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DESIGNING A SMART CONTRACT ON THE PLATFORM OF BLOCKCHAIN NETWORK WITH THE AIM OF SAFE SUPPLY OF MEDICINE

Abbas Jamshidi[1,*], Shirin Okhovat[2]

[1]*MSc, Electrical Department, Electricity distribution company of Chaharmahal and Bakhtiari province, Shahrekord, Iran*

[2] *Department of Reproductive Health, Student Research Committee, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran*

ABSTRACT

One of the problems of pharmaceutical companies is preventing the release of counterfeit drugs to the market during the period of drug use. Counterfeit drugs are considered as a very big challenge for pharmaceuticals all over the world. Therefore, it can be said that the pharmaceutical industry suffers from lack of transparency, problem of product tracking, lack of trust and shipment of expired products. Drug tracking should be implemented in such a way that it is economical in terms of the security of the executive network and the absence of human intervention. Drug tracking in the blockchain network platform is a potential solution to create a common platform for an immutable, reliable, accountable and transparent system. In this article, using the blockchain network, the design of a smart contract on the platform of the blockchain network has been discussed and an attempt has been made to present a real model of the drug supply contract to the customers. From the results of this article, we can mention drug safety and cost reduction.

***KEYWORDS*:** Blockchain Network, Drug Supply Chain, Smart Contract, Drug Traceability

1. INTRODUCTION

As one of the most important and vital sectors of health and public health, the pharmaceutical industry is facing many challenges. Among these challenges, I can mention fraud in fake drugs, lack of transparency in the supply chain, and the time-consuming processes of precise and only drugs. These problems not only endanger the safety of patients but also impose additional costs on health systems. Considering these challenges, the use of new technologies such as blockchain and smart contracts can provide an effective solution to improve transparency, safety, and efficiency in the drug supply chain. Blockchain, as a distributed and immutable technology, with the ability to accurately record and track transactions and data in a secure chain, has been able to find many applications in various fields, including finance, logistics, and health. One of the special features of this technology is the possibility of executing smart contracts. Smart contracts are self-executing contracts that

* *Corresponding Author, Email:* abbas.jamshidi133@gmail.com

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automatically perform transactions or execute desired processes after certain conditions are met. In the field of drug supply, smart contracts can be used to ensure the quality of drugs, verify the credibility of supply companies, and more effectively manage the supply process from production to consumption. Relying on blockchain, these contracts are able to increase the transparency and traceability of drugs, and as a result, they can help reduce fake drugs and increase patient safety. Blockchain, as a distributed and immutable technology, with the ability to accurately record and track transactions and data in a secure chain, has been able to find many applications in various fields, including finance, logistics, and health. One of the special features of this technology is the possibility of executing smart contracts (Mhamdi et al., 2022). Smart contracts are self-executing contracts that automatically perform transactions or execute desired processes after certain conditions are met. In the field of drug supply, smart contracts can be used to ensure the quality of drugs, verify the credibility of supply companies, and more effectively manage the supply process from production to consumption. Relying on blockchain, these contracts are able to increase the transparency and traceability of drugs, and as a result, they can help reduce fake drugs and increase patient safety. In order to provide safe and transparent medicine, which leads to increased control and management of the drug market at the level of pharmacies, distributors, and hospitals, specialized solutions have been provided, including the blockchain network (Harris et al., 2009; Blackstone et al., 2014).

Blockchain technology is one of them. It is one of the best options for managing and securing the pharmaceutical supply chain problem. One of the reasons drug supply companies are eagerly moving towards using the blockchain network is that the blockchain network provides an electronically distributed decentralized ledger where information about transactions can be viewed and verified (Khatoon, 2020; Hyperledger, 2025; Wu & Lin, 2019). This technology has very strong advantages because it can help achieve the above goals in various systems. Blockchain consists of linked blocks that form an immutable record of transactions protected by cryptographic hashes. The decentralized nature of blockchain eliminates the need for a central authority and ensures transparency and security (Taherdoost & Madanchian, 2023; Gahrouei & Esfandiari, 2022).

