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Saving Product Using Blockchain for E-BMT Platform

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ABSTRACT

Baitul Maal Wa At Tamwil (BMT) is a sharia financial institution that provides savings and loan services in accordance with the social, cultural, and economic needs of rural communities, especially in agricultural and plantation communities. The current data management is still using manual recording and a centralized server which can cause fraudulent financial reports and creates a lack of credibility between BMT and its customers. The research method is to decentralize the application data system by using blockchain technology, then replacing the conventional database to blockchain system. The simulation shows that the e-BMT application are connected to blockchain network as intended, users can use metamask to interact with the Ethereum network, the blockchain implementation on e-BMT application has run according to expectations with a 100% success rate with the average transfer time on two devices of 9.47 seconds and 12.13 seconds. While the results of data entry time on two devices obtained an average of 9.96 seconds and 37.09 seconds. While the blockchain implementation on e-BMT could provide access to every user so that each entity could confirm the validity of the transactions, the size of the transactions, and other data recorded on the blockchain without having to develop an integrated database system. The research contributes in two aspects, first, we develop the distributed blockchain system using public Ethereum blockchain network integrated with with popular e-wallet such as metamask, provides easy access for both customers and BMT parties who are connected to the network so that the recorded data can be accessed by anyone, and second, the application of blockchain technology to BMT is capable to interact with users as it is built on a website platform with RESTful API.

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1. INTRODUCTION

Cooperatives are economic organizations that operate on the principle of kinship. Gábor [1] argues that cooperatives are associations to meet economic and social needs and also democratically controlled shared ambitions. There is also an opinion [2] that cooperatives consist of various entities exchanging information and sharing resources to achieve compatible goals. There is a sharia cooperative in Indonesia called Baitul Maal Wa At Tamwil (BMT). BMT is a community company that develops aspects of production and investment to improve the quality of economic activities on a small and medium scale [3]. The development of fintech provides significant changes to large financial institutions such as banks or locally such as cooperatives [4]. However, financial institutions' administrations in Indonesia are still centralized [5], making money mandated in BMT vulnerable to financial statement fraud.

The centralization of fintech is contrary to the cooperative's slogan "from the members, by the members, and for the members", the principle of cooperatives requires transparency in every transaction to avoid misleading information [6] that occurs at BMT. Financial statement fraud exists due to the manual BMT

financial report system and the lack of human resources to manage the BMT system, causing low credibility in BMT.

In 2009, Satoshi Nakamoto created an electronic currency called Bitcoin which is the product of a technology called the blockchain. Blockchain is a technology that creates blocks of interconnected data sets containing transaction records [7], blockchain has a peer-to-peer nature which means that every entity on the network can perform functions as a client as well as a server. The benefit of blockchain technology is its security and distributed ledger's immutability [8]. To create a decentralized application, it requires solidity as it back-end program using remix ethereum as compiler to create the Application Binary Interface (ABI), then creating the website using React JavaScript with Visual Studio Code, Applying blockchain technology to e-BMT application could create a transparent and decentralized online-based financial system [9] which reduces vulnerability of financial reports, minimizing data fraud and increase trust between customers and financial institutions. A.H. Firdaus [10] has been working on the usage of blockchain in a public Hyperledger Fabric blockchain network to realize a saving's transactions in a cooperative being recorded through blockchain. Their research is lacking in deployment in a public blockchain network integrated with world's standard identity & e-wallet and the development of a system that can interact with cooperative users through a web interface. The research contributions are: (1) We develop the distributed blockchain system using public blockchain network integrated with with popular e-wallet such as metamask, provides easy access for both customers and BMT parties who are connected to the network so that the recorded data can be accessed by anyone, and (2) The application of blockchain technology to BMT is capable to interact with users as it is built on a website platform with RESTful API.

2. LITERATURE REVIEW

Fig. 1 shows how to apply for a loan on the e-BMT application using a conventional database, in this research, instead of using conventional databases, this research uses blockchain technology, to make it more distributed and to create transparency for each user. so that each party is not able to deny any received or sended transaction.

