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DIGITAL TRANSFORMATION OF BUSINESS: USE OF BLOCKCHAIN IN THE OIL & GAS INDUSTRY

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Abstract. The relevance of this paper is due to the rapid development and spread of modern digital technology in many areas of human activity, including the oil & gas sector. Effective communication between oil traders and banking organizations urges both parties to reimagine the approach of data and financial exchange. This brings new challenges to today's digital transformation of such organizations. The paper analyses possible applications of blockchain as well as explores the practical implementation of a blockchain platform in a petroleum trading company on the example of a payment execution process which involves three parties – client, petroleum trader and bank.

Keywords: digital technology, blockchain system, digital transformation

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ЦИФРОВАЯ ТРАНСФОРМАЦИЯ БИЗНЕСА: ИСПОЛЬЗОВАНИЕ БЛОКЧЕЙНА В НЕФТЕГАЗОВОЙ ПРОМЫШЛЕННОСТИ

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Аннотация. Актуальность данной статьи обусловлена стремительным развитием и распространением современных цифровых технологий во многих сферах человеческой деятельности, в том числе в нефтегазовом секторе. Эффективное общение между нефтетрейдерами и банковскими организациями побуждает обе стороны переосмыслить подход к обмену данными и финансами. Это создает новые проблемы для сегодняшней цифровой трансформации таких организаций. В статье анализируются возможные применения блокчейна, а также исследуется практическое внедрение блокчейн-платформы в нефтетрейдинговой компании на примере процесса исполнения платежа, в котором участвуют три стороны — клиент, нефтетрейдер и банк.

Ключевые слова: цифровые технологии, система блокчейн, цифровая трансформация

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Introduction

In the modern world, the data that companies possess is one of the most valuable assets on a par with the products they produce. Information can and should be used to support internal and external business processes of companies. In the era of Big Data, organizations gain access to a huge amount of data that brings great value in terms of studying, for example, customer preferences or internal performance indicators. Supply chain management concerns four flows: material flow, business flow, capital flow, and information flow. Driven by data, every department in the supply chain can exchange information with the adjacent ones and transfer information between different manufacturers. Quicker response, faster delivery, and more informed decision making can help a manufacturer to enhance the service level (Qi, 2019). So, the application of advanced Big Data analytics in supply chain management can help to improve decision making for all activities across the supply chain. In particular, in inventory tasks, big data can help organizations to design modern inventory optimization systems, predict inventory needs, respond to changing customer demands, reduce inventory costs, obtain a holistic view of inventory levels, optimize the flow and storage of inventory, or even reduce safety stock (Fern ndez-Caram s, 2019). Also, supply chain decision making is increasingly reliant upon access to real-time data. With a better understanding of data, a supply chain manager may effectively replace product flow with information flow, at a considerably reduced cost (Basolea, 2018).

Data flows need to be monitored and managed. Security and privacy preservation are important concerns for Industry 4.0 applications. There may be chances of unauthorized data breaching or information leakage leading to the financial losses to Industry 4.0-based applications. The blockchain technology has the potential to handle various security attacks as it can eliminate the need of the centralized

authority to perform various operations. In the blockchain technology, a number of users participate in transaction verification and validation. It uses a structural distributed database which stores data from all the nodes in an encrypted form validated (Bodkhe, 2020). As the database is distributed, so there is a risk of getting crashed or corrupted. Transactions are linked together with cryptographic keys and immutable ledgers which makes it difficult for attackers to manipulate or delete the recorded information (Amiri, 2021). Data is always stored in an immutable manner using timestamps, public audit and consensus mechanisms. The use of these mechanisms makes security architecture a robust and assures data integrity and privacy (Monrat, 2019).

In this paper, will be discussed the implementation of a blockchain platform in a company that specializes in trading of petroleum products in Russia – Petroleum Trading. With this implementation the process of accepting and processing payments between the company's customers, Raiffeisenbank, as a servicing bank, and the company itself will be automated.

In such a competitive market of petroleum products, mainly due to the strongest positions of such large companies as GazProm, ROSNEFT, Lukoil [1], the success of the players in this segment is influenced not only by the quality of the supplied raw materials, but also by the quality of service – the speed of payment acceptance, the speed of shipment and flexibility in service conditions [2]. Since the current processes of processing interbank transactions (the supplier company and its client do not always have accounts in the same bank), although possible for a certain period of time, they do not allow payments to be made in a matter of minutes, as well as they do not ensure one hundred percent immutability of transactions (the impossibility of forgery of any documents) (Cocco, 2017). These circumstances lead to the issue of optimizing the process of accepting and processing payments for an oil trading company.