In this article, the review and design of smart contracts in the platform of the blockchain network with the aim of safe supply of medicine is discussed. First, the current challenges and problems in the drug supply chain are identified and analyzed. Then, the role of blockchain and smart contracts in improving these problems will be examined and finally, an effective model for implementing smart contracts will be presented. The purpose of this research is to provide a technological solution to increase safety, transparency and reduce fraud in the drug supply chain.

2. RESEARCH BACKGROUND

Blockchain technology has the ability to track transactions using a decentralized distributed ledger, so this technology is an efficient solution for drug identification and tracking (Tseng et al., 2018). In 2021, an article was presented on how to use blockchain technology to track drugs in the pharmaceutical supply chain. In this article, the blockchain architecture is proposed based on HyperledgerBes4 and Hyperledger fabric. The authors compared these two platforms and stated the challenges that hinder the widespread adoption of blockchain technology for drug tracking (Uddin et al., 2021).

In 2018, a research was conducted by Vladimirplotnio-v on the topic of prospects for the use of digital technology in the pharmaceutical market. The purpose of this research is to analyze the positive effects of the blockchain network on the supply of medicine. The author has investigated the blockchain network with the aim of drug tracking and detection of counterfeit drugs, which results in reducing the number of counterfeit drugs in the market and improving the quality of medical care (Plotnikov & Kuznetsova, 2018).

Biopharmaceuticals are considered one of the key drivers of medicine and the advancement of biological sciences. Considering the unique challenges in biopharmaceutical supply chain management, we should look for a framework that can work with blockchain and has a smart contract based on proof of credit (ROA). In the research carried out using the blockchain network, pharmaceutical products have been protected against theft, counterfeiting, and temperature deviation, and the reliability, efficiency, and responsiveness of the drug supply

chain have been improved (Xie et al., 2019). Illegal drug trade has become a major problem worldwide. In 2019, a research was conducted by Jennifer Cristina and colleagues who proposed a system with the help of blockchain technology to track drugs, which in this system, while controlling the supply chain process, tracked and checked the delivery of drugs (Molina et al., 2019). In 2019, a study was conducted on the topic of combating drug counterfeiting by Monalisasahoo and colleagues. The author has tried to provide a system that is able to trace the drug supply chain and lead to the fight against counterfeit drugs, but he has not done any analysis on the delivery of drugs from end to end (E 2 E) (Sahoo et al., 2020).

In the article (Kumar & Tripathi, 2019), using the blockchain network and QR code, they ensure the safety of medicine. The authors have claimed that by using this method, they have eliminated fraud and corruption in drug us. In the research (Panda & Satapathy, 2021), the author has used the smart contract and the Web3.js library based on the blockchain network for the tracking and transparency of drug supply. In this system, it stores and records all the transfer history of the drug batch. The administrator uploads its details on the platform network. Most exchanges of this category require confirmation of the sender and receiver, and the details of the exchange are permanently stored in the network, which leads to the elimination of the third party and eliminates fraud in the supply of drugs, and finally, a decentralized program for supply We have medicine available.

In the article (Tanvir et al., 2023), he used the blockchain network to track drugs in the supply chain with the aim of transparency. To reduce interoperability challenges between blockchain networks, it has implemented inter-blockchain communication using the Burn-to-Caim protocol. In this article, the author has introduced Hyperledger fabric as the main blockchain and Quorum as another blockchain that provides traceability, transparency and accountability to provide safe and authentic medicines to consumers.

In 2021, a research was conducted with the topic of a blockchain-based approach for drug traceability in healthcare supply chain. Researchers have designed a smart contract in the remix environment using the blockchain network. The researchers tried to design buy and sell order and did not complete the process completely (Musamih et al., 2021).

In 2021, a research was conducted in the field of smart contract design with the aim of supplying medicine in the blockchain network. Using the remix environment, the researchers designed five steps: drug contract registration, price negotiation, purchase order, purchase discount and settlement. The problem of this contract is that if the buyer intends to add medicine during the execution of the contract, this possibility is not included (Omar et al., 2021).

The background works pertinent to this study are summarized in Table. 1.

