A BLOCKCHAIN-BASED ONLINE REVIEW SYSTEM OF TOURISM PRODUCTS USING ETHEREUM

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Abstract—Rapid technological advances have made blockchain technology applicable not only to digital money but in various fields. One of the areas that can be implemented by blockchain is digital tourism, specifically in the online review system of tourism products. The current online review system has several problems due to its centralized nature. The problem faced is the manipulation of review data which can be in the form of review deletion by a centralized party. This research proposes a decentralized online review system using the Ethereum blockchain technology, Smart Contracts, and IPFS to provide a secure, transparent, and trustworthy online review system platform. The purpose of this research is to implement a permission-less blockchain as storage for reviews (review forms and log notes) and develop a web application as a user interface. The data used is data from travel sites that contain details about hotels and restaurants in Bukhara. The results displayed are the development of a web application that implements a permission-less blockchain using Ethereum and the system performance is displayed based on system testing, which comprised of unit testing and Black-Box testing.

Keywords: Blockchain; Ethereum; Online Review System; Smart Contracts

Abstrak— *Kemajuan teknologi yang sangat pesat membuat teknologi blockchain tidak hanya dapat diterapkan pada uang digital, melainkan pada berbagai bidang. Salah satu bidang yang dapat diimplementasikan oleh blockchain adalah pariwisata digital, secara khusus pada sistem ulasan online dari produk pariwisata. Sistem ulasan online yang ada sekarang memiliki beberapa masalah karena sifatnya yang tersentralisasi. Masalah yang dihadapi yaitu manipulasi data ulasan yang dapat berupa penghapusan ulasan oleh pihak yang terpusat. Penelitian ini mengusulkan sistem ulasan online yang terdesentralisasi dengan menggunakan teknologi blockchain Ethereum, Smart Contracts, dan IPFS untuk menyediakan platform sistem ulasan online yang aman, transparan, dan dapat dipercaya. Tujuan dari penelitian ini adalah untuk menerapkan permission-less blockchain sebagai tempat penyimpanan ulasan (form ulasan dan catatan log) dan mengembangkan aplikasi web sebagai antarmuka pengguna. Data yang digunakan adalah data dari situs perjalanan yang berisi tentang detail hotel dan restoran di Bukhara. Hasil yang ditampilkan adalah pengembangan aplikasi web yang mengimplementasikan permission-less blockchain menggunakan Ethereum dan kinerja sistem ditampilkan berdasarkan pengujian sistem, yaitu pengujian unit dan pengujian Black-Box.*

Kata Kunci*: Blockchain; Ethereum; Sistem Ulasan Daring; Smart Contracts*

INTRODUCTION

Almost every business, product, or service can now be reviewed or rated using online review platforms, including tourism products. Travel accommodation providers like Booking.com, TripAdvisor, and Airbnb are using popular online review systems as well as online shopping stores like Alibaba, eBay, and Amazon. Two of the most popular review websites out there are Yelp and TripAdvisor. According to statistical information on Alexa (2020), Yelp and TripAdvisor ranked as the 64th and 118th of the 500 most visited websites in the United States, respectively.

People believe that this ability to review businesses is vital to their rights as empowered consumers. Because of that, almost 40% of leisure travelers use travel-related websites such as TripAdvisor, Priceline, and Expedia to make a purchasing decision (Mccarthy et al., 2010), (Reyes-Menendez et al., 2020). The businesses themselves also benefit from online user reviews. One research concluded that a one-star increase in Yelp application ratings translates into a 5% to 9% increase in revenues for restaurants (Luca, 2012).

Despite the popularity of online review systems, the credibility of these systems is being questioned. The reviews in these systems can be exploited, modified, or deleted by a central authority due to their centralized nature. For example, TripAdvisor was accused of deleting customer reviews that raise warnings about potential danger (Doukopil, 2017). The

trustworthiness of these reviews is also an issue since centralized systems can be manipulated by tourism industry players such as hotels and restaurant owners (Önder & Treiblmaier, 2018). In one case, a fine of $2.2 million was given to an Australian hotel chain for deleting negative reviews on TripAdvisor (Williams, 2018).