With the development of blockchain technology, it has ceased to be associated only with the cryptocurrency, for which it was originally created to support (Monrat, 2019). The most popular niche for the use of blockchain after cryptocurrencies is precisely the financial sector (VK Cloud Solutions, 2019). Taking into account the main characteristics of this technology, which consist in the use of a distributed registry in which each block of information contains a set of confirmed transactions (Cocco, 2017), it can allow not only to exclude some intermediaries from the service payment chain, but also to increase security and transparency for network participants at the same time, reduce human labor costs.

The purpose of this work is to consider the concept of using blockchain in the oil sector from the point of view of Petroleum Trading and its assessment in the context of working with many different clients. In the current conditions, the company and its clients need to constantly monitor the transactions made in order to make various data-driven decisions regarding not only asset allocation, but also logistics. Thus, the integration of the blockchain platform between Petroleum Trading and Raiffeisenbank should be based on the principles of continuous access to transaction information of all deal participants, high speed of document flow and flexibility in the customization of the system for the company.

Materials and Methods

The following was used as methods of research of the given topic: logic, analysis, systematization of data.

The energy sector, in addition to being one of the most important sectors in today's society, is at a time of profound change. This transition is due, among other reasons, to the population's need to consume renewable energies. The population is realizing the impact that the consumption of non-renewable energies has on the environment and is concerned about it. Not only that, but new business models and a new type of digitized and environmentally concerned consumers are also emerging.

Blockchain technology is offering many advantages to the energy sector. On the one hand, new companies are being born whose strategy includes Blockchain as the main element. But, on the other hand, there are already many traditional energy companies that are looking for ways to apply this technology in their activity. For example, Iberdrola at the beginning of 2019 launched a project through which it is

intended to accelerate the decarbonization process. The main objective is to certify that the energy supplied by Iberdrola and the energy consumed by the customer is 100% renewable. The first experience has been carried out with the Spanish bank Kutxabank, "which has been able to trace the origin of the energy supplied by Iberdrola, from the generation asset to the point of consumption" (Iberdrola website, 2019).

Blockchain overview

A blockchain, or "chain of blocks", is a "single source of truth" of shared information, such as data related to financial transactions (eg: an amount in bitcoins), legal contracts, property titles and documents identification. The information is recorded in a database distributed in different transaction three nodes (e.g., a computer) in a network on the Internet and is structured and encrypted in such a way that it cannot be altered without the consent of the majority of nodes in the network (which automatically and simultaneously verify the change compared to the database). Any change, such as payment made from person A's bitcoin wallet to person B's, must be requested by the data owner (person A, in this case) using a combination of public and private keys that validate the identity and legality of the transaction (Huaimin W., 2018).

The greater the number of nodes in a network, the more secure it is, since any fraud attempt would require corrupting the same chain on every node in a network simultaneously during the few seconds that the chain processes the change (Centobelli P., 2022). This process directly affects the underlying theme of trust in society and the business world, which creates the need for validation by a third party (e.g., by banks or lawyers), since the network itself validates the change. When new information is added to the chain, a new block is created, which is connected to the previous one (containing or contract related to it) and, therefore, the historical data remains in the chain and provides an audit trail.

For example, in a relatively simple transaction, such as buying a home, currently, the seller would have their lawyers draw up the paperwork, the terms would be agreed upon, the contracts would be physically signed by both parties, proof of payment would be provided, and, subsequently, the lawyers would be in charge of transferring the property title. Using blockchain technology, the seller could send the contract with the digital certificate of ownership of the house to the buyer through the chain. Once the buyer fulfilled the conditions of the contract and made the payment, the contract would be executed automatically and the digital certificate of ownership would be transferred to the buyer.

The nodes in the blockchain validate the transaction and simultaneously update the database. In this way, the updated entitlement can be checked on any node. The transaction is completed quickly, without the need for a third party to verify the signatures and payment, and the ownership history is kept in a safe and unquestionable place: the chain.

Among the main potential advantages of blockchain technology, it is worth highlighting:

1. time and cost savings;
2. greater transparency for individuals, companies and authorities;
3. a lower risk of fraud and litigation.