Table. 1. Summary of research background

Title of the article	Results	Authors	Year
Blockchain for drug traceability: Architectures and open challenges	This article examines the challenges that hinder the widespread adoption of blockchain technology for drug tracking.	Mueen Uddin, Khaled Salah, Raja Jayaraman, Sasa Pesic, Samer Ellahham	2021
Trace and track: Enhanced pharma supply chain infrastructure to prevent fraud	Using the blockchain network, researchers create transparency, authentication, and auditability to trace the origin of a product.	Archa, Bithin Alangot, Krishnashree Achuthan	2017
The Prospects for the Use of Digital Technology "Blockchain" in the Pharmaceutical Market	By using the blockchain network, medical care has improved and the amount of counterfeit drugs has decreased.	Vladimir Plotnikov,Valentina Kuznetsova	2018
Simulation-based Blockchain Design to Secure Biopharmaceutical Supply Chain	By using the smart contract in the blockchain network, they protected pharmaceutical products against theft, counterfeiting and improved the reliability and efficiency of the pharmaceutical chain.	Wei Xie , Bo Wang , Zehao Ye , Wencen Wu	2019
Using Blockchain for Traceability in the Drug Supply Chain	Supply chain process control, drug delivery and tracking in the blockchain network	Jennifer Cristina Molina ,Daniela Torres Delgado , Giovanny Tarazona	2019
A Blockchain Based Model to Eliminate Drug Counterfeiting	Providing a tracking system for drug supply in the blockchain network with the aim of combating drug trafficking	Monalisa Sahoo Sunil Samanta Singhar Sony Snigdha Sahoo	2020
Traceability of counterfeit medicine supply chain through Blockchain	QR code design in the blockchain network with the aim of safe supply of medicine	Randhir Kumar Rakesh Tripathi	2019
Drug traceability and transparency in medical supply chain using blockchain for easing the process and creating trust between stakeholders and consumers	Designing a smart contract and WEB3.JS library based on blockchain network for tracking and transparency of drug supply	Sandeep Kumar Panda Suresh Satapathy	2021
Blockchain interoperability for a reputation-based drug supply chain management	Implementation of the Burnto-Caim protocol with the aim of communicating between the blockchain network and also providing a blockchain network for drug tracking	Deluwar Hussen Tanvir, Ruhul Amin, Ashraful Islam, Mohammad Shamsul Islam, Muhammed Mamunur Rashid	2023
A Blockchain-Based Approach for Drug Traceability in Healthcare Supply Chain	Designing a drug purchase and sale contract using the blockchain network	Ahmad Musamih, Khaled Salah, Raja Jayaraman, Junaid Arshad, Mazin Debe, Yousof Al-Hammadi, Samer Ellahham	2021
Automating Procurement Contracts in the Healthcare Supply Chain Using Blockchain Smart Contracts	Contract design is designed for drug contract registration, price negotiation, purchase order, purchase discount and settlement without taking into account the new needs of the customer.	Ilhaam A Omar, Raja Jayaraman, Mazin S Debe, Khaled Salah, Ibrar Yaqoob, Mohammed Omar	2021

3. RESEARCH METHODOLOGY

The research method of this article is designed as a combination of qualitative and quantitative methods so that both theories and practical data related to smart contracts and blockchain in the drug supply chain are well examined. The flowchart of the implementation of the contract in Remix is as follows (see Fig. 1):

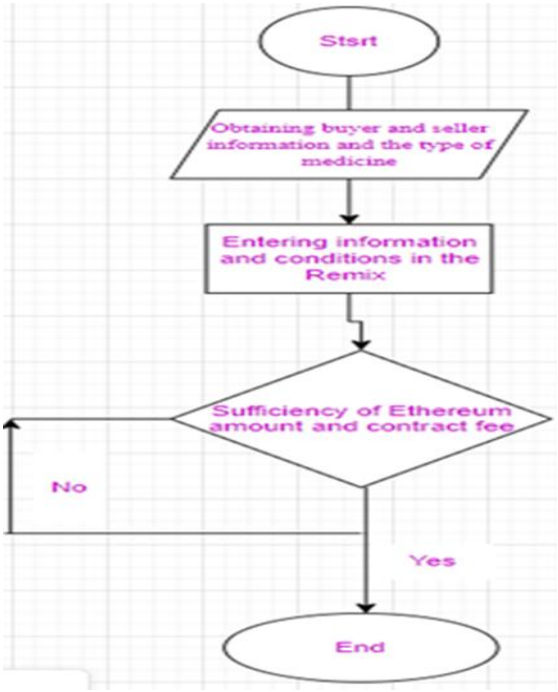

Fig. 1. Contract flowchart

- Reviewing the literature

In the first step, extensive library studies are conducted to explore key concepts related to blockchain, smart contracts, and pharmaceutical supply chain. This stage will include the study of scientific articles, industry reports, and documents related to blockchain technology and smart contracts in the field of health and pharmaceuticals. This step helps researchers to identify current challenges and potential solutions in the field of safe drug supply.