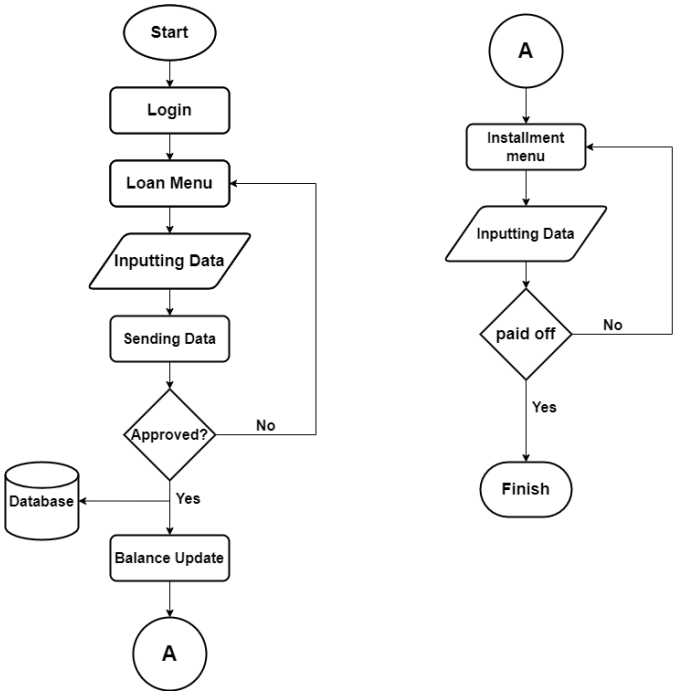


Fig. 1. Flowchart

2.1. BMT

Baitul Maal Wa At Tamwil (BMT) is a sharia financial institution consisting of two words; baitul maal and baitut tamwil which means zakat and financial institutions. BMT consists of two business units, namely ZIS management, and Islamic financial services, if one of the units is not established within the BMT, the financial institution cannot be called BMT, but only called "Baitul Maal" or only "Baitut Tamwil" [11]. BMT functions to collect and distribute zakat, on the other hand, BMT also provides services such as managing

funding and savings [12]. BMT acts as a financial institution that reaches rural areas by providing savings and loan services that are in accordance with the social, cultural, and economic needs of rural communities, especially in the agricultural and plantation communities. BMT is growing rapidly in Indonesia since it meets the aspirations and demands of micro-businesses and low-income communities [13] by providing unsecured loan services, convenient installment payments, and providing business management skills. Although BMT still needs to keep pace with the rapid fintech development in conventional banks [14].

BMT has its own differences from conventional banks, conventional banks apply an interesting system, a cost of using assets as one of the income sources other than external funding, while BMT gets income from two sources, namely internal and external. Internal funding sources are obtained from members registered with BMT in the form of principal savings, mandatory savings, and voluntary savings. While external sources are obtained from Islamic banks or government funding [15]. The profit-sharing system is applied which is commonly called "mudharabah" and "musyarakah" financing [16]. Mudharabah is a form of cooperation between two or more parties with a profit-sharing agreement, while "musyarakah" is a form of cooperation that involves two or more parties to increase assets that are owned together.

Fig. 2 explains how BMT generates profits with funds obtained from members, after the income has been collected, the residual Income is distributed to its members. To request a loan, an individual must be registered as a member of the BMT, upon registering a member is required to pay the principal savings as registration fees and mandatory savings per year with an agreed nominal value. Five kinds of loan contracts exist in BMT:

a. Murabahah

In a sale-purchase contract between the debtor and the creditor, the debtor buys goods that will then be resold to the creditor as installments or payments in advance. The debtor generally increases the selling price of the goods, if the price is agreed upon, this contract can be proceeded.

b. Ijarah

It is a loan agreement with a leasing system, this system begins with the debtor buying the property the creditor needs, then the creditor rents the property until a mutually agreed period. At the end of the period, the creditor buys the property and has full ownership over the property.

c. Musyarakah

It is a loan agreement with a cooperation system. Debtor and creditor work together in a business either by business or funding, and the profits are divided according to the agreement between the debtor and the creditor.

d. Mudharabah

This contract begins with the funding provided by the debtor to the creditor's business. At maturity, the profit earned is divided by the amount agreed by both parties.

e. Qard

It is a loan agreement on the principle of helping, this contract is not allowed to seek profit

