permanent, allowing anyone to verify the flow of funds directly. Such accessibility enables donors to track their contributions, thereby enhancing system trust and accountability.

In addition to transparency, the system eliminates the need for intermediaries typically present in conventional crowdfunding platforms, which usually act as fund custodians. This role is replaced by *smart contracts* that automatically enforce fund withdrawal rules, allowing only legitimate campaign owners to withdraw funds after meeting the target or deadline. This creates a trustless system where certainty is guaranteed by the protocol rather than an institution. Moreover, this approach is more cost-efficient. Compared to conventional platforms that charge 5–10% of total donations as fees, this system only requires fixed *gas fees*, with average costs from testing approximately Rp 4,158 for campaign deployment, Rp 154 for donations, and Rp 88 for fund withdrawals, based on a conversion rate of 1 ETH = Rp 63,000,000, as shown in Table 3 below.

Table 1. Comparison of estimated costs: blockchain platform vs. traditional platform

Campaign Scenario (Funding target)	Traditional Platform Fee (5%)	Traditional Platform Fee (10%)	Blockchain Platform Fee (Estimate, 200 Donors)
Rp 10,000,000	Rp 500,000	Rp 1,000,000	Rp 4,158 (Deploy) + (200 x Rp 154) + Rp 88 (Withdraw) = Rp 30,690
Rp 100,000,000	Rp 5,000,000	Rp 10,000,000	Rp 4,158 (Deploy) + (200 x Rp 154) + Rp 88 (Withdraw) = Rp 30,690

From a quantitative perspective, the blockchain-based platform demonstrates substantial percentage savings compared to conventional crowdfunding services. For a funding target of Rp 10,000,000, the total blockchain operational cost of Rp 30,690 corresponds to approximately 93.9% savings compared to a 5% platform fee and 96.9%

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savings compared to a 10% fee. For a Rp 100,000,000 campaign, the same operational cost results in approximately 99.4%–99.7% savings, since blockchain expenses remain nearly constant regardless of the fundraising scale, based on the system testing conducted. These comparative values are derived from the cost simulation presented in Table 3, which highlights the widening efficiency gap as the funding target increases. This indicates that the economic efficiency of the system increases proportionally with higher funding targets, making blockchain-based crowdfunding significantly more cost-effective than traditional intermediary platforms.

4. CONCLUSION

This research successfully designed and developed a blockchain-based crowdfunding system on the *Base* network with secure authentication using wallet addresses as the primary identity. The system supports key features such as campaign creation, donations, and fund withdrawals. Campaign creation allows for the setting of targets and deadlines, donations are recorded directly on the blockchain to ensure transparency, and fund withdrawals can only be performed by the campaign owner after the requirements are met. The implementation of *smart contracts* plays a crucial role in ensuring transparent, secure, and accountable transactions.

In addition to ensuring transparency, this system effectively eliminates the need for intermediaries common to conventional platforms. By replacing the role of fund custodians through *smart contracts*, the system no longer requires high administrative fees, but only incurs a fixed *gas fee* that is significantly lower.

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