- Analysis of the drug supply chain system

In this step, the drug supply chain process is analyzed in detail. Different components of this chain, including manufacturers, distributors, and pharmacies, will be systematically reviewed. The purpose of this analysis is to identify weaknesses and risk factors in the supply chain that can lead to the entry of counterfeit or unsafe drugs into the market. This analysis is based on interviews with experts and data collected from the pharmaceutical industry.

- Modeling smart contracts

After analyzing the supply chain, a conceptual model for designing smart contracts based on blockchain technology is presented. In this step, modeling tools will be used to simulate different processes in the drug supply chain. The proposed model should include contracts that are able to guarantee drug validity, transparency in distribution, and ensure safety throughout the drug supply path from production to final consumption.

- Implementation of contract in Remix environment

In this step, we implement a contract in the remix environment in Solidity language. The contract is drawn up between the buyer and the seller. The contract must have the ability to add drugs during execution. The contract has been executed correctly when the contract amount and the commission fee have been deducted

from the presented wallet. Therefore, at this stage, the wallet address and also the payment history should be displayed.

4. IMPLEMENTATION

4.1. Smart contract

A smart contract is a program or code that is stored on the blockchain and will be executed without intermediaries and without the need for anyone's approval if certain conditions occur. Blockchain based on Bitcoin or Ethereum and other similar software instructions, which are widely referred to as distributed platform technology, exhibit stability and smart contract (Bayern, 2014). As a permanent transaction management system, this system takes the place of a trusted third-party intermediary in intra-border or cross-border transactions using a mutual consent mechanism. Such a monitoring mechanism occurs based on the instructions given to the artificial intelligence and guarantees the execution of the contract. In the world of DLT (It stands for Distributed Ledger Technology and refers to distributed digital transaction ledgers that store blocks of data distributed across a network of computer nodes), a smart contract is a computer protocol of an algorithm that can confirm, limit or enforce the terms of the contract according to the instructions given to it (CARLA, 2018). To pay for Hoshmed contract, you can use digital currencies, especially Bitcoin Blockchain (Bitcoinbased blockchain) or Ethereum Blockchain, which contain digital currencies as public headers. The smart contract is concluded under the supervision of competent authorities and artificial intelligence, and after the signature of the parties, it is reread by artificial intelligence, and if the terms of the contract match with the instructions given to it, regarding the approval, implementation of the terms of the contract and its registration in the applicable codes. Rereading takes place in chain blocks (Levy, 2017; O'Shields, 2017). The special conditions of concluding a smart contract can be mentioned in two cases:

Recognizing permission to use digital signatures to sign transactions: To sign and conclude smart contracts, people need to obtain permission to use digital signatures. The process of allocating a license to use digital signatures is such that the person who is authorized to conduct transactions in the laws of that country or later his license will be revoked, the license granted to him or the license given to him will be invalidated. They are considered to have the ability to carry out transactions unless it is proven otherwise (Blythe, 2008). The second desired condition is the recognition of the possibility of acquiring virtual currencies in accordance with the Convention on Uniformity of Transactions Based on Virtual Currencies approved in 2017 by the International Trade Law Commission. This resolution states that the acquisition of encrypted currencies for the use of electronic transactions is subject to obtaining a license for the possibility of acquiring these currencies in the competent authorities with the formalities of issuing a license to have digital signatures in Article 2 of the Convention on the Consolidation of Electronic Transactions Based on Approved Virtual Currencies 2017 is also emphasized (Reyes, 2017).