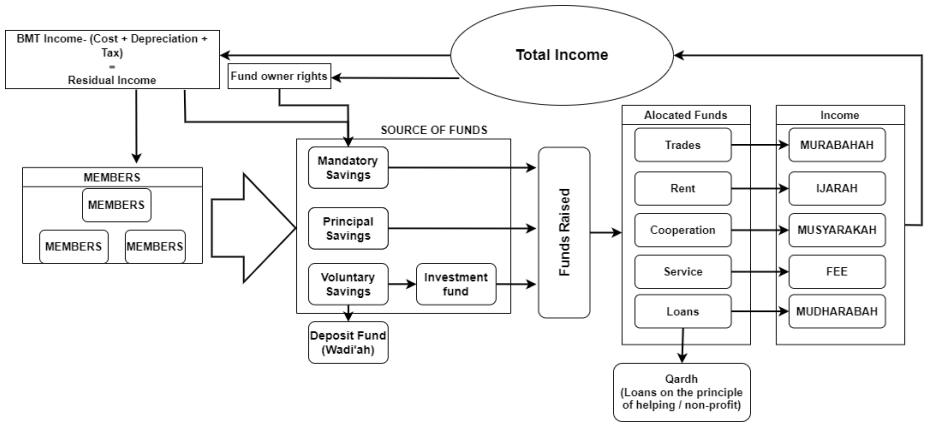


Fig. 2. BMT Business Process

2.2. Blockchain

Blockchain is a technology that creates interconnected data sets that store encrypted data transactions as well as track assets of a network. Blockchain is a digital ledger that allows each entity to validate ongoing transactions [17]. It allows the user to make the transaction directly without third-party intermediaries [18] The advantages of implementing blockchain technology are the trust and reliability of the decentralized servers, the hash function consists of a cryptographic algorithm that is based on a pseudorandom number generator [19],

making it an obstacle for the intruders to validate data on the blockchain network, and the efficiency because all data is executed automatically through predetermined procedures [20]. Blockchain has brought a major change to the financial institution since business between organizations no longer requires a trusted third party [21]. In its application, blockchain has been used as the basis for the development of cryptocurrency so that fund transfers can be done digitally without interference from a central entity [22], projects in the telecommunications industry, environmental monitoring, banking, money exchange, and government.

The way blockchain works are by connecting one device to another to record and check transaction data that has been executed like a digital ledger [23]. For every transaction that has been completed, a new block has been added to the existing chain, The Hash Function diagram can be seen in Fig. 3, making it almost permanently immutable

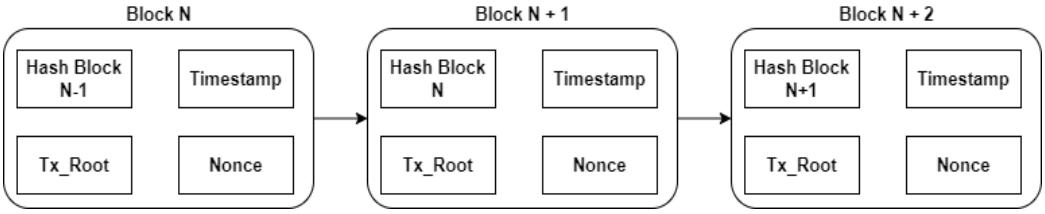


Fig. 3. Hash Function Diagram

For its security from data modification, the blockchain distributes packets called blocks, each block contains information about data transaction and can be accessed by authorized user [24], it also assigned a special randomly generated hash code called nonce to reduce transaction duplication [25], each block is linked to the previous hash ensuring the data is the original data, not the modified one. It can be assumed that if an intruder can change the data in a certain block, the registered hash will also change automatically. Therefore makes the modified block invalid. The time it takes to convert a block of bitcoin is 10 minutes. The attacker could validate the block on a blockchain by changing the majority of data up to 51% of the connected blocks [26][27], the more entities connected to the network, the more time it takes for the attacker to validate the modified block.