Time and cost savings and greater transparency

In complex transactions for the purchase of goods, for example, buyers issue orders; carriers, delivery notes; sellers, invoices; and the banks release the corresponding funds, all of which are formalized through contracts, contractual conditions and numbering systems that allow tracking, delivery and payment (Rahul C.B.M. 2018).

The use of blockchain technology for these activities would drastically speed up the process, eliminating the current need to include the intermediaries for the validation of documents and the release of products and funds. Likewise, it would generate a clear audit trail of documentary blocks marked with the date and time, which could be accessed by the tax authorities, among others, in real time, which would result in greater transparency and reduce the administrative burden for the involved parts (Yu H.,

2021).

Reduced risk of fraud and litigation

Companies have important administrative expenses in order to guarantee trust with their counterparts and reduce costs of possible misunderstandings, litigation and fraud. This covers the drafting and monitoring of all contracts, as well as compliance, reporting and monitoring, both internally and with its service providers, along with supporting documentation. If the documentation and identity of the participants, as well as their location, the type of asset and its value, were recorded and added to the block chain, any litigation that might arise could be settled by the participants, who would only have to consult that single database, instead of reconciling different databases and contracts.

Main uses of the blockchain technology and possible applications for oil and gas companies

The oil and gas sector presents particularly interesting opportunities to take advantage of blockchain technology in view of the high transaction values (and therefore the risks) and economic pressures to reduce costs. A secure system capable of mitigating risk, increasing transparency, providing an audit trail and speeding up transactions at a significantly lower cost could be of interest to oil and gas companies. Next, taking into account the main applications of blockchain technology, we will examine its possible use in this sector.

One of the advantages of cryptocurrencies, such as bitcoin, is the considerable reduction in costs associated with cross-border payments, in addition to the immediacy of transfers, which eliminate the need for intermediaries and the time required for them to validate and release the funds.

Oil and gas are sold in high volumes, representing considerable value, with a size and scale similar to transactions between banks. Likewise, the frequency of transactions is also high. For example, a refinery that produces 300,000 barrels of oil per day will need to use a large tanker each week to maintain adequate volumes, and such transportation can cost up to US $100 million (two million barrels at $50 each).

Oil companies must also take into account the real origin of the crude oil. Sometimes, exporting nations are subject to sanctions that prevent trade in this raw material. Thus, blockchain technology could provide a fully transparent and secure record of the entire supply chain.

When using a distributed database, digital tokens or currencies can be used to represent the asset that is the subject of the transaction. A recognized authority could issue such digital currencies to meet the needs of businesses or participants. For example, if oil and gas companies were to use a blockchain database to trade barrels of crude oil, the transactions could include digital currencies called Brent or WTI. These coins would represent the underlying asset, a barrel of oil, and would remain linked to it digitally through their journey through the supply chain. Currently, around 9% of crude oil transactions are subject to litigation, which amounts to about 150,000 million dollars annually. Through the use of tokens or digital currencies on a blockchain, payments could be processed faster, documentation such as transfers of ownership would be eliminated, and the number of transactions would be significantly reduced.

Smart contracts

Oil and gas contracting can be complex, with lengthy contracts and agreements. Often, a contract is adjusted based on a change order that needs to be tracked, and in some cases, contracts can be agreed years before they are scheduled to be executed.

Smart contracts are self-executing contracts, based on agreed criteria and written in code, which remove ambiguity from the terms and reduce the need for drafting and interpretation by lawyers. When the contract criteria are met, ownership or payment, for example, are transferred automatically. A smart contract could be modified whenever the parties agree, and a record of all its versions and modifications would be kept. Subsequently, it would be executed automatically once the criteria of the latest version were satisfied. Criteria could include payment or even government authorization of the transaction. This could save time and costs when it comes to interpreting legal terms and keeping track of records, and government authorities could access the relevant parts of the contracts to audit or pre-authorize their tax

treatment (Nikolaev A. 2021, Zhang L., 2022).

Joint ventures are common in the oil and gas sector and generally require a series of complex contracts (e.g. relating to the distribution of costs and benefits), which could take the form of smart contracts. Most contracts contain audit clauses that give the parties the right to audit each other to ensure that they are all complying with the contract. Through the introduction of an on-chain database for the recording of joint venture transactions and the use of smart contracts to define, negotiate and execute contractual terms, it will be provided to all parties involved, including tax authorities. This single audit trail, agreed upon by all participants, will considerably reduce the effort required to ensure timely compliance with tax and reporting obligations, as well as the effort expended by tax authorities to understand tax positions (Balcerzak A, 2021).