4.2. Creating a smart contract in Solidity language

Solidity language is a programming language for smart contracts based on the Ethereum blockchain, which is used to build decentralized blockchain-based applications on the Ethereum network. The SOLIDITY language is a contract-oriented and high-level language and is the best language for implementing smart contracts. This language is compiled as bytecode executed in the Ethereum Virtual Machine (EVM). Contracts in SOLIDITY are similar to object-oriented languages. which include state variables, functions and events. In order to work in the Solidity language, it is necessary to have an understanding of the basic principles of the blockchain network and how it works. Smart contracts can be created in the Remix web environment. Remix is an open source and online IDE for Solidity development on the Ethereum blockchain.

Remix features include the following:

- Warning about the cost of gas, unsafe code, repetition of variable names and the possibility of constant functions,
- Static analysis,
- Integrated debugger,
- Integrated test and development environment,
- Send directly to mist or Metamask.

The contract in the concept of solidity is a set of code and data located at a specific address in the Ethereum blockchain, and declares a state variable called the stored data of the unit type, which is called the functions of the code that manages the database.

4.3. Designing a smart contract in the blockchain network

To create a smart contract, I enter the Remix IDE page and create a contract with the name of drug contract using the solidity language. The contract that we show the seller and the buyer. The contract is written with solidity version 0.5.16. Contract details include seller, buyer address, contract number, contract type. We create a structure for the buyer structure includes: drug name, lock period, contract signing time, buyer's address and seller's address. The pseudocode below (see Fig. 2) outlines how the specified features were integrated into the developed smart contract.

```
pragma solidity ^0.8.0;  //Let Ethereum know your Programming language

// Define the main contract for managing the medicine supply
contract MedicineSupplyContract {

// Structure to hold information about each drug
struct Drug {
    string name; // Name of the drug
    uint256 lockPeriod; // Duration for which the contract is valid
    uint256 contractSigningTime; // Timestamp when the contract was signed
    address buyer; // Address of the buyer
    address seller; // Address of the seller
}

  // State variables to hold contract information
  address public seller; // Address of the seller
  address public buyer; // Address of the buyer
  uint256 public contractNumber; // Unique identifier for the contract
  string public contractType; // Type of the contract
  mapping(uint256 => Drug) public drugs; // Mapping to store drugs by contract number
  mapping(address => uint256) public paymentHistory; // Mapping to track payment history for each buyer
  uint256 public commissionFee; // Fee charged for the contract
  uint256 public totalAmount; // Total amount due for the contract
  uint256 public lastPaymentTime; // Timestamp of the last payment made by the buyer

  // Events to log significant actions
  event ContractExecuted(address indexed buyer, address indexed seller); // Event for contract execution
  event DrugAdded(string drugName); // Event for adding a new drug
```

```
    event PaymentReceived(address indexed buyer, uint256 amount); // Event for recording a payment

    // Modifier to restrict access to certain functions to the buyer only
    modifier onlyBuyer() {
        require(msg.sender == buyer, "Only the buyer can execute this contract");
        _; // Placeholder for the function body
    }

    // Constructor to initialize the contract with seller and buyer addresses, contract number, and type
    constructor(address _seller, address _buyer, uint256 _contractNumber, string memory _contractType) {
        seller = _seller; // Set the seller's address
        buyer = _buyer; // Set the buyer's address
        contractNumber = _contractNumber; // Set the contract number
        contractType = _contractType; // Set the contract type
    }

    // Function to confirm the authenticity of the drug (placeholder for actual logic)
    function confirmDrugAuthenticity(string memory drugName) internal pure returns (bool) {
        // Implement drug authenticity verification here
        return true; // Placeholder for actual implementation
    }

    // Contract functions are placed here …

}
```

Fig. 2. Pseudo-code structure of the smart contract

For security and confirmation of the sent messages, the following code is designed and written by the sender as a confirmation of the messages. After the correctness of the messages sent by the sender has been confirmed, the correctness of the sent drug must be confirmed. After confirming the authenticity of the messages sent by the sender, the authenticity of the medicine sent must be confirmed.

Also, one of the important things that must be checked in the contract is whether the buyer has the financial ability to pay or not. The buyer must have a sufficient amount of Ethereum currency (Eth) to pay for the contract and his personal wallet.

Time is an important parameter in smart contracts. In smart contracts, it should be specified when the contract ends or how much time is left.