2.3. Ethereum

Ethereum is an open service platform for accessing cryptocurrencies and data-friendly services with blockchain, Ethereum is the most used blockchain platform for running smart contracts [28] which are a program to ensure the data is non-modifiable, so when the data has entered the node, the data cannot be modified. Smart contracts are written in Solidity [29], in which the syntax is similar to JavaScript. The smart contract has a lesser process rate than the conventional database, over time it would be able to compete with conventional databases [30]. Smart contracts are generally used to create tokens that can represent currencies, assets, virtual shares, and proof of membership [31]. Smart contracts are low-level script code that runs on a blockchain platform, smart contracts are created as unbreakable promises since they were created from algorithms with the purpose to avoid report falsification.

2.4. Web3

Web3 is a third-generation web service that can process information like humans, Web3 use artificial intelligence and machine learning technology so that applications could be more adaptive and smarter than the current Web2. Web3 also has an emphasis on distributed applications and the utilization of blockchain technology which consists of four modules [32]:

- Web3-eth for Ethereum blockchain and smart contracts.
- Web3-shh for peer-to-peer communication and broadcasting.
- Web3-bzz for decentralized file storage.
- Web3-utils contains Decentralized App (Dapp) developer functionality.

In Fig. 4 Web3 is committed to the use of decentralized architecture. Today's digital society demands global change to put people in control of their own data. Governments, banks, and tax offices often use cloud services as their data storage, but the cloud service has privacy issues and lacks multi-party trust which can cause data violation [33] [34]. Not only that, but banking services currently also have several deficits, such as disproportionate transaction costs, especially if it involves external payment services.

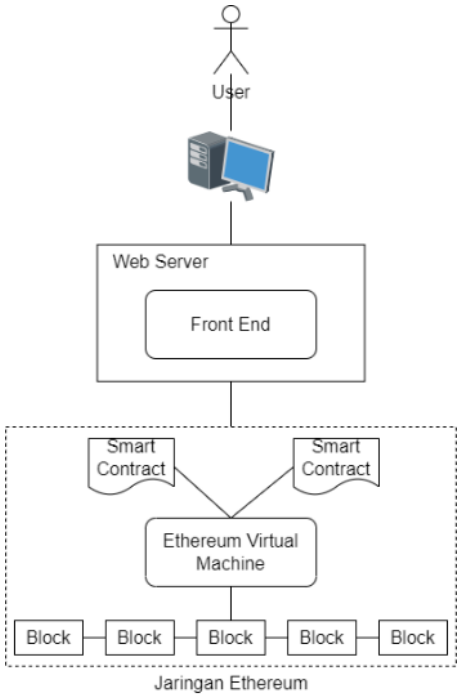


Fig. 4. Web3 in this service

3. BLOCKCHAIN IMPLEMENTATION

To apply blockchain to the BMT system, several technical specifications are needed in the blockchain to adapt to the existing business model. For now, some BMTs still store their data centrally, the data centralization on BMTs causes a lack of information on prospective customers as a review of the level of trust. To overcome this, BMT must have a distributed system to share data with other BMTs, this is done so that the track records of prospective customers and BMT managers can be reviewed to increase transaction transparency and credibility in BMT.

In Fig. 5 The features that will be run in this research are divided into two categories, namely users and admins, users can perform activities such as transfers, loan applications, and balance checking. Meanwhile, the admin can carry out activities such as transfers, checking balances, and validating proposals.

