JURNAL TIMES
TECHNOLOGY INFORMATICS & COMPUTER SYSTEM

Volume XIII No 2, Desember 2024
*p*ISSN : 2337 – 3601
*e*ISSN : 2549 – 015X

Tersedia *online* di http://ejournal.stmik-time.ac.id

THE IMPLEMENTATION OF BLOCKCHAIN SYSTEM IN VEHICLE REGISTRATION CERTIFICATE (BPKB) DATA BASED ON A WEBSITE

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Abstract
The Vehicle Registration Certificate (STNK) and the Vehicle Ownership Document (BPKB) are crucial documents for identifying and proving vehicle ownership. Without a BPKB, verifying the legitimacy of a vehicle becomes difficult, potentially rendering it illegal and increasing the risk of it being classified as stolen. The process of verifying a BPKB at the central office involves lengthy and time-consuming procedures, complicating the process. The lack of efficient methods for verifying vehicle documents can lead to the production of counterfeit documents by unauthorized parties. This research proposes the development of a secure and easily traceable web application utilizing Ethereum blockchain technology. The application employs Ethereum blockchain architecture and MetaMask as a digital wallet for transactions and login, along with JavaScript, HTML, and CSS for the front end. This solution aims to streamline the verification process, enhance document security, and prevent the circulation of fraudulent vehicle documents. With this system, vehicle document verification becomes faster and more efficient. Blockchain ensures that every transaction and document is securely recorded and immutable, reducing the risk of forgery. MetaMask provides additional security, while modern web technologies ensure the application is user-friendly. This solution strengthens vehicle document security and simplifies the verification process.
Keywords : Blockchain, BPKB, Ethereum, MetaMask, JavaScript, Html, CSS.

1. Introduction

Criminal activities involving motor vehicles are a serious problem that often occurs worldwide, including in Indonesia. Handling cases of fraud, traffic violations, document forgery, and motor vehicle-related criminal activities is often challenging due to the difficulty of tracing the ownership history of motor vehicles. In the Yogyakarta province alone, data shows that there have been 1,011 reported cases of motor vehicle theft in the past five years [1]. According to data from Robinopsnal Bareskrim Polri, the Indonesian National Police's Criminal Investigation Bureau, 766 motor vehicle theft cases were handled by the police from May 1 to May 24, [2]. With such a high number of cases, it is not surprising that many motor vehicles circulate without proper documentation, including fake documents.

Vehicle documents are crucial for ensuring the legitimacy of circulating vehicles and preventing the use of counterfeit or fraudulent vehicles. However, in an interview conducted by Agung Kurniawan Basri and Adi Hermansyah with a Criminal Investigation Detective from the Langsa Police Resort, it was mentioned that several factors hinder the resolution of motor vehicle document forgery crimes. These factors include the lack of public understanding of fake Vehicle Registration Certificates (STNKB), insufficient diligence on the part of the police, and criminal networks. These obstacles are rooted in the lack of public awareness to verify the status of a vehicle before conducting a purchase transaction at the Vehicle Registration Office (SAMSAT), the lack of media for checking the authenticity of a vehicle document, and the prevalence of illegal document producers [3].

Considering these challenges, blockchain technology can provide a solution. Blockchain can store data with a high level of complexity, making it difficult to manipulate data within a system and easy to trace information from a document. This can facilitate law enforcement agencies and civilians in tracking vehicle information without cumbersome procedures, thereby preventing civilians from purchasing vehicles with fake or manipulated documents. Blockchain can serve as a trusted and easily traceable platform, providing promising security.

Blockchain is a distributed database system that employs autonomous nodes for the storage and retrieval of data. Instead of relying on a central authority, blockchain databases operate across a global network of voluntary nodes. This means that no single entity has control over either the data or the network. Every transaction is logged, easily accessible, and completely transparent. Blockchains use a structured data storage format. Each data set, referred to as a "block", accommodates a specific amount of information. Once a block reaches its capacity, it links to prior and subsequent blocks, effectively creating a chain of blocks, hence the name "blockchain". These

filled blocks act as a permanent record of data, each having a distinct timestamp, and they remain linked to the wider network indefinitely [4].