In the last stage, after reading the contract, the buyer and the seller sign it. It should be noted that the contract is executed only if the user is the buyer.

During the execution of the contract, sometimes the buyer intends to purchase a new drug and add a code to the contract.

Payment transactions by the buyer is an important parameter. Transactions indicate whether 30 days have passed since the buyer's last payment.

The following Pseudo-code (Fig. 3) presents the necessary contract functions.

```
    // Function to confirm the authenticity of the message (placeholder for actual logic)
    function confirmMessageAuthenticity() internal pure returns (bool) {
        // Implement message authentication logic here
```

```
        return true; // Placeholder for actual implementation
    }

    // Function to check if the buyer has enough funds for the contract
    function checkFinancialCapability() internal view returns (bool) {
        return (msg.value >= totalAmount + commissionFee); // Return true if sufficient funds are available
    }

    // Function to calculate the remaining time for the contract
    function timeRemaining() public view returns (uint256) {
        return (drugs[contractNumber].contractSigningTime + drugs[contractNumber].lockPeriod) - block.timestamp; // Calculate and return
remaining time
    }

    // Function to execute the contract
    function executeContract() public payable onlyBuyer {
        require(checkFinancialCapability(), "Insufficient funds"); // Check financial capability
        require(block.timestamp >= lastPaymentTime + 30 days, "Payment must be made every 30 days"); // Ensure payment schedule is met

        // Update payment history for the buyer
        paymentHistory[buyer] += msg.value; // Add the received payment to the buyer's history
        lastPaymentTime = block.timestamp; // Update the last payment time

        emit PaymentReceived(buyer, msg.value); // Emit event for payment received
        emit ContractExecuted(buyer, seller); // Emit event for contract execution
    }

// Function to add a drug to the contract
    function addDrug(string memory drugName, uint256 lockPeriod) public onlyBuyer {
        require(confirmMessageAuthenticity(), "Message not authenticated"); // Check message authenticity
        require(confirmDrugAuthenticity(drugName), "Drug not authenticated"); // Check drug authenticity

        uint256 currentTime = block.timestamp; // Get the current timestamp
        // Create a new Drug instance and store it in the mapping
        drugs[contractNumber] = Drug(drugName, lockPeriod, currentTime, buyer, seller);

        emit DrugAdded(drugName); // Emit event for adding the drug
    }

    // Function to display the payment history for the buyer
    function displayPaymentHistory() public view returns (uint256) {
        return paymentHistory[buyer]; // Return the total payments made by the buyer
    }
```

Fig. 3. Pseudo-code structure of the smart contract

After finishing coding, the contract, we start to compile the contract. To pay for the contract, we select the called digital account address and specify the amount of the contract (Gas limit). All the performed transactions can be seen in the History of Remix IDE (see Fig. 4).

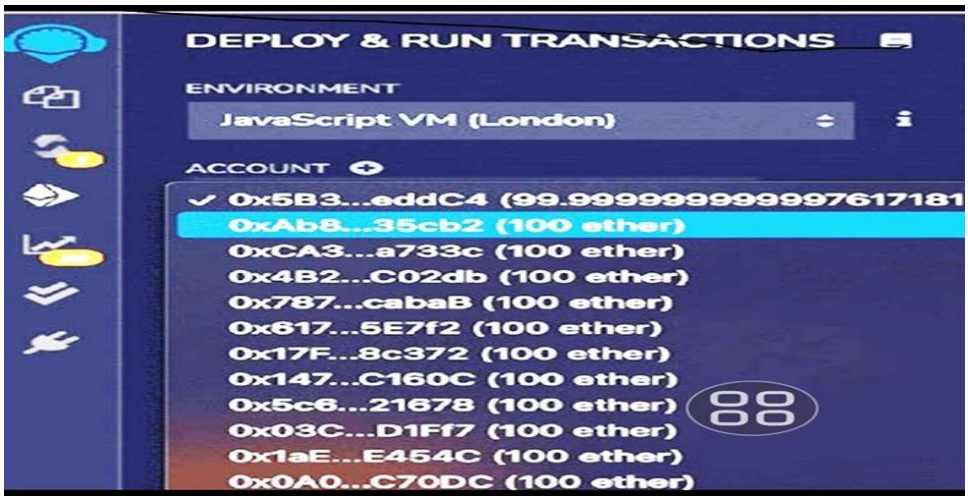

Fig. 4. Pseudo-code structure of the smart contract

5. DISCUSSIONS

In this article, an attempt has been made to design a complete and principled contract for drug suppliers to prevent drug forgery and the spread of counterfeit drugs. This section presents the findings from this research.

