Student Activity Credit Framework (PSUCOIN)

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Abstract—**Prince of Songkla University, Phuket Campus (PSU Phuket) has activities every semester. Students have to collect activity hours (as credits) for completing the condition of graduation. Sometimes, students who regularly participate in activities will receive enough activity credits. This prevents them from participating in the further activities. Gain more activity credits are not tempting anymore. For this reason, if there is a utility token that can represent as an activity credit, then students can use it for other purposes. It causes joining activity more attractive. The traditional activity credit system uses a simple spreadsheet file, which has several issues such as offline, errors and transparency because all information is stored at a PSU staff only. Thus, it leads us to propose a utility token, called PSUCOIN, changing from a centralized system to a blockchain-based system. Students receive PSUCOIN coins when they attend an activity organized by PSU campus. They will be more involved in activities since PSUCOIN coins can be exchanged for items or other future purposes as well. It can be used to motivate students who are not participating in activities.**

Keywords: activity credit framework; blockchain; smart contract; PSUCOIN; distributed system;

I. INTRODUCTION

PSU Phuket campus store activity credits in a centralized database working with spreadsheet files. The disadvantage of storing data in a centralized way is to trust a data manager. In addition, centralized database can be always edited by the owner. Failure of some operations in the system may cause the database interruption, and data loss. Moreover, the data cannot be recovered if there is no efficient database backup system. In this work, PSUCOIN system uses the blockchain technology, which provides more transparency, integrity and verifiable. These characteristics are difficult to achieve in the centralized system. The PSUCOIN system provides more benefits to many students. They can use the PSUCOIN coins to exchange products in PSU stores. Moreover, the PSUCOIN system allows outer organizations to join in. They can buy PSUCOIN coins in order to hire students for their tasks. The PSUCOIN system has been tested in PSU campus environment. The feedback result from students is going well since student credits in the original reward system are not useful when they have the credit higher than the credit limit. Therefore, the PSUCOIN system helps motivate students increasingly.

The rest of the paper is organized as followings: the old approach is compared to the blockchain-based approach, and research for the related works in section II. In section III, we propose our framework. Then, the testing procedure and the results are presented in section IV. Finally, we conclude the work in section V.

II. RELATED WORKS

A. Centralized System

Transaction data storage is located at the centralized place. It has a very high chance that data may be attacked by outsiders since there is only one intermediary (Fig. 1) to manage user data and various transactions. If there is a large amount of usages, it may result in delays due to high load at the server [1]. All other security issues (transparency, integrity, traceable) depending on the trust level at the server.

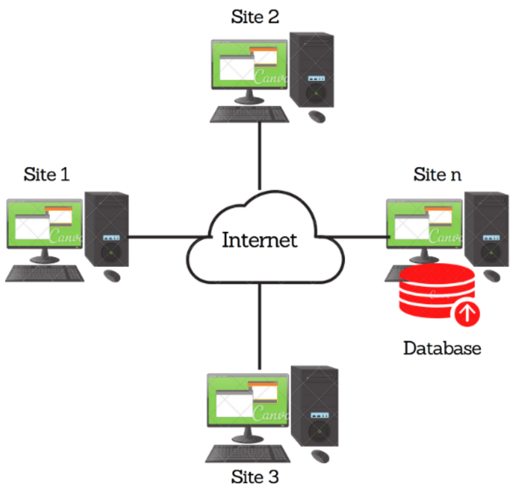

Fig.1. The centralized system

B. Blockchain and Smart Contract

Blockchain is decentralized public ledgers, which are used to store financial transactions and other assets. In the future, financial institutions may not have an intermediary. For example, Bitcoin [2] is a cryptocurrency that used to be sent from a user to another user on the peer-to-peer Bitcoin network without the need for intermediaries. Transactions are checked by regarding nodes and recorded into blocks, called blockchain. However, blockchain not only plays a role in financial transactions but also develops in numerous areas e.g., Voting [3], Review [4], and the credit reward system [5] etc. It uses to store transaction executed through functions in a smart contract [6] of users. When PSUCOIN is transferred to other users, the system will store transactions on blockchain which can access any time. The blockchain system does not have an intermediary node, thus those results are more transparent.