In the framework of a global sector, companies in the oil and gas sector must consider the consequences related to double taxation and transfer prices. The use of smart contracts for transfer pricing profit allocation is another area with potential for simplification, greater transparency and overall cost reduction.

Results and Discussion

The context of the chosen process

Petroleum Trading is a young independent company that, being a participant in a highly competitive market, tries to implement modern IT solutions in its business processes. The company interacts with both large and small counterparties, selling all kinds of petroleum products - light and dark petroleum products and LPG.

The company's clients strive to receive their petroleum products quickly and continuously under some types of contracts. However, in general, contracts in the petroleum products market have historically been characterized by a large number of identical transactions, for which a significant number of documents are required, which means time and financial costs [3]. It is in such conditions that the company in question should provide fast payment processing (which mostly depends not on itself, but on its bank), and, accordingly, fast shipment of raw materials.

The process of making transactions from a financial point of view involves several parties, which certainly affects the speed of money transfer between counterparties (Asteriou D., 2021). The modern banking system working with large organizations still does not allow fully automating business processes for the rapid receipt, processing and transmission of payment information from the client to the supplier company (Batae O.M., 2021). On the part of sellers and buyers, there is a large number of involved employees, manual work to maintain the workflow, tracking the execution of the contract and processing payments. It is for this reason that the organization in question seeks to automate its processes to eliminate errors related to the human factor, to ensure fast and correct document flow.

The description and analysis of the chosen process

Making payments on transactions is one of the key processes that is implemented before the delivery of ordered products to customers. As a rule, it is a cycle from placing an order to confirming payment and shipment of goods between the buyer company, the supplier company and the banks of these organizations (or one bank, if both organizations are serviced in one place). At each stage of the transaction process, sets of documents confirming the status of the order should be formed not only for the purposes of internal control over its execution, but also due to legal requirements (tax and other reporting). A simplified diagram of this process is presented in Figure 1.

As follows from the diagram, after placing an order by the client through the official website or mobile application, the Petroleum Trading ERP system forms a contract and a document with payment details and sends them by e-mail to the client. The client, for his part, pays for the order through his bank and sends information to the company. Raiffeisenbank, which is the servicing bank of Petroleum Trading, checks the company's current account and transfers funds to it. After the financial transaction, the bank

notifies both parties about the payment status of the order. From this moment on, the supplier company attaches the order payment notification to the existing package of documents and ships the goods.

This process involves a lot of manual labor in the process of communication between the parties to the transaction, the formation and verification of documents. Since payment must be carried out first of all safely and quickly, it is necessary to minimize all possible risks associated with the imperfection of this process using modern approaches and information technologies.

The process of settlement of transactions in the "as is" state has a number of weaknesses that the company seeks to eliminate by implementing an IT solution into its architecture. The key disadvantages are:

1. document flow, partially carried out by employees of the companies involved;

2. high payment processing time by banking organizations and, accordingly, delays in notification of payment status.

These disadvantages include the possibility of making mistakes due to the human factor and the high cost of the process itself due to operating costs and the volume of current assets.

How the process can be improved

The company, already having its own ERP system, seeks to exclude human labor in the process of paying for orders, speed it up and create a common information space for all participants in the transaction.