5.1. Advantages and disadvantages of smart contracts in the blockchain network

5.1.1. benefit

- Higher transparency and security:
  Due to its decentralized and immutable nature, blockchain increases transparency in the drug supply chain. All stages of the transfer and production of drugs are recorded in the network and these records cannot be changed, so you can be sure of the accuracy and authenticity of the drugs.
- Accurate tracking of medications:
  Using smart contracts, it is possible to track the exact path of medicine from production to consumption. This feature helps to quickly identify counterfeit drugs and prevent them from entering the market.
- Increase operational efficiency:
  Smart contracts automatically execute agreements and execute transactions, reducing the need for intermediaries and increasing the speed of transactions. This helps to reduce costs and processing times (Ioannis ,.
- Reduce costs:
  By eliminating intermediaries and automating processes related to the supply chain, operational costs are reduced. Also, reducing human errors in these processes can lead to more financial savings.
- Increasing trust between parties:
  Smart contracts reduce the need for trust between parties due to their automatic and immutable nature. All information and terms of the contract are visible and unchanged for all parties, which increases transparency and trust (Buterin, 2014).

5.1.2. Disadvantages

- Implementation complexity and costs:

Creating and implementing smart contracts requires specialized skills in programming and blockchain technology, which can increase implementation costs.

- Lack of flexibility:

  One of the biggest problems of smart contracts is their lack of flexibility. After the contract is registered in the blockchain network, it is very difficult to change it, and even if it needs to be changed, its implementation will be costly and time-consuming.

- Legal and regulatory issues:

  Smart contracts are not yet legally recognized in many countries. This can cause challenges in their implementation, especially in jurisdictions that have strict drug supply laws (Zibin ,.

Despite its many benefits, including transparency and security, the blockchain network poses privacy risks. In the following, we will examine these risks and suggest solutions to reduce them:

5.1.3. Privacy risks in blockchain

- Identifying users through transaction data:
  In public blockchains such as Bitcoin and Ethereum, transactions are transparent and anyone can see transaction information. Although users do not display their names directly, through data analysis and matching with other information, the identity of users can be identified.
- Permanent access to data:
  The data stored in the blockchain is immutable and permanent. Therefore, even if a transaction was committed in the past, it can still be accessed. This can lead to leakage of sensitive information over time.
- Transaction tracking:
  Despite the anonymity of user names, all transactions are stored publicly. This allows users and their transaction patterns to be tracked with advanced analytics. Many blockchain analysis software can analyze a chain of transactions to identify users.
- Profiling of users:
  The data stored in the blockchain can be easily used to profile and identify the behavior and transaction patterns of users. This information can allow companies, governments or hackers to monitor user activities.
- Problems associated with smart contracts:
  Smart contracts that run on the blockchain may contain sensitive user data. If this data is not properly encrypted or made publicly available, users' privacy is compromised (Cong & He, 2019).

5.1.4. Solutions to reduce privacy risks

- Using private or permissioned blockchains:
  In public blockchains like Bitcoin or Ethereum, all transactions are public. While private or permissioned blockchains restrict access to data to authenticated users and help maintain privacy. These types of blockchains are more suitable for organizational and sensitive applications. - Blockchains with the ability to completely anonymize some blockchains such as Monero and Zcash 3.
- Use of disposable addresses:
  Instead of using the same address for multiple transactions, users can use disposable addresses for each transaction. This makes it more difficult to track and profile users and helps protect privacy.
- Privacy management platforms:

Development and use of privacy management platforms that can protect users' sensitive data in blockchain transactions are among the effective solutions. These platforms allow users to encrypt the information they don't want shared and publish only the necessary data.

- Encryption of information in smart contracts:

  Smart contracts can store sensitive data such as personal information of users. The use of information encryption in smart contracts helps to maintain the security and privacy of this information and prevents their public disclosure.