C. *Existing Blockchain applications*

1) *Blockchain-based Loyalty Program*

Due to blockchain advantages, it can be used to collect rewards from customers' shopping with the verification and cheating protection. The customers will receive rewards after purchasing [5]. For example, a coffee shop system provides benefits to customers at different levels. It will vary depending on the points accumulated from coffee purchase. Hence, customers who use this service continuously will get more points and they can change to an advance level through the accumulated points. The above idea is an example of using blockchain to store data instead of centralized database since the centralized system is a collection of data storage in one device, which may have transparency and trustworthy issues.

2) *Blockchain for Educational Record*

The authors in [7] indicate that university of Nicosia is the first university to issue educational certificates which can validate data through blockchain. It prevents the forgery of documents. A human resource manager can inspect in the case of jobs applying because it can be checked the information stored in blockchain which is accessible from outsiders. Then, it results in a decreasing corruption. Moreover, student profiles and coins are managed in this platform.

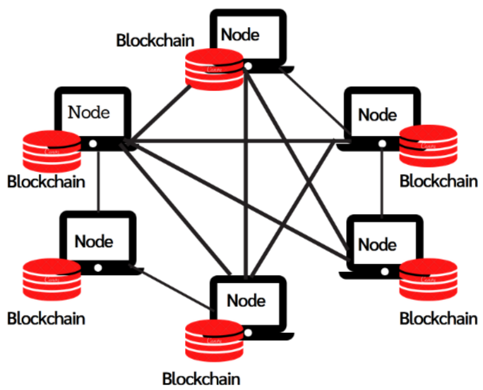

Fig.2. The blockchain-based system

III. PROPOSED FRAMEWORK

A. *System architecture*

Blockchain is a widely distributed system, as shown in Fig. 2. Blockchain system are extending it in many areas, such as blockchain trends [8], because there is no intermediary node, data transparency, and protection.

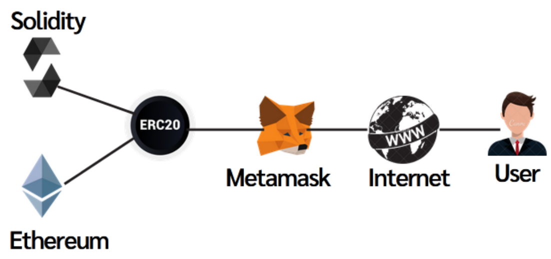

Fig.3. The PSUCOIN system

Transactions and the smart contract are stored in the system that makes data more secure [9]. All users can check the information within the smart contract stored on the blockchain. In this architecture, PSUCOIN token is created regarding to ERC20 standard based on Ethereum to be used as the utility tokens as shown in Fig. 3. The system and PSUCOIN coins have already been tested at PSU campus which be able to support many users. A user can access PSUCOIN system, through an existing e-wallet (e.g., Metamask). Each transaction has been called at the smart contract defined by Solidity language. Since the system is based on Ethereum, it needs gas for all transaction. The system provides not only the smart contract for PSUCOIN token, but also a web server with user interface.

B. *User Interface*

PSUCOIN website is a page that allows users to choose to access various functions of the website. Hence, the PSUCOIN website consists of 3 main functions which are *transfer, balance* and *transaction*. Fig. 4 shows the user interface for the "*transfer*" function. Users can enter into the system by student ID. Then it will retrieve a user profile, a public key, a private key and the column on the right side shows user personal information. PSUCOIN uses name and surname to confirm a user identity pre-validating by the university. When a user enters the amount of PSUCOIN coins, and presses on the sending button, the system will transfer PSUCOIN coins immediately. If the transaction is completed, the page will show the link to Etherscan of Kovan network [10]. Users can check the transaction that has been transferred in that link. Next on the following page is the "*balance*" function, which can be used to check the PSUCOIN coins in a digital wallet. Users can click the reload button to get the latest state of balance. After that, the system will process the data and extract the amount of PSUCOIN from blockchain to be shown on the website as illustrated in Fig. 5. In addition, when we would like to check the users' transactions whether a coin is transferred to another person or another user transfers PSUCOIN coins to our digital wallet. We can check the balance amount as shown in Fig. 6.