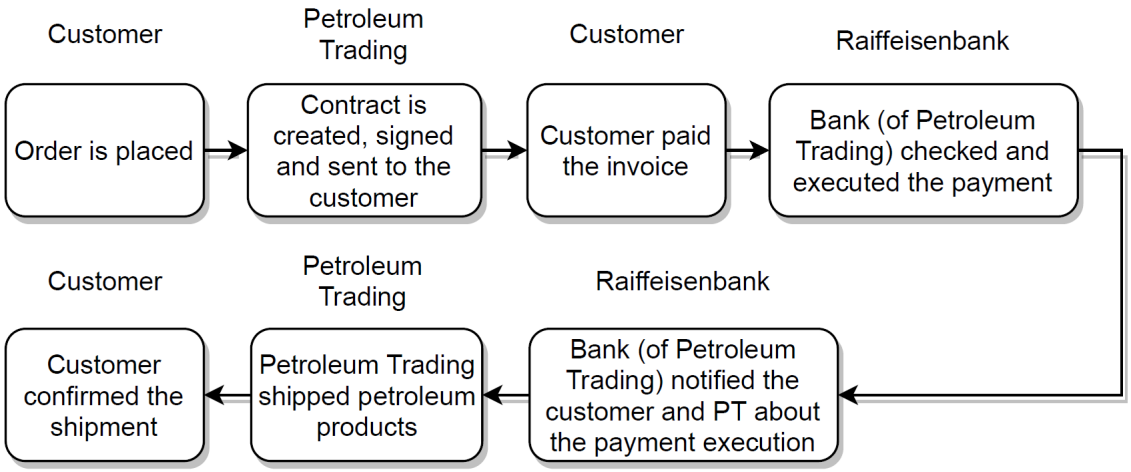


Fig. 1. Payment execution process “AS IS”

A possible option for transforming the order payment process may be to involve a consulting company to conduct research, analyze internal business processes and change them. Such a solution is usually expensive (E&Y company in the Russian market can request up to 200 thousand dollars) and it is possible to deploy it only within the company itself, without the participation of Raiffeisenbank. Also, such a transformation of the business process does not make it flexible in terms of possible changes in the goals and principles of the company. Another possible option is to implement a blockchain platform using smart contracts together with a servicing bank. In this case, the registries of the company and the banking organization are linked for joint fast and automated work. The implementation of the platform requires the active participation of both parties in the project, because it is about the mutual integration of systems sensitive to stored data.

Since Raiffeisenbank is one of the largest banks in Russia, it has sufficient professional resources to develop and deploy a blockchain system and will not require the involvement of third-party specialists (including for security reasons). Petroleum Trading will also involve its own specialists, since the involvement of a third party (that is, a third-party developer company) has some disadvantages:

1. the complexity of supporting the developed solution;

2. the complexity of making changes to an already developed product;

3. the probability of a significant change in cost and execution time during the project.

Thus, the payment process in the "as it should be" state will be a sequence of iterations depicted in Figure 2.

The description of the to be applied technology

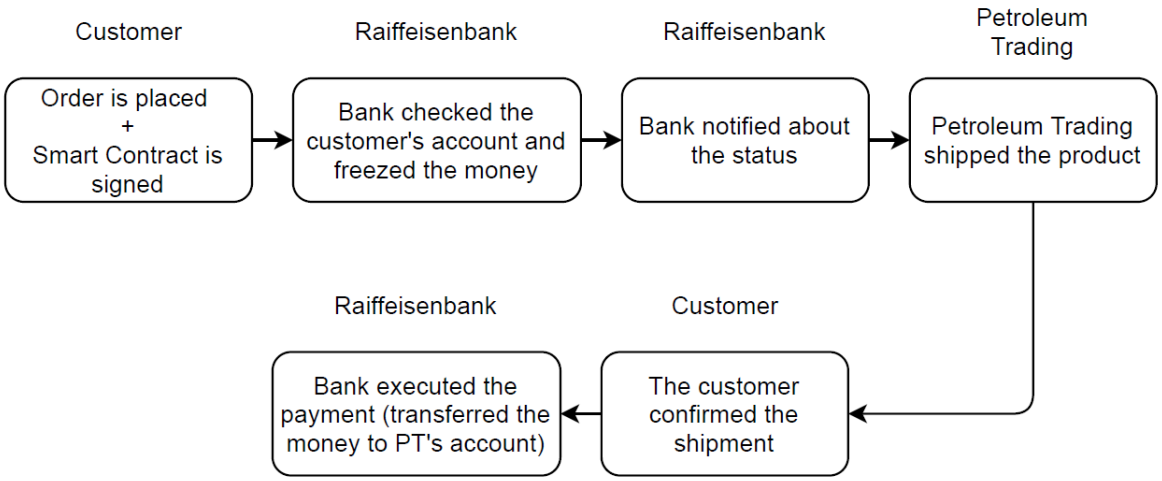


Fig. 2. Payment execution process “TO BE”

Petroleum Trading and Raiffeisenbank have come to an agreement to create a blockchain platform for automating settlements with customers using smart contracts. Smart Contract is a computer protocol designed to verify or execute the terms of a contract in digital form. They help people safely use their assets in an open, conflict-free ecosystem based on blockchain, in other words, they are automated digital versions of traditional real contracts (Zheng Z., 2020).