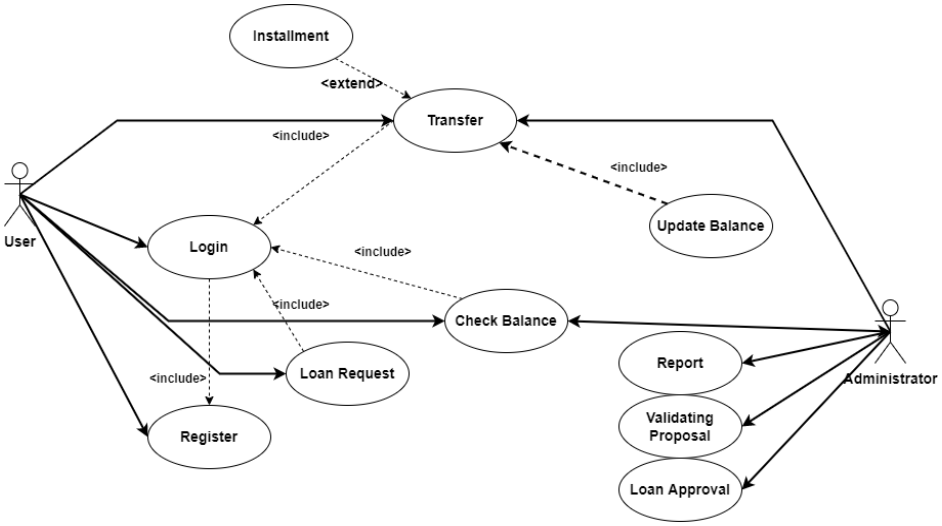


Fig. 5. Use case diagram of the business process

The tools needed to create smart contracts can be constructed easily with the remix.ethereum.org compiler. Once the smart contract creation is complete, the smart contract functionality test can be done locally with Ganache [35]. Ganache can be used to test our smart contract while also managing the chain function

[36]. The interaction between the website and the smart contract can be done by entering the ABI (Application Binary Interface) of the smart contract into the javascript front-end code. The blockchain architecture can be seen in Fig. 6.

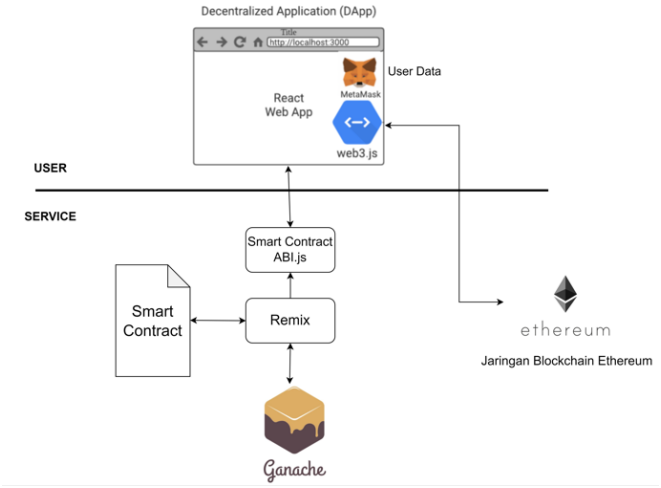


Fig. 6. Blockchain Architecture

Metamask is a browser plugin used to interact with the Ethereum network [37], Metamask reads and writes Dapps information by connecting to nodes that connect to the blockchain network [38].

Fig. 7 shows the data stored on a blockchain consists of the sender's address, gas used, how much ether was sent, block id, and TX data. The gas fee is a transaction cost that occurs on every transaction [39]. TX data is obtained from the input data, this happens so that the privacy of the input data is maintained even though the data controller can be accessed by anyone, it can also be concluded that the recorded data corresponds with the input form. The same thing also happened to the testnet network, on testnet network the stored data can be accessed through the etherscan.io [40] website which can accommodate the main blockchain and testnet networks such as Kovan, Ropsten, Goerli, and others.

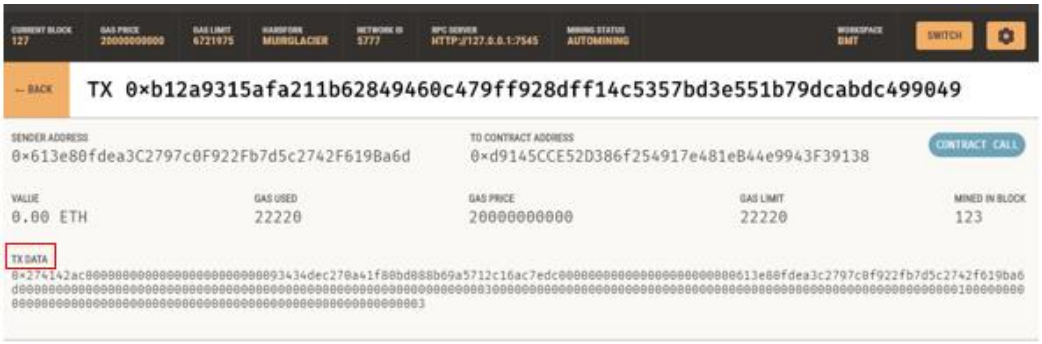
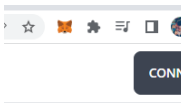
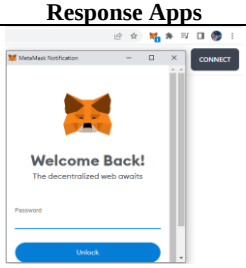
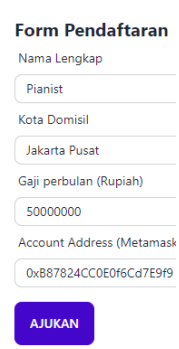
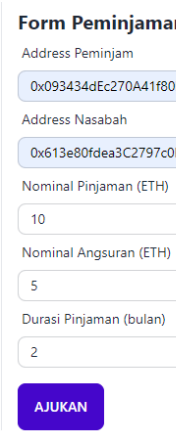
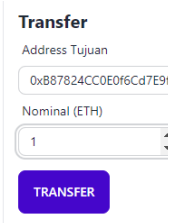
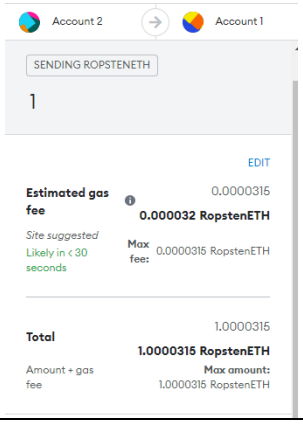