This research involves the development of a website that stores vehicle ownership documents (BPKB) information using blockchain technology to facilitate easy access and registration of motor vehicle ownership, particularly for the public and law enforcement agencies as the user of the application and for the Vehicle Registration Office (SAMSAT) to become the admin which in charge for create and update all the data that related for the vehicle documents. The website's design utilizes Solidity programming language to create a smart contract on the Ethereum blockchain, and it uses MetaMask as a digital Ethereum wallet. The website to be created will be simple, ensuring that it can be understood and used by people of all age groups that owned a vehicle.

2. Literature Review

Blockchain

Blockchain is the cryptocurrency technology of Bitcoin. This technology was invented by "Satoshi Nakamoto" in 2008. Currently, blockchain has been implemented in many things, including digital identity, digital voting, and decentralized notaries. Simply put, blockchain can be described as a decentralized database, without trust between nodes in a peer-to-peer network [5].

BPKB

The BPKB (Buku Pemilik Kendaraan Bermotor) is a document issued by the Indonesian National Police Traffic Unit as proof of ownership of a motor vehicle. The purpose of registering and identifying motor vehicles through BPKB is for the implementation of tasks by the Indonesian National Police in creating public safety and order, particularly concerning investigations into violations and crimes related to motor vehicles. Additionally, as criminal activities become more sophisticated and complex, the Indonesian National Police needs to deploy all efforts to address these issues, including through the registration and identification of motor vehicles. Therefore, it is necessary to take steps to align perceptions and actions in the process of issuing BPKB, especially in the mechanisms and procedures involved in BPKB issuance [6].

Waterfall

The Waterfall model is a traditional software development methodology that follows a sequential and linear approach to software development. The Waterfall model is characterized by its sequential nature, where each phase must be completed before moving on to the next. While it offers clarity and structure, it can be less adaptable to changes that may arise during the development process [7].

Metamask

MetaMask is a popular cryptocurrency wallet and gateway to blockchain applications, primarily built for the Ethereum network. It operates as a browser extension or a mobile app, allowing users to manage their Ethereum accounts, interact with decentralized applications (dApps), and securely store their digital assets. MetaMask simplifies the process of accessing Ethereum-based services by providing a user-friendly interface and integrating seamlessly with web browsers like Chrome, Firefox, and Brave. Users can create multiple Ethereum accounts within MetaMask, each with its unique address for sending and receiving ether (ETH) and ERC-20 tokens [8].

Javascript

JavaScript is a versatile programming language primarily used for web development, enabling dynamic and interactive content on websites. Initially developed by Netscape, it has evolved into a fundamental tool for front-end and back-end development. JavaScript allows developers to manipulate webpage elements, handle user interactions, and dynamically update content without reloading the entire page. Its widespread adoption and extensive ecosystem of libraries and frameworks, such as React, Angular, and Vue.js, have made it a cornerstone of modern web development [9].

Html

HTML, or Hypertext Markup Language, is the standard markup language used to create web pages and applications by structuring content with elements like headings, paragraphs, links, and images. It serves as a foundational technology of the World Wide Web, working alongside CSS (Cascading Style Sheets) for layout and style, and JavaScript for interactivity. HTML elements, defined by tags, form the building blocks of web pages, allowing developers to organize and present content effectively [10].

CSS

CSS, or Cascading Style Sheets, is a stylesheet language used to describe the presentation of a document written in HTML or XML. It allows developers to control the layout, colors, fonts, and overall visual aesthetics of web pages, ensuring a consistent and attractive design across different devices and screen sizes. By separating content from design, CSS enables more flexible and maintainable web development [11].

3. Research Methods

Data

A. Primary Data

Primary data is collected through observation. Observation is carried out by observing how the vehicle is registered and what data will be required when registering the vehicle

B. Secondary data

Secondary data is collected through literature studies such as journals, articles, and from the internet during the research preparation process.