Any blockchain platform in a broad sense includes many components that determine a number of parameters of the target system – the degree of privacy, stability, speed, bandwidth, and so on.

To determine the functionality necessary for the implementation of the platform, the following initial conditions were set:

1. The execution of the transaction is accompanied by the exchange of documents between the parties.

2. The main settlement of the transaction is made through the usual (fiat) settlement channels.

3. All transactions on the transaction must be legally confirmed as much as possible based on. the current regulatory documents and regulatory provisions.

4. All operations and signals of transitions between operations should be automated as much as possible.

The analysis of the initial conditions implies the need to use the following functional components:

1. Blockchain - as a trusted register of transactions and the execution environment of smart contracts that ensure the transaction.

2. Decentralized File Storage (DFS) - as a medium for storing and sharing files related to a transaction.

3. Certified SCSI - as a means of providing additional encryption, legally significant electronic signatures and protected timestamps. In addition, it can be used to organize an additional virtual file access distribution layer if DFS does not support multi-user access mechanisms.

4. Oracles and providers of external requests - for access to the bank's accounting systems and sources

of events from the outside environment (BlockchainHub, 2019).

5. Document analyzers - for automatic analysis of documents submitted by the parties to confirm the terms of execution of the transaction.

During the preparation and execution of the transaction, the platform components actively interact (Figure 3).

Client software (for example, mobile banking). It is used to enter the initial information on the transaction, create the necessary smart contracts and manage the status of smart contracts at manual stages of the business process. It should be noted that the manual stages of the business process can mean both those stages at which real "personal" user actions are required — for example, attaching documents to a smart contract, and in general any stages at which the status of a smart contract is changed without using its internal logic - outside the blockchain. The latter case can be attributed to the verification of documents attached to the smart contract on the bank's accounting systems, which can occur automatically, but outside the blockchain.

The files attached to the smart contract are signed by an enhanced qualified EDS (electronic digital signature) of the creator for his unambiguous legally significant identification. Further, the files are encrypted with the formation of a crypto package that can be decrypted only by the participants of the transaction. The resulting cryptographic package is placed in DFS, while the hash of the source file is stored on the context of the smart contract, as well as the address (link, manifest) of the storage object given to DFS. The address of the storage object allows you to extract a cryptographic message from DFS, decrypt it (to the participants of the transaction) and process it properly.

When processing transactions, a smart contract can use the information of broadcast oracles, for example, control the date of receipt of a transaction by calendar, use exchange rates, etc.

When switching to a certain status, a smart contract can send a certain request for an expected external event or an order for the execution of an external action to the Provider of external requests. When external events "ordered" by the smart contract occur, the Provider sends a transaction with information about the event to it. Based on the results of processing this transaction, the smart contract can switch to a new state or remain in the same state pending the occurrence of subsequent events.

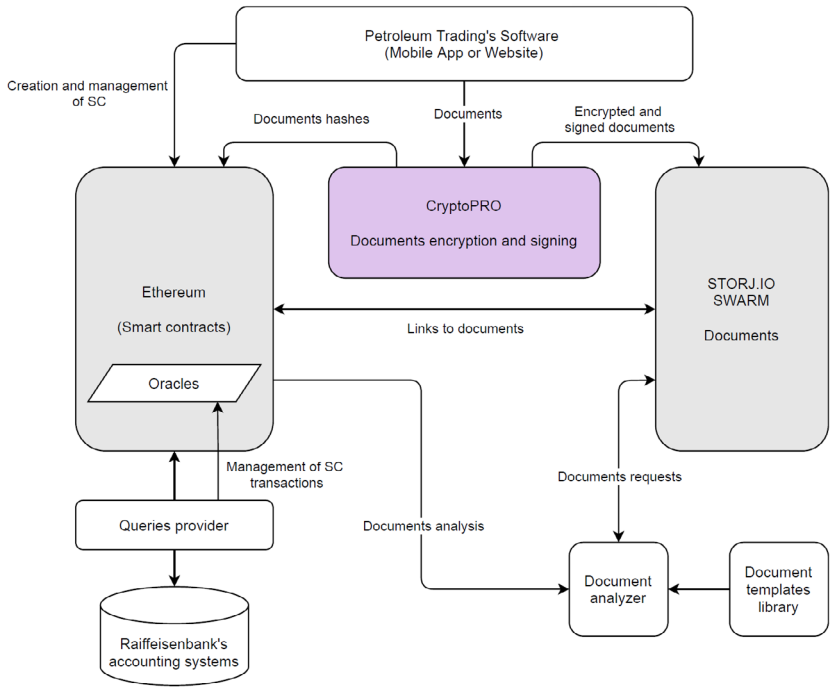


Fig. 3. Platform scheme

Similarly, to external requests, when attaching certain formalized documents to a smart contract, the smart contract can send them to the Document Analyzer for analysis, followed by waiting for a transaction with the results of the analysis.