Online review manipulation can come in many forms, such as removal of negative reviews, promotion of advertised reviews, and fake reviews (Salah et al., 2019). One research concluded that 38% of online reviews for certain products are fake (Mukherjee et al., 2012). This stems from the fact that all review systems to date are mostly centralized. They are subject to compromise, hacking, and tampering of their data by insiders or outsiders. They are also prone to failure and outside attacks (Salah et al., 2019). The current development of blockchain technology can solve this problem.

Based on the description above, the object used in this research is permission-less blockchain using Ethereum based on online review systems and hotels and restaurants as the tourism objects. Users add a review of the restaurant and hotels that are listed on the website to the blockchain and send it to the network. Transaction requests are taken by miners or validators. Transactions that have been compiled and validated will be sorted and packaged to the candidate block and then given a timestamp. Transactions will be stored in the ledger and distributed through the network.

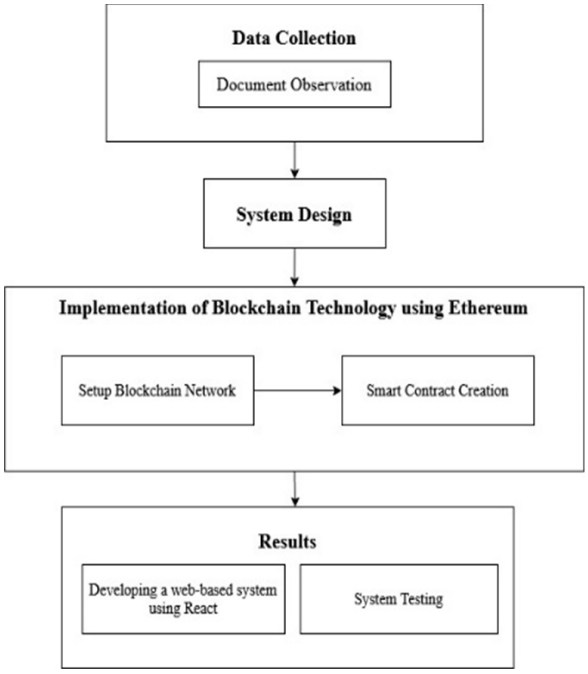
Research on blockchain implementation in online consumer review has been done before. In their research, Salah et al. (2019) presented a blockchain implementation using Ethereum's smart contracts for online consumer reviews by storing the reviews' hash and the address of the reviewer on decentralized file storage called Inter-Planetary File System (IPFS). After that, the reviewer that gave a valid review is rewarded using Ether. This system can track reviews to their original reviewers, but there is no front-end application for the users to interact with (Salah et al., 2019).

This paper uses Design-Based Research (DBR) as a methodology to implement blockchain using Ethereum and to develop a web application for users to interact with (Rizal, 2021). The DBR method has several advantages, one of them is that it can lead to contextually sensitive design principles and theories (Wang & Hannafin, 2005). The tests that are used in this paper are black-box testing and unit testing. Black-box testing is done for the website and unit testing is done for the smart contract implementation.

This paper uses Solidity as the programming language to implement smart contracts. Ganache and Truffle are used for the development of smart contracts, including the deployment and testing framework. IPFS is used to complement the blockchain as storage of images generated by the reviews because it is expensive to store a large quantity of data in the blockchain. React.js is a Javascript library that is used to develop the web application; also Web3.js connect the website to Ethereum nodes.

MATERIALS AND METHODS

This paper uses Design-based Research (DBR). The following are the stages of developing an online review system based on the blockchain using DBR as seen in Figure 1.