The lack of transparency, lack of security and trust in the drug supply chain has led to fraud and increased costs for drug suppliers. To solve these problems, solutions in the blockchain network are suggested as follows:

- In order to increase transparency in the drug supply chain, smart contracts are designed in the blockchain network. These contracts provide information related to each stage of drug supply (such as production, storage, transportation and distribution) in a transparent and unchangeable manner in the network. Blockchain records and gives every stakeholder access to detailed information at every stage.
- By creating a blockchain-based identity verification system that verifies the authenticity of drugs at each stage of the supply chain with the help of smart contracts, it is possible to reduce fraud and forgery in the drug supply chain. This system can work by scanning QR codes or using RFID devices to confirm the identity and source of drug production.
- Using smart contracts to automate regulatory processes and reduce costs related to drug approval and supply reduces regulatory and executive costs. These contracts automatically check data related to compliance with legal regulations and health standards and take appropriate action in case of violation of these regulations.
- By using smart contracts in the blockchain network, consumers and hospitals can have more confidence in the authenticity and quality of medicines. Using data recorded in smart contracts, these platforms can assure consumers and doctors that the drugs they consume are obtained from reliable sources, thereby increasing public trust in the supply of drugs.
- The use of smart contracts for the safe and fast supply of medicine is a fundamental solution to guarantee the supply, quality and delivery time of medicine. These contracts automatically record financial transactions when conditions such as delivering the drug to a specific destination or passing the quality control steps have been fulfilled.

Therefore, with the above solutions, it is possible to eliminate the manual and complex processes of drug supply and improve the monitoring of the supply and distribution of drugs, which will ultimately reduce fraud, improve efficiency and reduce costs.

5.2. Findings

In this article, the design of a drug purchase contract in the blockchain network has been discussed. This contract is done in Solidity language in the remix environment. The contract between the buyer and the seller that we create the payable address (42-character hex string with prefix: "0x") and public variables with uint (256-bit unsigned integer). Payment is done smartly and from the wallet defined in the contract. The fee for transferring Ethereum currency from the buyer's wallet should be the least expensive for the buyer. In smart contracts, a page must be created where the purchased items are approved by the buyer before shipping, therefore, in this contract, a page for confirming the authenticity of the drug is defined so that the buyer can complete the payment process with full confidence while confirming the purchased drug. Confirming the assets of the buyer's wallet is a basic condition to complete the transaction, therefore, a code must be defined to confirm the amount of assets inside the wallet, which will be suspended at this stage of the contract if there is no balance. An important parameter

in a smart contract is its duration. At this stage, it should be coded in such a way that if any of the parties to the contract do not fulfill their obligations within the defined period of time, a fine will be included, so both the seller and the buyer will put a stamp of approval on the provisions of the contract by confirming this period of time. The main problem of smart contracts is that during the execution of the contract, adding the product purchased by the seller is not possible, so it should be coded in such a way that this is possible. In this contract, coding is written in such a way that the buyer can add a new drug by entering the type of drug, its price, and the delivery address of the recipient. To verify the seller's payment for the drugs he adds, we need to code the payment history for a period of 30 days. By checking these transactions, the seller confirms the payment status of the buyer. Finally, the payment page containing the address of the payment wallet is displayed to confirm the validity of the contract and is considered a valid receipt for the buyer.

6. CONCLUSIONS

In conclusion, this study highlighted the critical issue of counterfeit drugs in the pharmaceutical industry, which poses a significant global challenge. The findings indicated that a lack of transparency, ineffective product tracking, diminished trust, and the distribution of expired products contribute to this ongoing problem. Implementing a robust drug tracking system that minimizes human intervention while ensuring economic viability is essential. Our exploration of blockchain technology revealed its potential as a solution, offering a transparent and immutable platform for drug tracking through smart contracts. Ultimately, this innovative approach not only enhances drug safety but also reduces costs within the supply chain, paving the way for a more trustworthy pharmaceutical landscape. The following presents our plans for future works:

- Generalization of smart contracts in the blockchain network by adding a tag or memo in the payment section
- Extending the contract for consumers to submit drug reports
- Adding secondary digital currency for payment
- Extension of the contract to send a copy to the judicial authorities

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