Research Stage

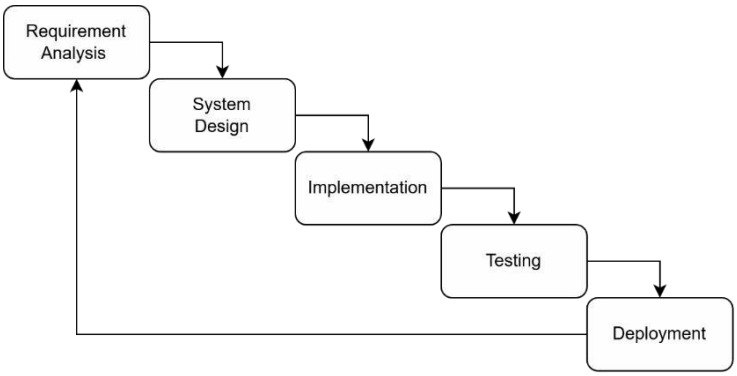

Figure 1. Research Stage Waterfall Method

The development of this BPKB blockchain website uses the Waterfall method, which consists of six stages: Requirements, System design, Implementation, Testing, Deployment, Maintenance. Here is an explanation of each stage adopted in this research:

Requirement Analysis

The first phase requirements for blockchain software are gathered and analyzed throughly. This includes program scenario to be created, functional and non functional requirement, and the data design.

System Design

In this phase, the system architecture and design are planned based on the gathered requirements. This includes defining UMLs diagram, designing the blockchain architecture, selecting the appropriate blockchain platform, designing the user interface for the website.

Implementation

With the design finalized, comes the development of the system. This involves code a logic in smart contracts for vehicle registration and ownership transfer into the blockchain using Solidity. The front-end of the website is developed using HTML, CSS, and JavaScript, integrating with the blockchain backend through APIs or Web3.js nd connecting the wallet into the JavaScript. Security measures such as encryption, authentication, and authorization mechanisms are implemented to ensure data integrity and user privacy.

Testing

Once the implementation is complete, the system undergoes rigorous testing to identify and fix any bugs or issues. Testing includes functional testing to ensure that all features from the smart contract work as expected, and some measurements that all the data is inside of blockchain.

Deployment

Once testing is successful, the software is deployed to local hosting, making it accessible to use with the UI website to make it easier to use also that makes somewhat close to what befitting to the finished product.

4. Result

Requirement analysis

A. System Analysis

Based on the observation with step by step on how to register and checking a BPKB. Both had the same method but, in this case, will be pointed at the checking for the vehicle information based on the BPKB because to solve the problem there is nothing wrong with the procedure with registering the vehicle that handling all the require document such as owner identification documents and the invoice of the vehicle that will be register. On the other hand, we can shorten the time we spend on to check the vehicle information that is already been registered by making a website that can be accessible for anytime that needed to check the information of the vehicle.

B. Functional Requirement and Nonfunctional Requirement

This software must fulfil some of the requirement either that for the functional and the nonfunctional requirement. As for the functional requirement there are some but not many that is:

Table 1. Functional Requirement

Requirement	Description
Login	User or admin can login to the website through a button
BPKB registration	Admin can store new vehicle data inside of the blockchain
Update Owner	Admin can update the current owner of the vehicle
Verification	Admin need to verify every transaction to store a data inside of the blockchain
Search and view record	User can search for the information of the vehicle and for the admin can search the data for the vehicle and the owner
Notification	Admin will get notification if the transaction is successful
Record immutability	Every transaction within the blockchain is recorded and cannot be change once it been recorded

And as for the non-functional requirement that is:

Table 2. Non-Functional Requirement

Parameter	Description
Availability	Can be access all the time or 24/7
Multiplatform	Can be access through multiple website
Security	All the data and transaction are encrypted
Usability	The website is easy to use and straight forward
Performance	The respond time for searching a data is not more than 10 second