Source: (Rizal, 2021)

Figure 1. Research Stages

1. Data Collection

The data collection method in this research is document observation. Documents observation is done by observing and studying every documentations and report through a source that provides information about the tourism products, such as the name of the place, address, amenities, images of the place, and an overview of the workflow of the existing online review system.

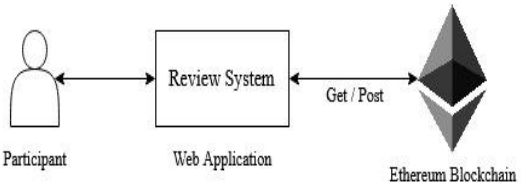
2. System Design

Based on data collection, the researcher proposes blockchain technology to be implemented in the review posting section of tourism product's online review system. Blockchain is applied to the review storage by posting it to the blockchain using an online review system web-based application. Because it is expensive to store data with large sizes,

such as images, IPFS will be used to store the images of the user's review. And then, the hash of those images is stored on the blockchain.

The system will run in a decentralized network and submit transactions that are immutable and secure. Transaction ordering and transaction block validation will be carried out by consensus protocol. Validated transactions are stored in the ledger and distributed to all participants' nodes on the blockchain. Permission-less blockchain type is used for participants who will join the blockchain network and can interact with the system. The participant is comprised of users who want to post a new review of tourism products to the blockchain.

An overview of the designed application workflow diagram for an online review system is in Figure 2.



Source: (Rizal, 2021)

Figure 2. Application Workflow Diagram

Participant in the network consists of users who want to post a new review of tourism products to the blockchain. Participants interact with the review system application web interface to post new reviews to the blockchain. The participant then signs the raw transaction which consists of a new review using Metamask. After that, the transaction is broadcasted to the whole nodes in the network. Then, all the nodes in the network verify that transaction using consensus protocol. Transactions in Ethereum consist of Log and New Review Data that will be stored in the block and validated by the nodes in the network. A ledger on each node is used to record and synchronize all transactions.

Table 1 shows the mapping of the Rating enumerable. Table 2 shows the structure of the ReviewDetails struct in the smart contract. Table 3 shows the structure of the log data model.

Table 1. Mapping of Rating Enumerable

Field	Type	Description
Bad	int	Mapping of 0
Poor	int	Mapping of 1
Average	int	Mapping of 2
Good	int	Mapping of 3
Excellent	int	Mapping of 4

Source: (Rizal, 2021)

Table 2. Structure of ReviewDetails

Field	Type	Description
title	string	-
comment	string	-
overall	int	Rating Enumerable
service	int	Rating Enumerable
atmosphere	int	Rating Enumerable
cleanliness	int	Rating Enumerable
food	int	Rating Enumerable
images	string[3]	Hash of images on IPFS

Source: (Rizal, 2021)

Table 3. Structure of Log Data Model

Field	Type	Description
reviewer	address	Account address of the reviewer
placeName	bytes32	The name of the place in hexadecimal form
reviewDetails	struct	Contains the ReviewDetails struct
timestamp	uint	Current time

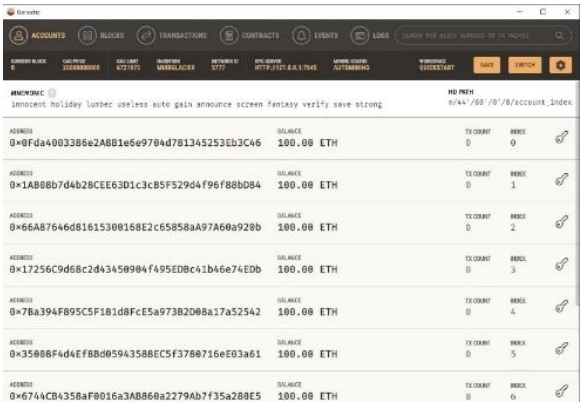
Source: (Rizal, 2021)

3. Setup Blockchain Network

Ganache client is used for the setup process of the blockchain network. Ganache client will create a local blockchain in the local machine. Ganache environment is configurated for the development phase. In the development phase, new blocks are created when there is a pending transaction. Ganache is an efficient development tool because blocks are stored on the memory, rather than in the storage. There are two ways of setting up Ganache as a blockchain network; by installing ganache using npm install -g ganache-cli command on the terminal and then typing ganache-cli to run it as shown in Figure 3, or by downloading Ganache UI from Ganache website and then installing it on the local machine as shown in figure 4.

