Evaluation of the Economic Efficiency of Blockchain for Customer Identification by Financial Institutions

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Abstract. Today, digital technologies are developed and used in all economic sectors without any exception. The financial sector is one of the drivers for the digitalization of the economy, which caused the emergence of fintech, an innovational industry that is based on the fusion of state-of-the-art digital and financial technologies. Blockchain is one of the most promising technologies in the financial sector. It has become widely used to create cryptocurrencies. This technology is used in many areas of the financial sector, for example, for customer identification by financial institutions. This research involved building of a model using the net present value method to evaluate the efficiency of the implementation and use of the automated decentralized database using the blockchain technology for bank customer identification. The paper presents the results of the modeling for three cases: for the most favorable economic conditions with minimum costs and maximum benefits, for average conditions and the least favorable economic conditions. The analysis of the modeling results identified financial institutions with a certain number of customers for which it will be economically viable to implement blockchain.

1. Introduction

Blockchain has been developing for about ten years. This technology was used for the first time in 2008 to create bitcoin, the first cryptocurrency, which is still the most widely-used and capitalized currency in the world.

Blockchain is a technology that collects information into a chain of blocks protected with cryptography. Chains of data are not stored on a separate server and are available at the same time on all devices connected into a network. [1-4]

Blockchain is a self-sustaining system that does not need third parties to operate. At the same time, this system is extremely open. Blockchain developers aimed, first of all, to avoid intermediaries.
It can be affirmed that the wide use of blockchain will lead to significant changes in the information world. The reasons are quite simple: decentralized data storage protects them from being changed without authorization, for example, from being hacked, falsified or controlled in any way.

Today’s global blockchain market is estimated at over one billion dollars, the financial sector accounting for 70% of the market.

One of the most promising ways of blockchain use is to build information systems for person identification, in particular, customer identification by financial institutions. The advantages of blockchain may help to significantly decrease the amount of banks’ losses resulting from fraudulent transactions. On the whole, the global financial system loses around 15-20 billion a year because of these transactions, which is quite a lot to introduce innovative data storage and processing technologies. [2], [4,5]

The goal of the research is to build an investment model to evaluate the efficiency of the development and use of the blockchain-based information system for customer identification by financial institutions in order to decrease the number of fraudulent transactions with cash.

The following objectives are set to achieve that goal:
- conduct a comparative analysis of approaches to innovative information project evaluation;
- determine input and output parameters and the structure of the investment model;
- form a database for modeling based on the model built; and
- conduct an analysis of input parameters for economic efficiency of the implementation of the blockchain-based information system and then determine the size of financial institutions that can implement these technologies.

When all objectives are reached, an investment model should be built to conduct an analysis of the economic efficiency of the development and use of the blockchain-based information system.

2. Literature review and research methods

Blockchain technologies have been developing for less than ten years, therefore, there is no fundamental research that would make it possible to assess the prospects of blockchain. However, it should be noted that despite the fact that such technologies in the financial sector are only emerging, many authors have addressed that rather relevant and promising topic.

M. Pilkington (6), Z. Zheng (7), F. Hawlitschek, B. Notheisen, T. Teubner (8) and many others describe the main principles of blockchain systems, analyze advantages and disadvantages of blockchain technologies and review possibilities of their use in different economic sectors.

Blockchain is more widely used in the financial sector, which is not a coincidence as blockchain was used for the first time to create bitcoin, the first cryptocurrency in the world. Today, blockchain is used for many financial purposes.

Person identification information system is one of the promising ways of using blockchain. Many authors, such as H. Arslanian, F. Fischer (9), K. Wüst, A. Gervais (10), H. Hassani, X. Huang, E. Silva (11) and many others, consider the possibility to use blockchain for customer identification by financial institutions. These authors focus on the technical possibility to build such information systems, analyze their configurations and assess their advantages and disadvantages from the perspective of blockchain development but the reasonableness of blockchain use at financial institutions is one of important economic problems. There are only few studies on that topic and they are often superficial, that is why the research of that area is rather relevant and important both from the theoretical and practical perspectives.

There are many methods used to evaluate the efficiency of innovative information projects, which can be divided into three main groups: financial (quantitative), qualitative and probabilistic (Fig. 1). [12] Financial methods analyze principal financial indicators of a project. Qualitative methods are mostly additional to the previous group of methods and assess these or those parameters in terms of the applicability of the system to accomplish a task. Probabilistic methods are one of the most complicated ones and are considered as methods that give results with the certain probability degree.
Implementation of innovative information projects comes with the difficult task to determine the final result of the system to be implemented expressed in monetary terms. In our case, such result is obvious and presents the amount of cash to be saved due to the blockchain introduction into customer identification by financial institutions for protection against fraudulent transactions. It is thus possible to apply the net present value method, one of the principal financial methods, that considers changes in income and expenses as a result of an investment project.

\[ NPV = \sum_{t=0}^{T} \frac{C_{F,t}}{\prod_{i=0}^{t}(1+r_i)} - \sum_{t=0}^{T} \frac{I_{t}}{\prod_{i=0}^{t}(1+r_i)} = \sum_{t=0}^{T} \frac{NCP_{t}}{\prod_{i=0}^{t}(1+r_i)} \]  

(1)

3. Results

Let us build a net present value model, which is a financial method used to evaluate the efficiency of the information project involving the introduction of the decentralized database for customer identification by financial institutions.