C. Data Design

Table 3. Data Design

Field Name	Data Type	Description
NIK	uint256	citizen identification number serves as primary key
Name	string	name of the owner
Domisili	string	current city owner live
nomorMesin	uint256	vehicle machine number serves as primary key
platNomor	string	vehicle number plate
merk	string	brand of the vehicle
jenis	string	type of the vehicle
model	string	model of the vehicle
year	uint256	construction year vehicle made
isiSilinder	uint256	cylinder of the vehicle
warna	string	color of the vehicle
bahanBakar	string	type of fuel for the vehicle
jumlahRoda	uint256	total of wheels of the vehicle
pemilikNIK	uint256	the citizen identification number for the vehicle owner

System Design

A. Use Case

Starting the use case like the Figure 1 where the user can do a login and then can check the full information of the vehicle with using the machine number of the vehicle. While the user can only do login and checking the information of a vehicle, the admin can insert data of a vehicle or data of a vehicle owner into the blockchain and update the ownership of the vehicle information.

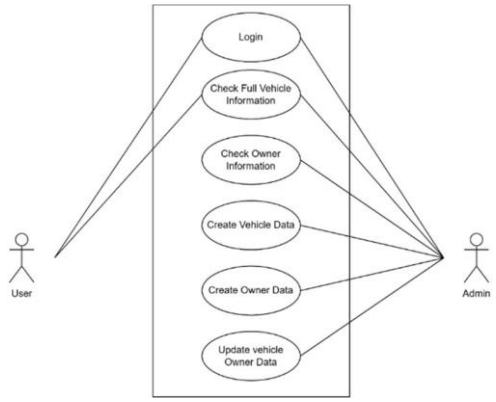

Figure 2. Use Case Website

B. Admin Flowchart

With the use case is solved we moved on to how the flow of the website will be with the Figure 4 below where it showing the admin flowchart that starting from opening the website and then goes to login to the website that will be deliver to the home page. From the home page the admin can either choose to create or update vehicle and owner data to enter a new data to the blockchain, or the admin want to check the information of a vehicle or owner simply by fetching the available data inside the blockchain.

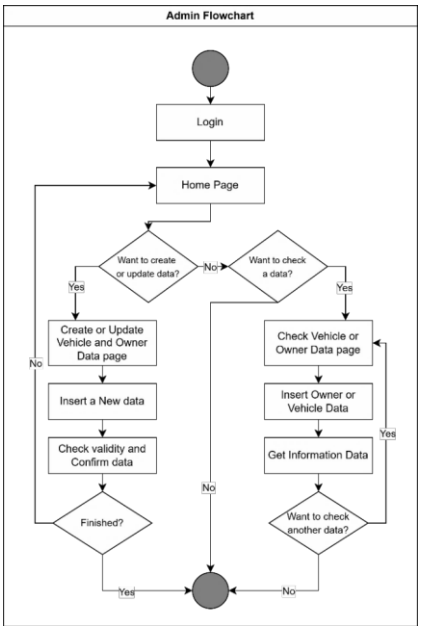

Figure 3. Admin Flowchart

C. User Flowchart

While the admin flowchart consists create update vehicle owner data and checking vehicle information, the user flowchart only had home page where only functioning as checking vehicle information by inserting vehicle machine number (Figure 4).

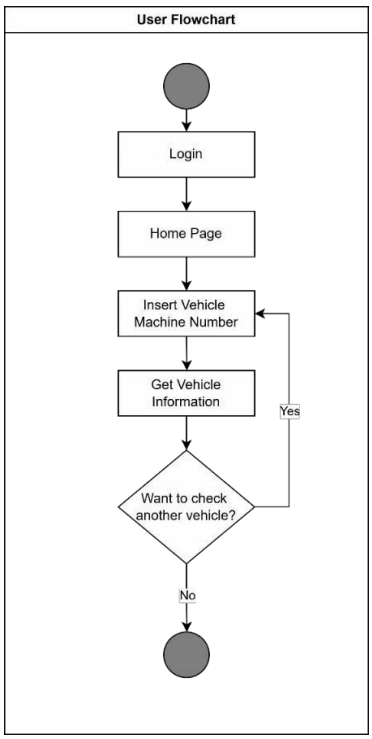

Figure 4. User Flowchart

D. Activity Diagram

In the activity diagram, we can observe the actions that can be performed by both the user and the admin. The user is limited to a single activity by checking the data of the desired vehicle. Where the flow is, user login into the website using MetaMask account and then straight to the home page that had check vehicle data form by entering vehicle machine number (Figure 5).