Source: (Rizal, 2021)

Figure 3. Setup Ganache Using Terminal



Source: (Rizal, 2021)

Figure 4. Ganache UI

4. Smart Contracts Creation

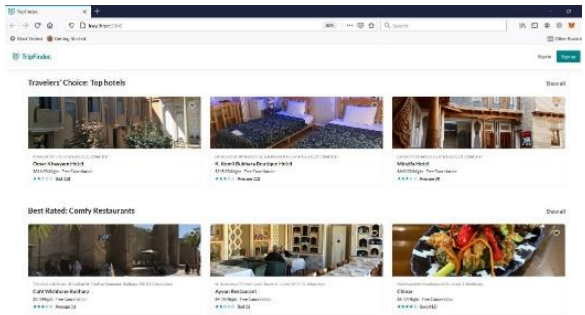
After setting up the blockchain network, there is a smart contract creation stage. In this stage, the Solidity programming language is used to create the smart contract for the review system.

RESULTS AND DISCUSSION

The discussion in this paper discusses the ways to get results of interface implementation using React. Accompanied by two tests, namely unit testing and black-box testing.

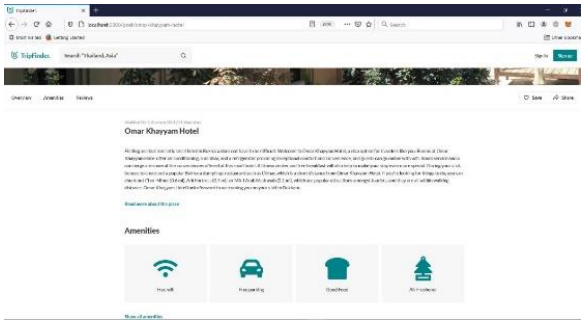
1. Interface Implementation using React

This implementation phase shows the system output that has been made. This implementation shows the user interface that can be used to view all tourism object that is available to be reviewed. This implementation is done using React, which is a Javascript library, and Web3.js to connect the website and the Ethereum nodes. Metamask is used as a gateway for the user to sign the review posting transaction to the blockchain. There are four main interface menus, which are: the main page of the website, Metamask interface for users to post their reviews, tourism object details page, and the review form page. The interfaces can be seen in Figure 5, Figure 6, Figure 7, and Figure 8.



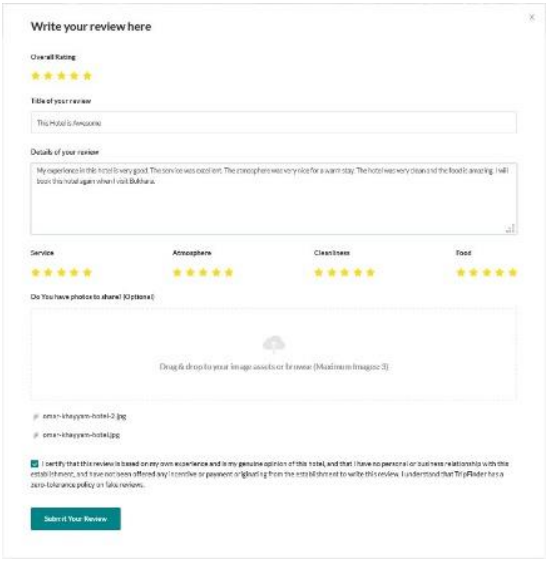
Source: (Rizal, 2021)