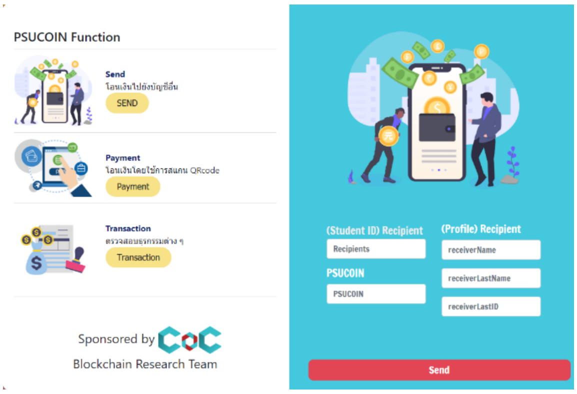

Fig.4. Transfer function page

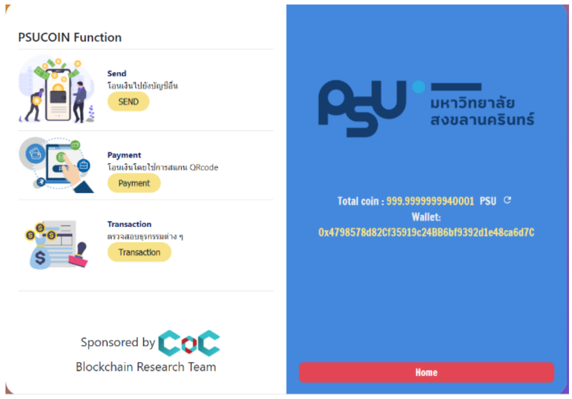

Fig.5. Show balance page

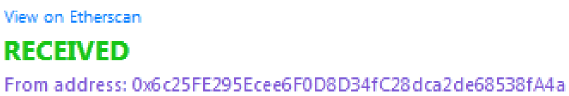

Fig.6. Check transaction page

IV. SYSTEM PERFORMANCE

In this section, we compare the advantages of blockchain-based approach with the centralized system. Utilizing the blockchain technology provides many benefits over the centralized approach. However, there still exist some drawbacks of using the blockchain approach. The cost and response time are the main tradeoffs that should be considered. The blockchain usage results in terms of response time and cost are presented in the experiment section. We also analyze those advantages and tradeoffs in this section. All the details are described as followings:

A. Advantages

Using blockchain technology improves the system in many aspects. We summarize those advantages comparing to the centralized system as shown in Table I. We compare the advantages of blockchain-based approach in 5 domains as followings: (1) ***Motivation*** for participation in activities: the old activity recording system stores students' activity hours in the centralized database. The activity hour is a condition for student graduation. Students need to participate in activities organized by the university or activity clubs. In general, the students who finish all required activities will no longer participate in further events. It is reasonable because there is no reward for the exceeded activity hours. In contrast, our work utilizes the blockchain technology to make student activity hour more valuable. The students can use the activity hour to various things not only for the graduated condition.

TABLE I. BLOCKCHAIN-BASED APPROACH

	Centralized	**Blockchain-based**
Motivation	No rewards for joining activities	With automatic rewards for joining activities
Transparency	User cannot verify all transaction	User can monitor and verify transaction
Backup	Pay additional cost for database backup	Public blockchain with no backup cost
Data integrity	Difficult to provide integrity	Data cannot be altered
Collaboration	Complex to collaborate, need to share APIs	Data on public blockchain, simple to manage sharing data

In the proposed framework, we call the activity hour point as "PSUCOIN". Students can use PSUCOIN coins to exchange products in PSU. Moreover, some shops can use it as coupons or promotions to increase their sales. Furthermore, PSUCOIN can be used to reflect the student contribution score as well. The students who contribute in the university will have a lot of PSUCOIN. It is possible to use PSUCOIN in referring to the students who know the real problems in the university. The voting system with PSUCOIN is likely to be fairer since the students who contribute more should know more about the university's needs. When the activity hour has more value, protecting its data blockchain based is more important. PSUCOIN should not be lost or hacked. As a result, the weak security centralized database is not the feasible approach to this scenario. The data can be changed by the hacker if it is stored in the low protection system. To solve those problems, we use the blockchain to store PSUCOIN data for higher protection. (2) ***Transparency*** is a problem in the centralized system. Students only see their activity hours when it is recorded by the student affair. When the data is lost, no one knows what happened to that data. There are many causes for data loss in the old system. Even the staff cannot trace that data. The centralized database does not keep track of data automatically. It is not easy to trace the data losing when the problems occur in the hardware-level. On the other hand, blockchain technology record the data in form of transaction history. It can be traced in every action publicly. As a result, everyone knows all movements in a blockchain. (3) ***Backup*** is an important problem that centralized systems will incur user data maintenance fees due to data users' loss prevention, however a blockchain does not have to pay for backup data because all data is stored in public distributed blocks. Thus, cost of data backup is reduced. However, some public blockchain networks (e.g., Ethereum) require a gas which is a cost paid by users. The gas cost will be experimental in the next section. (4) ***Data integrity*** is difficult to provide data integrity in centralized system while blockchain based offers data integrity as default. As a result, data modification cannot be done in a blockchain. (5) ***Collaboration*** is difficult to provide in the centralized system since it needs to share APIs for data sharing. In contrast, blockchain system stored data in public blocks. Then, it is simple to manage sharing data and the user can always check data in a blockchain.