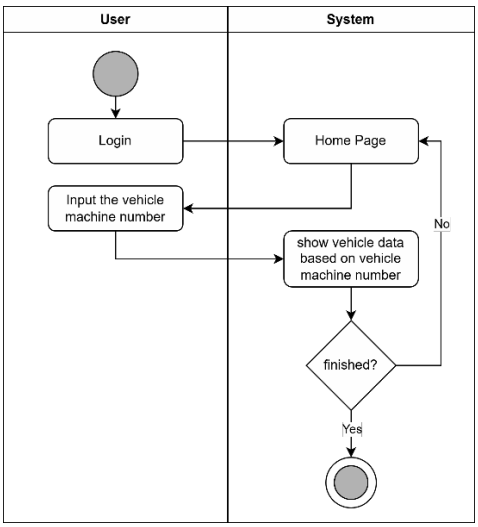

Figure 5. User Activity Diagram

For the admin activity diagram there is two indicate it as two activity that can be done by an admin whether it was create or update a data of a vehicle and owner or check a data form the blockchain. the activity is basically the same for checking a data form blockchain but for admin case it was not in the home page but in the other page that propose only for check data from the blockchain. And the other activity is for create a new data of the owner or the vehicle and update the data owner of the vehicle (Figure 6).

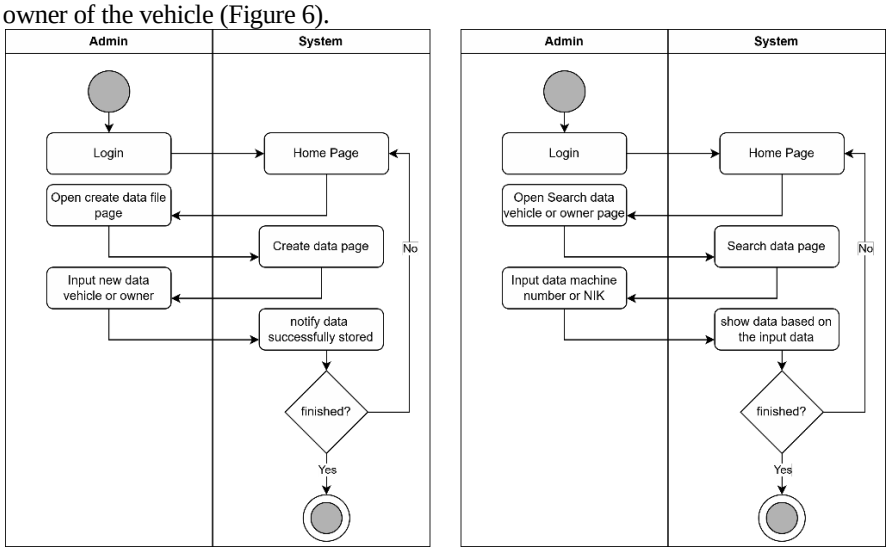

Figure 6. Admin Activity Diagram

E. Sequence Diagram

The sequence diagram illustrates the process flow when a user wants to register a vehicle to be added to the blockchain (Figure 7).