Implementation including indication of the costs/time, cost benefit analysis and break-even point

The main purpose of the implementation of the blockchain platform between Petroleum Trading and Raiffeisenbank is to reduce the time for making payments, automate the workflow of transactions. This implies, first of all, a reduction in the cost of personnel performing documentation and control tasks and costs associated with a reduction in current assets (about $ 50 000). Development and implementation tasks were carried out by full-time programmers of Petroleum Trading (labor costs for 150 hours about $ 7 500), and Raiffeisenbank developers also participated; their work is paid for the license and maintenance for the company ($15 000 and $ 1 000). A comparison of financial results is presented in Table 1.

Since the transformation of the order payment process affects only indirectly affects the increase in the company's revenue (improving the reputation, improving customer experience, and so on), it is more correct to determine the changes in the company's costs.

Table 1. Financial results analysis

Parameter	Before implementation	After implementation
Revenue (per month)	$ 42 000 000	$ 42 000 000
Costs (per month)	($ 41 900 000)	($ 41 850 000)
Platform investment costs	–	($ 22 500)
Platform operating costs	–	($ 1 000)
Net Profit	$ 100 000	$ 126 500

To calculate the effectiveness, it is necessary to calculate the static indicators IRR (Internal Rate of Return) and PP (Payback Period):

$$IRR = \frac{NP_2 - NP_1}{TIC}$$

$$IRR = (126500 - 100000) * \frac{12}{22500} = 14.13(\frac{1}{year})$$

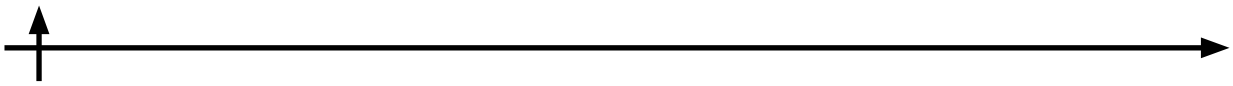
$$PP = \frac{TIC}{NP_2 - NP_1}$$

$$PP = \frac{22500}{126500 - 100000} = 0.85(months)$$

These indicators mean that the development and implementation of the blockchain platform will bring the company about $14 additional profit per year for every dollar of investment costs, and it will pay off in about 0.85 months.

Conclusion

The potential uses of block chain technology are numerous and varied, and it is starting to catch on. In the oil and gas sector, as in many others, companies could be faced with the dilemma of adopting new technologies in a pioneering way and, in doing so, revolutionizing their own sector and business model, or continuing to focus on their main areas of activity and wait for other players to revolutionize the market. The rate at which blockchain technology is adopted and markets transfigured remains to be seen, and to some larger companies, which will need to work side by side to drive innovation and solutions, given the global and collaborative nature of this technology. For their part, oil and gas companies



could consider establishing or becoming part of working groups to explore blockchain technology and its possible applications or start testing it with a trusted partner to better understand this technology and the value it brings.

This paper explored the implementation of a blockchain platform for payment process automation between a supplier and buyers. The creation of such a platform is the result of the joint work of Petroleum Trading and Raiffeisenbank. From the point of view of efficiency, the introduction of blockchain in this process has had a positive impact on the company's financial results. Taking into account the focus of Petroleum Trading on the implementation of innovative solutions in internal business processes, it was able to achieve a significant reduction in the time of payments execution with customers, simplifying document flow and thereby reducing its costs.

Blockchain is a modern tool for supporting many business processes. It ensures data security, connects various process participants with a single information field and reduces the time for performing various operations. For this reason, the company under consideration can expand the functionality of the blockchain platform to transform its processes.

It should also be noted that Raiffeisenbank also benefited from the integration of the platform in the company, because it not only strengthened partnerships with a large client, but also gained the opportunity to attract new customers from among the customers of Petroleum Trading.

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