Fig. 7. Ganache Block UI

Table 1 shows that the implementation of blockchain in the e-BMT application runs as expected such as connecting to the Ethereum network, sending data, and transacting using the blockchain technology. In this test, each function is tested ten times, while for performance testing, several samples are taken from each function for analysis. This test is carried out in two scenarios, namely tested on localhost 127.0.0.1 and tested on the Ropsten Ethereum testnet network that has been provided for blockchain development. This test is carried out with two devices with the Table 2 following specifications.

Testing the response time on the transfers function in Fig. 8 has a faster processing time than form submission in Fig. 9 since there's no need to record input other than entering the destination address and cryptocurrency nominal value. Meanwhile, the speed of the localhost form submission process has a better and more stable speed than the form submission on testnet, this is because the number of blocks on localhost is still very less than the number of blocks on Ethereum testnet.

Tabel 1. Testing result

No.	Display Apps	Goal	Response Apps	Result
1		The website is able to connect to Metamask		e-BMT website is able to connect to Metamask
2		The data filled in the member registration form can be recorded and accessed on the blockchain network	0x88643af15f874d573994d307db4714ba9d41120863a84cea50f1c4c8859541cc	The data is recorded in hex data and can be accessed on etherscan.io using the transaction hash beside
3		The data filled in the loan application form can be recorded and accessed on the blockchain network	0x702df8616cbc6be5b23dd31bf892574b719b698db94726a6534f0973f00542fd	The data is recorded in hex data and can be accessed on etherscan.io using the transaction hash beside
4		Users can send a certain amount of ether to the destination metamask account		Users can send a certain amount of ether to the destination metamask account if the user account has the ether needed for transactions

Tabel 2. Device specification

Specification	Laptop A	Laptop B
Device	Lenovo B40	HP OMEN 15-dc1111 tx
RAM	4GB	16GB DDR4
Processor	Intel Pentium Quad Core 2.20 GHz	Intel Core i7 2.60 GHz 12 CPU
OS	Windows 10	Windows 11