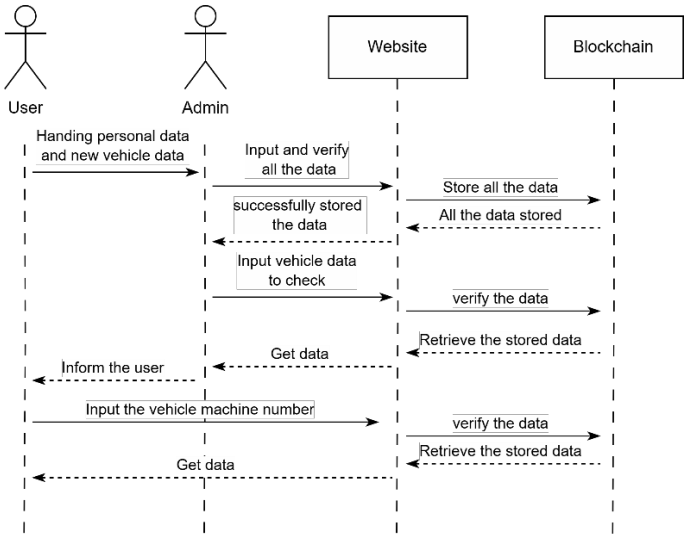

Figure 7. Sequence Diagram

F. Blockchain Architecture

The architecture that will be using in this website is Ethereum blockchain architecture (Figure 8).

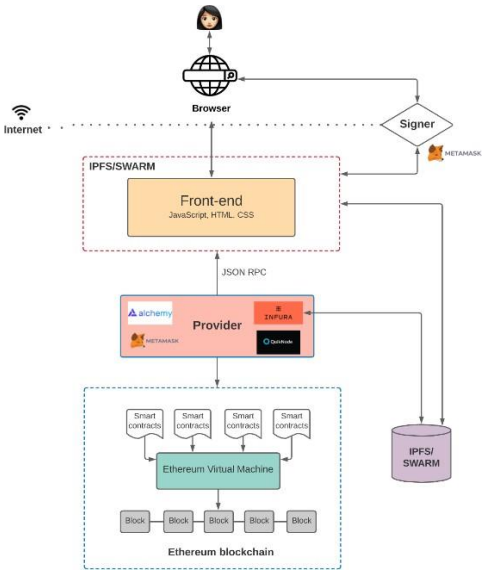

Figure 8. Blockchain Architecture

G. UI Design

Other than architecture, the design of the UI website for login page, the admin pages, as well for the user is determined in this phase. For the login page is the simple UI design where only have logo, some description text and login button (Figure 9).

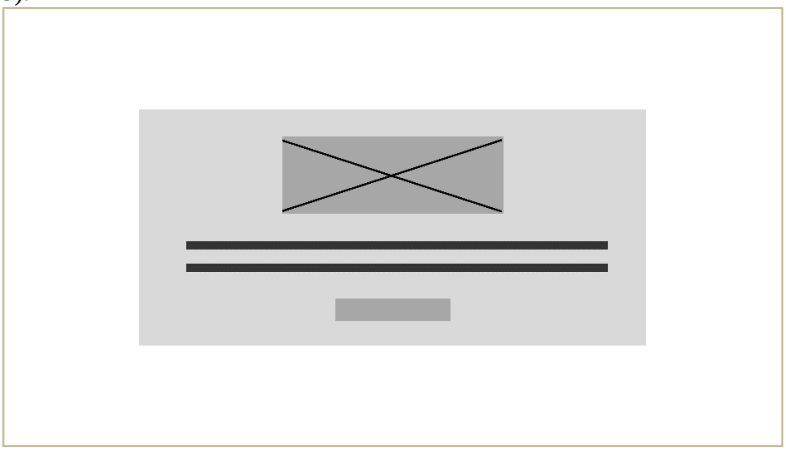

Figure 9. Login UI Design

The UI design of the admin will be the theme of a dashboard to make it easier for the admin to use and understand. At the home page consist some information about the total count of vehicle and owner data inside of blockchain (Figure 10). And there is two other parts of the page where the admin can create a new data Where the layout is the same for all create vehicle data, create owner data, and update vehicle owner (Figure 11). The other part is for checking vehicle data and owner information where the design is the same (Figure 12).