B. Experiment environment and results

1) Environment

This work is tested in the Kovan test network [10] and Ethereum node is used through the Infura service to access the blockchain network with Web3JS library.

2) Cost

When users transfer the PSUCOIN coins, they need to spend the transaction cost. There are two values they must specify: the gas limit and the gas price value. The gas limit is the maximum unit of cost for that transaction. The gas price is the cost per unit. When a transaction is being executed, the unit of cost (gas used) is accumulated for each operation. If the gas used value exceed the gas limit value, the transaction is terminated and failed. The gas price value effects the transaction speed since the miners select the transaction by considering higher reward (gas price).

$$\textit{Transaction Cost (Ether)} = \textit{Gas Used} * \textit{Gas Price} \quad (1)$$

From the experiment, the gas used for the "transfer" function is 37,265 units for every transaction. Thus, the transaction cost presented in table II is calculated by using the equation (1). We compare the different gas price in order to demonstrate the difference of transaction cost the user spent. The experiment result is shown below:

TABLE II. TRANSACTION COST

Gas price (GWei)	Transaction cost (Ether)	Transaction cost (Baht)[a]	Transaction cost (USD)[b]
1	0.000037	0.28	0.0087
25	0.00093	6.90	0.22
50	0.0019	13.81	0.44
75	0.0028	20.72	0.65
100	0.0037	27.62	0.87

[a] 1 Ether = 7,141 Baht at the time of writing., [b] 1 Ether = 234.17 USD at the time of writing.

From the experiment, the gas price (in the range of 1 to 100 GWei) are different for a transaction as shown in the table II. The transaction cost is not affected by the amount of PSUCOIN coins transferred. Thus, transferring more PSUCOIN coins is cheaper than rapid transferring with the low amount of coins. However, the transaction costs for the low amount of gas price are acceptable for users comparing with the benefits they received. The baseline will be depending on value of PSUCOIN regarding to the gas fee.

3) Response Time

Average response time can be separated into two parts: the hash time and the block time. The hash time is the duration from sending a transaction until it gets a transaction hash. The block time is the duration from sending a transaction until it is recorded in the blockchain. We tested sending 20 transactions and collected the response time. From those transactions, we summarize the result by averaging data. Table III shows the response time result.

TABLE III. RESPONSE TIME

Gas Price (GWei)	Hash Time (ms)	Block Time (ms)
1	2099.1	4992.2
25	2029.7	5834.5
50	1950.9	4865.1
75	1937.4	4707.1
100	1967.4	5716.3

Theoretically, a gas price directly relative to a response time when there exist many transactions in a row. However, the experiment result in table III indicates that these two values are not directly correlated. This circumstance can happen when there is not crowded usages. Gas price is freely set by users. Thus, there might be the case that user can quickly complete a transaction with the low amount of cost.

V. CONCLUSION AND FUTURE WORK

In this article, we use blockchain technology to improve the activity credit system. We create a utility token named PSUCOIN to represent the student activity credits as an incentive for students within the PSU campus to be more interested in activity participation. In addition, it helps reduce the security issues from using a centralized database system. Moreover, it provides the high level of transparency. All users can check the information any time without an intermediary node. We also propose the PSUCOIN website, which consists of important functions such as *transfer, balance,* and *transaction*. It supports user operations for interacting with the blockchain system. The main contribution is not only to develop PSUCOIN system but also to provide performance analysis in the views of blockchain technology. Furthermore, the PSUCOIN website are developed for the external users. This helps upgrade the PSU campus to be the smart university. Eventually, the PSUCOIN framework improves the blockchain ecosystem to grow more rapidly.

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