Figure 5. Main Page



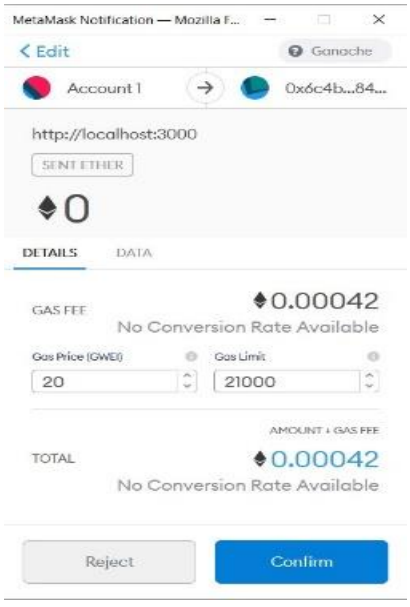
Source: (Rizal, 2021)

Figure 6. Hotel Information Displayed in The Website



Source: (Rizal, 2021)

Figure 7. Review Form



Source: (Rizal, 2021)

Figure 8. Metamask Interface to Confirm Review Posting

2. Testing

The performance of the system can be seen from the results of system testing, which are unit testing and Black-Box testing. The following section will display the result of each testing method.

a. Unit Testing

Unit testing of the smart contracts is done using the Truffle framework. To unit test, the smart contracts, unit test cases have to be designed and the test environment for the unit under test has to be developed. The test cases were developed to determine whether the smart contract can post a review to the blockchain, display reviews that have been posted to the blockchain and whether the logging system runs accordingly. The smart contract that was created pass all three test cases, as shown in Figure 9.

Source: (Rizal, 2021)

Figure 9. Unit Test Results

b. Black Box Testing

Black box testing is done to determine whether all website functions run properly according to the functional requirements that have been designed. The black box testing method is done by deriving a set of input conditions that fully utilize all functional requirements for a program. The results of the testing using the black-box method can conclude that all system interface components are functioning accordingly. Table 4 is the black box test results. Status: S for success and F for failure.

Table 4. Result of black-box testing

Function	Input	Expected Output	Output	Result
View Details	User click "View Details" button on the main page	Displaying the details of the object chosen	Displaying the details of the object chosen	S
Overview	User click "Overview" button	Displaying the description of the object chosen	Displaying the description of the object chosen	S
Amenities	User click "Amenities" button	Displaying the amenities that an object has	Displaying the amenities that an object has	S
Write a Review	User click "Write a Review" button	Displaying the review form page	Displaying the review form page	S
Submit a Review	User click "Submit a Review" button after filling all of the required fields on the Review Form	Displaying the pop-up Metamask Interface	Displaying the pop-up Metamask Interface	S
Submit a Review	User click "Submit a Review" button without filling the required fields on the Review form	The form will display a "This field is required!" message in every blank field	The form will display a "This field is required!" message in every blank field	S

Source: (Rizal, 2021)

CONCLUSION

In this paper, the implementation of the permission-less type of blockchain using Ethereum has been carried out successfully. The development of blockchain implementation is displayed in the form of a web application based on the workflow of the online review system of tourism products. Web applications run on a decentralized network using React library from Javascript and the data is stored in a distributed ledger. The stored data is in the form of new reviews and event logs. Each transaction that is carried out will produce a status, transactionHash, transactionIndex, blockHash, blockNumber, contractAddress, cumulativeGasUsed, gasUsed, and logs. The data and transactions are immutable, accountable, and transparent. Based on system testing using Black-Box Testing, features on the website run successfully. Using unit testing, the features that are provided in the smart contracts also run successfully. Unit testing is done by checking whether the smart contracts can pass three test cases that were created. The result is that the smart contracts pass the three test cases that were created; meaning it can add a review to the blockchain, it can display review that was stored on the blockchain, and the logging system run

accordingly. Unit testing of the smart contract is carried out using Truffle Framework.

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