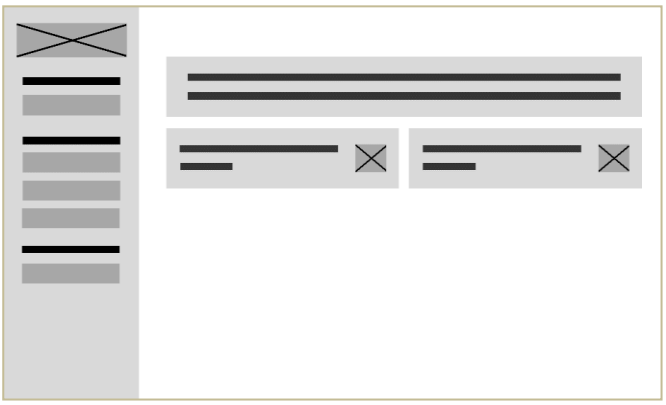

Figure 10. Admin Home UI Design

Figure 11. Create Data UI Design

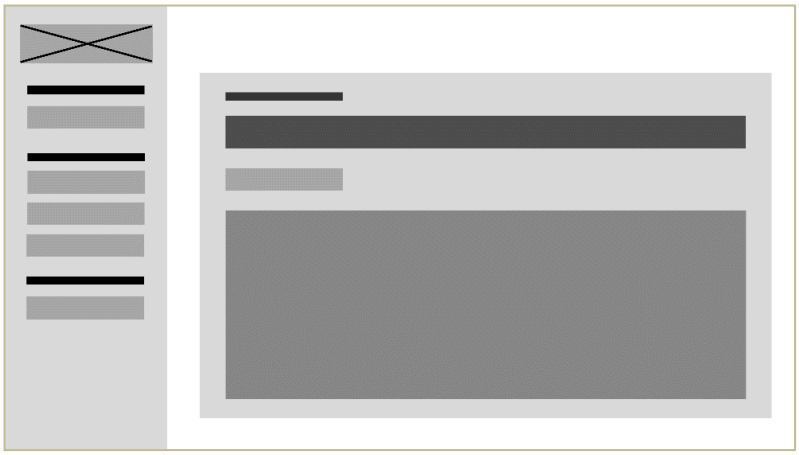

Figure 12. Check Data UI Design

As for the user UI design is also quite simple where on the home page only had a form for checking vehicle data with machine number (Figure 13).

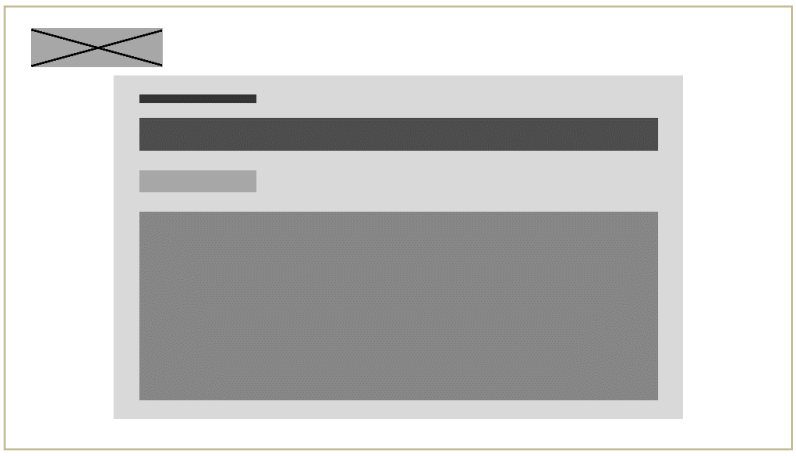

Figure 13. User Home UI Design

Implementation

This is phase involve making the logic for the smart contract using solidity language. Where inside the contract there is function to store vehicle data and owner data inside of blockchain and retrieve it from the blockchain also to update for the new owner of the vehicle in case if the vehicle is bought second handedly.

After the code and logic in the smart contract finished, we moved on to the code for JavaScript to make it accessible into the user interface later with html and CSS. In the JavaScript it all start with connecting the JavaScript into the wallet we are going to use for our website, in this case we are using MetaMask. After that we called a function to connect the contract inside the JavaScript using contract ABI and address. In the next step we only just called up our function to match the same one within the smart contract.

With the JavaScript is fixed we can move on to make the UI base on the UI design from the system design phase. With using HTML and CSS we can got a Website UI closes to the UI Design (Figure 14 Through 18).