NPV (Net Present Value) is the key indicator showing the efficiency of the information project. It is calculated using the following formula:
where

T – number of planned time periods of the information project implementation,
NCF_t – net cash flow during a time period t,
r – discount rate.

NVP for the investment project implementation related to the blockchain-based decentralized
database can be calculated as follows:

\[ NPV = \sum_{t=0}^{T} \frac{NCF_{t,db}}{\prod_{t=0}^{T}(1+r_t)} \]  

where

\( NCF_{t,db} \) – net cash flow for the blockchain-based database for customer identification by financial
institutions during a time period t.

Let us analyze expenses for designing and implementing the blockchain-based decentralized
database, which will be basic up to one million customers. They can be estimated based on the
following formula:

\[ IC_{db} = K_1 + K_2 + K_3 + K_4 + K_5 \]  

where

- \( K_1 \) – expenses for database design;
- \( K_2 \) – expenses for technologies;
- \( K_3 \) – expenses for information base formation;
- \( K_4 \) – expenses for personnel training; and
- \( K_5 \) – expenses for testing.

Expenses for database design can be calculated using the following formula:

\[ K_1 = K_{11} + K_{12} + K_{13} + K_{14} \]  

where

- \( K_{11} \) – payroll expenses;
- \( K_{12} \) – software expenses;
- \( K_{13} \) – hardware expenses; and
- \( K_{14} \) – other expenses.

The more customers a bank has, the more expenses it has to incur to design and implement a
decentralized database for customer identification. This is caused by the longer database design
period, bigger amount of customer information to be input into the database and higher infrastructure
expenses. Figure 2 shows the approximate dependence of the cost of the decentralized database on the
number of bank customers.

![Fig. 2 Dependence of the database cost on the number of customers of a financial institution, in
measurement units of the basic database](image)

The cost of commercial blockchain projects depends on many factors, such as their purpose, size,
industry, country, team, marketing etc., therefore, it is impossible to say for sure how much the project
will cost if you are not aware of these factors.
But it is possible to use the statistical data on completed ICOs in order to look at the average figures for the industry and extrapolate them on similar projects. According to CoinDesk, the average amount of ICO in 2018 was 31 million US dollars, almost a twofold increase against 2017. The Fabric Ventures report provides similar figures: 30 million US dollars. Projects are classified according to their cost in Figure 3. [6], [8], [13-15]

Fig. 3 Big blockchain projects broken down by their cost, in percent

Thirty million US dollars is a statistically average amount based on all investments in ICO and the number of projects. This figure is overstated as 25% of all investments were obtained by 20-30 start-ups out of 1000. For example, EOS received over 4 billion US dollars. The average median value is 10-13 million US dollars per project. [12], [14], [16-20]

The industry which uses blockchain is also important as the development cost to a great extent depends on it. For example, the biggest hard cap is in start-ups that develop blockchain products in the industries related to energy, utilities, legal services, real assets and blockchain infrastructure (Fig. 4). [21,22]
The average project cost in the financial sector is estimated at 52 million US dollars. The development and implementation of a project can take from several months to several years depending on its complexity (Fig. 5). [23-27]

According to Codementor.io, blockchain developers from North America take 80-100 dollars an hour on average (Fig. 6). [19], [21], [28]
The average wage also depends on the region: Western Europe – 70-100 US dollars an hour, Eastern Europe – 40-70 US dollars an hour, India – 40-50 US dollars an hour, Africa – 20-40 US dollars an hour. [29,30]

Operating expenses for the blockchain-based decentralized database with up to one million customers can be calculated using the following formula:

$$C_{bdDb} = C_1 + C_2 + C_3 \ (5)$$

where

- $C_1$ – payroll expenses for database operation;
- $C_2$ – maintenance expenses; and
- $C_3$ – other expenses.

Operating expenses for innovative information projects can usually vary a lot and they are often evaluated in terms of the time spent (Fig.7). [18], [20], [31]

The average share of operating expenses in all non-recurring expenses is around 52%.

When implementing and using an innovative information system, the key issue is to estimate an economic result of its operation. The result of the project for creation of the blockchain-based decentralized database for customer identification by financial institutions is a decrease of bank losses from fraudulent transactions.
That figure can be calculated based on the following observations. First of all, let us find the amount of cash per one bank customer stolen in fraudulent transactions using the following formula:

\[ q_c = \frac{N_{all}}{Q_{all}} \]  

(6)

where
- \( q_c \) – cash stolen in fraudulent transactions per one customer all over the world;
- \( N_{all} \) – number of all bank customers in the world; and
- \( Q_{all} \) – cash stolen in customer identification transactions all over the world.