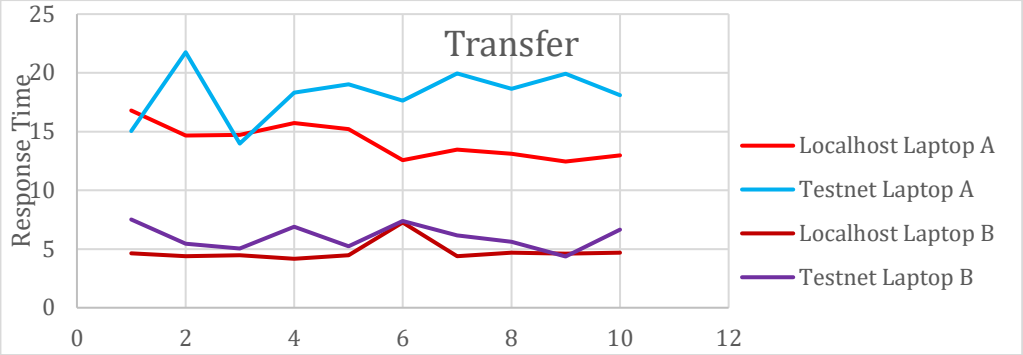


Fig. 8. Transfer Rate Comparison

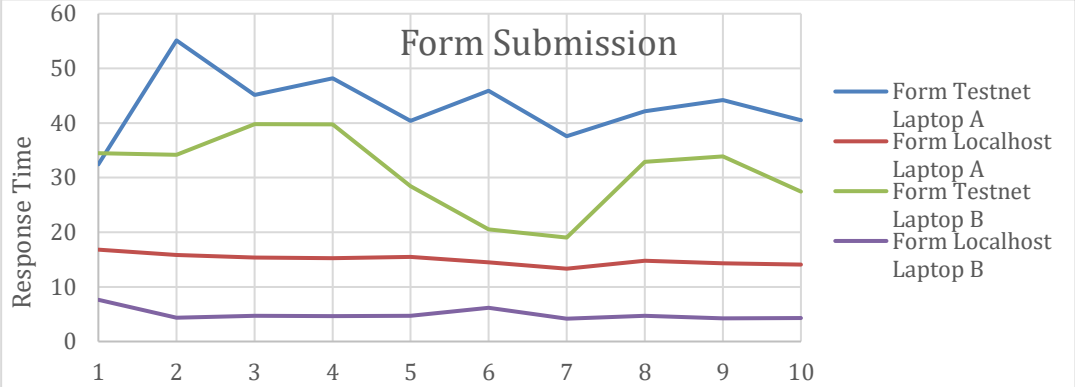


Fig. 9. Form Submission Comparison

Fig. 9 shows that Laptop B has a better performance, due to its superior specifications than Laptop A, the testnet speed process is not only affected by device specifications [41] but also influenced by internet speed since the data are channeled to the global Ethereum blockchain network.

A.H. Firdause [10] evaluates their system only in terms of functional testing whereas as a software we need to conduct other tests to our users. This is a usability test to find out whether the application is sufficient or ideal for the user's experience. We do the test through a Lab usability testing with both in-person and remote settings. The test evaluates the quality in terms of appearance, usability, and ease of use of the application. The usability test use likert scale as shown

$$Score = N \times Pn \tag{1}$$

$$Index = \frac{Total\ Score}{Y} \times 100 \tag{2}$$

where N is total responden, Pn is *likert* Score (minimum 1, maximum 5), Y is Highest *likert* score x responden amount.

Table 3 is a summary of all usability tests in the form of questions. The value of each question represents aspects such as learnability (LR), efficiency (EF), memorability (MR), errors (ER), and satisfaction (SF). Each question is also given a validity test which aims to measure the validity of the questions on the questionnaire. The respondents of the existing questionnaire consist of 13 people who understand blockchain technology, The results show that all questions are valid, the first question has an R-value of 0.814, the second question has an R-value of 0.870, the third question has an R-value of 0.832, and the fourth question has an R-value of 0.652. Since the calculated r-value of each question is greater than the table r value which is 0.5529, all questions can be used as a conclusion.

Tabel 3. Usability Test Result

No.	Category	LR	EF	MR	ER	SF	Score
1	Design Interface of the e-BMT app	v	v	v	v	v	80%
2	Ease of use of the e-BMT app	v	v	v	v	v	83.08%
3	Response time of the e-BMT app		v		v	v	76.92%
4	Feature of the e-BMT	v	v	v	v	v	78.46%

4. CONCLUSION

The blockchain implementation on the e-BMT is applied to the transaction and data entry functions running as expected with a 100% success rate. This system has also been tested for its validity and usability, all forms of transactions and data entry on the blockchain network can be accessed together ensuring the inputted data cannot be modified. Therefore creating blocks of interconnected data sets containing transaction records, improving trust among entities within BMT cooperation since blockchain's data transparency ensures that the data is in accordance with the user input and can be accessed by any party connected to the network. In future, explorations of large-scale deployment into blockchain network is necessary to be further researched as well as how monitoring and evaluation of cooperatives (financial reports), whose having blockchain as the system backbone, can be constructed.

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