Figure 14. Login Page

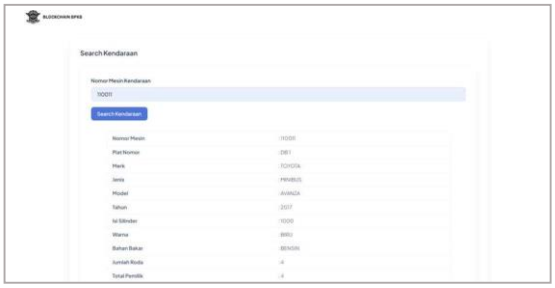

Figure 15. User Home Page

Figure 16. Admin Home Page

Figure 17. Create Data Page

Figure 18. Check Data Page

Testing

In this testing phase all the code from smart contract using solidity language and JavaScript will be test. The smart contract will be tested using Remix IDE because it provides access to various testing networks and is user- friendly. Within Remix IDE, we can conduct comprehensive unit testing to verify all functionalities of the smart contract. This includes testing whether it can store data variables of a vehicle and owner into the blockchain. The tests will not only involve storing data but also fetching the stored data from the blockchain. For instance, we will input the NIK, name,

and domisili for owner data to ensure the accuracy and reliability of the data storage and retrieval processes. (Figure 19).

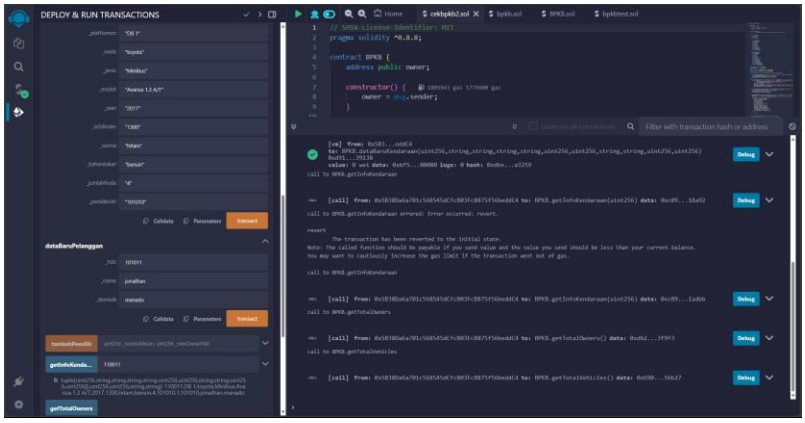

Figure 19. Manual Testing using Remix IDE

For testing the JavaScript, html, and CSS we directly using plugin inside the visual studio code to test if all the functionality is running as we planned or not. To easily spot an error inside the JavaScript, adding an error code at the ending of the function to show us if there is an error inside the function we proceed using web console. All testing, whether for the smart contract, JavaScript, HTML, or CSS, is considered complete once all errors have been fully resolved.

Deployment

After completing code testing, we transitioned to the deployment phase by using the Sepolia test network to integrate the smart contract into the blockchain via Remix IDE. This process required a specific amount of Sepolia test network tokens in MetaMask. These tokens can be acquired through a Sepolia faucet website, but there is a weekly limit on the number of tokens that can be received. Lastly, the Remix IDE and MetaMask will automatically connect when we deploy the smart contract within the sepolia test network. and it is ready for usage of the end user.

5. Conclusion

The purpose of this thesis is to develop a blockchain-based website application that simplifies the tracing and retrieval of vehicle information while providing a highly secure system that is nearly impossible to manipulate. Blockchain technology, with its inherent traceability and security features, offers a safe environment where data integrity is maintained, and unauthorized data fabrication or manipulation is prevented. The traceability feature ensures that all data within the blockchain is accessible only to authorized users, providing transparency and accountability.

This application presents a comprehensive solution to the existing problems faced by both the police and individuals looking to purchase used vehicles. It addresses the challenge of quickly and accurately verifying the authenticity of a BPKB by enabling real-time verification through the website. Prospective buyers can easily check the authenticity of vehicle documents using the vehicle's engine number, bypassing the lengthy procedures at Samsat offices and eliminating the risk of encountering fabricated documents.

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