Losses of each specific financial institution can be estimated as follows:

\[ Q_b = q_c \times N_b \]  

(7)

where
- \( Q_b \) – cash stolen in fraudulent transactions at a specific financial institution; and
- \( N_b \) – number of customers of a specific financial institution.

Formula (7) can be presented based on Formula (6) as follows:

\[ Q_b = \frac{N_{all}}{Q_{all}} \times N_b \]  

(8)

According to different estimates, the introduction of blockchain in the customer identification process can reduce losses by 50-75%, the amount of cash saved after the implementation of the decentralized database can be calculated as follows:

\[ Q_{bs} = Q_b \times k = \frac{N_{all}}{Q_{all}} \times N_b \times k \]  

(9)

where
- \( k \) – correction factor, which shows which share of potentially stolen cash will remain in a financial institution.

Cash stolen in transactions related to customer identification is estimated at about 15-20 billion US dollars annually around the world.

Modeling is conducted for three different options: under the most favorable economic conditions, average conditions and the least favorable conditions. The planning horizon is ten years.

Figure 8 shows the dependence of NPV on the number of customers of a financial institution under the first option.

![Fig. 8 Dependence of NPV on the number of customers of a financial institution for minimum model values, in millions of people](Image)

Figure 9 shows modeling results for average values.

![Figure 9](Image)
Fig. 9 Dependence of NPV on the number of customers of a financial institution for average values of the model, in millions of people

Figure 10 shows modeling results for the least favorable conditions.

Fig. 10 Dependence of NPV on the number of customers of a financial institution for maximum values of the model, in millions of people

4. Discussion
The research resulted in a model based on the net present value intended for the evaluation of the economic efficiency of the blockchain-based decentralized database implementation and use for customer identification by financial institutions.

The modeling showed that under the most favorable values of the model with the minimum cost of development amounting to 20 million dollars, minimum operating expenses accounting for 20% of non-recurring expenses and the maximum correction factor of 75% of the potential losses from fraudulent transactions, blockchain can be used in financial institutions with about 1.4 million customers.

It is almost impossible to reach minimum values for information innovative projects as all new technologies require increased expenses, that is why modeling was based on average values, in particular, the correction factor was set at 65% and operating expenses were increased to 50% of non-recurring expenses. In that case, the efficiency of the blockchain-based decentralized database implementation can be applied to financial institutions with at least nine million people.

The modeling was aimed to determine maximum values that allowed for the efficient implementation of blockchain. When the correction factor was set at 50% and operating expenses were increased to 80% of non-recurring expenses, such value for new systems is usual and sometimes the system operation costs more than the system itself, in that case, the blockchain implementation is not efficient. In that case, maximum values are affected by the system scaling, which significantly increases the cost of the information system because of the drawbacks of the blockchain technology emerging when the number of customers in the system significantly increases, which requires the improvement of existing data processing algorithms and productivity of these systems. In that case, it can be concluded that the implementation of that technology is possible only to ensure more reliable protection of customers and improve the bank image in the industry.

The modeling results for maximum inefficiency values with the operating expenses of 60% and the development and implementation cost of 25 million US dollars for the basic configuration showed
that the use of that information system would be efficient from the economic perspective if the customer base exceeded 37.5 million people, i.e. under these conditions it could be used by rather big banks.

5. Conclusions

Information and communication technologies have been widely implemented in the modern world, which provided for the digital transformation of the global economy, which has a new innovative direction: the digital economy that develops and uses state-of-the-art information technologies;

The financial sector is one of the leaders in the digital transformation of the economy, modern banks are ranked second after telecommunications companies in terms of the amount of investments in digital innovations, it is not a coincidence that fintech emerged in the financial sector as a result of the fusion of digital and financial technologies, which allowed for not only innovative banking products, but also for brand new forms of financial institution organization and management, which help businesses to expand;

Blockchain is one of the recent breakthrough technologies in the financial sector, which is a distributed ledger system implemented for the first time in 2008 in order to create bitcoin, the first cryptocurrency and the most capitalized currency in the world;

Blockchain has been used in many industries, but it is the financial sector that is the most promising for such technology, the use for customer identification being one of possible usage options for financial institutions as this process can be fully automated and provide for reliable protection of customer data, banks today lose 15-20 billion US dollars annually because of fraudulent transactions related to customer identification, at the same time regulators in many countries are strengthening requirements to financial institutions related to money laundering prevention and bank customer identification;

Blockchain is one of the customer identification solutions based on biometric data, which allows for reliable data protection, but the main issue is the economic efficiency of blockchain, the research showed that 15-20% of blockchain implementation cases in financial institutions would be inefficient from the economic perspective, only big financial institutions with the customer base containing over 37.5 million people can afford blockchain, in the future, if this technology is developed further for better application and performance, such systems may be used for the customer base of nine million people;

Financial institutions are one of the biggest investors in blockchain today as they conduct related research and implement blockchain projects in practice, so in the nearest couple of years blockchain information systems under development will be widely used not only by big financial institutions but also in smaller banks.

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