Revolutionizing Molten Gold Ownership Transfer:

Unlocking the Power of Blockchain Technology

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Abstract: Molten gold ownership transfer holds both historical and economic significance, serving as a crucial aspect of financial and wealth management practices. Traditional systems for transferring ownership of molten gold are often inefficient, susceptible to fraud, and lack transparency. In contrast, blockchain technology, with its decentralized, immutable, and transparent characteristics, presents a promising solution to these challenges. This paper explores the transformative potential of blockchain technology in revolutionizing the transfer of molten gold ownership. Utilizing blockchain for this purpose provides a secure and transparent method to track and verify ownership of gold assets. The proposed model facilitates the creation of digital tokens that represent physical gold, which can then be exchanged on a blockchain platform. By highlighting the transformative potential of blockchain in molten gold ownership transfer, this paper contributes to the ongoing discourse at the intersection of blockchain technology and asset management, paving the way for a more efficient, secure, transparent, and decentralized gold market.

Keywords: Molten Gold, Ownership Transfer, Blockchain Technology, Token, Smart Contracts

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1. Introduction

Since the beginning of humanity, gold has been the most expensive and popular metal in the world. It has been used since ancient times to make all kinds of jewelry and ornaments. The origins of gold ownership can be traced back to ancient civilizations, where gold was valued as an indicator of wealth and power. Throughout history, gold has witnessed various forms of ownership transfer including inheritance, conquest, and trade. In modern times, gold ownership transfer has become important due to its role as a safe-haven asset and a hedge against economic uncertainties. The significance of gold ownership transfer lies in its ability to provide individuals and institutions with a means to secure their wealth, diversify their investment portfolios, and preserve value during times of inflation or financial crises. Additionally, gold ownership transfer plays a crucial role in global economies and international trade, as many countries engage in gold transactions to establish monetary reserves and strengthen their currencies (O'Callaghan, 1991; Augusto, et al., 2019).

When buying new gold, you have to pay a percentage as a wage and also a percentage as a seller's profit. Also, a 9% value-added tax is calculated on profits and wages. In buying second-hand gold, you do not pay a percentage as a wage, but the seller's profit and tax are also calculated in this case. But, in buying molten gold you only pay a small amount as profit to the seller and you do not pay any percentage of wages. Therefore, investors have a great desire to buy molten gold (Baur, et al., 2021).

Traditional systems for transferring gold ownership face several challenges and limitations, including physical transfer issues, lack of transparency, time consumption, high transaction costs, limited accessibility, inefficiency, and counterparty risk (Dennin, 2023).

One solution to counter these challenges and limitations is employing blockchain technology. Blockchain technology is a decentralized and transparent digital ledger system that has immense potential to revolutionize gold ownership transfer. By using blockchain, gold ownership can be securely recorded and transferred in a tamper-proof manner, eliminating the need for traditional intermediaries and boosting efficiency. The immutable nature of blockchain ensures that ownership records cannot be altered, providing greater trust and transparency to gold transactions.

Additionally, blockchain enables fractional ownership, making gold more accessible to a larger pool of investors. With its ability to streamline and democratize gold ownership transfer, blockchain technology has the potential to reshape and optimize the gold market, enabling smoother transactions and opening up new opportunities for investors worldwide (Garg, et al., 2022; Chen, et al., 2018).

The purpose of this paper is to explore how blockchain technology can transform the ownership transfer of molten gold. It aims to highlight the potential benefits of utilizing blockchain in the gold market and the challenges it can address.

The key objectives of the paper are:

- ◇ To analyze the existing challenges and inefficiencies in the molten gold ownership transfer process.
- ◇ To explain how blockchain technology can provide transparency, security, and efficiency in molten gold ownership transactions.
- ◇ To discuss the potential impact of blockchain on the molten gold market, including reducing fraud, improving liquidity, and expanding accessibility.
- ◇ To examine the role of smart contracts in automating gold ownership transfer and streamlining related processes.
- ◇ To evaluate the challenges and limitations associated with implementing blockchain in the gold market.

Overall, the paper aims to enlighten readers about the potential of blockchain technology in transforming the molten gold ownership transfer process and fostering a more efficient and secure system. Since we use digital tokens to assign and transfer the ownership of gold, the focus of this research is on molten gold. Because it is possible to assign a digital token to molten gold.

In the next section, we review the previous research in the area of ownership transfer using blockchain technology. Then, We describe the molten gold ownership process without employing blockchain technology. We discuss their challenges and limitations. In the fifth section, we state our blockchain-based model in detail. Afterward, we analyze the functionality, cost, and security requirements of our proposed model. Finally, we discuss and compare our model with previous research.

2. Literature Review

Ownership transfer on the blockchain involves utilizing innovative technologies like RFID tags and smart contracts to streamline the process securely and efficiently. Various papers highlight the significance of blockchain in facilitating ownership transfer, especially in scenarios involving asset management and supply chain ownership. The use of public blockchains guarantees transparent data transfer, maintains data integrity, and provides security against various types of attacks.

Munoz-Ausecha, Cesar, et al. (2023) presented a proof-of-concept system to offer a modernized and practical solution to asset ownership transfer and inventory problem using the advantages of blockchain technology and speeding up the process by using assets identified with UHF RFID technology to permit the reading of many tags that can be embedded and hidden with no need for line of sight, allowing fast ownership transfer using smart contracts in the Ethereum private blockchain.

An RFID ownership transfer protocol with the help of zk-SNARKs (Zero Knowledge-Succinct Noninteractive Arguments of Knowledge) using the Ethereum blockchain was proposed, which enhances the scalability of the supply chain system by creating a trusted setup in off-chain mode (Vijayalakshmi, et al., 2022).

J. Shen, et al. (2022) proposed a blockchain-based accountable auditing protocol with multi-ownership transfer for the first time, which achieved simultaneous achievement of verifiability, accountability, and multi-ownership transferability, merely with very little extra cost.

A group ownership transfer protocol that incorporates blockchains to enable the efficient transfer of large quantities of products and prevent disputes regarding transfer completion was presented, which can resist common off-chain radio frequency identification ownership transfer attacks (Yang, et al., 2022).

PharmaChain was suggested by Bali, V., et al. (2022) for real-time traceability and tractability information of drugs from end-to-end of the pharmaceutical supply chain by creating a Blockchain Network in which each participant and the drug is registered to maintain transparency of transactions among all the participants.

Janbandhu, S. et al, (2023) explored the potential of using blockchain technology for land registration and discussed the current land registration systems and the challenges associated with them, such as fraud, corruption, and inefficiency.

Land and building certificate ownership recording system was built using blockchain technology, which facilitates basic processes in the form of certificate ownership transfer transactions through the functional requirements and improves data transparency by providing various information retrieval features (Syawaludin & Munir, 2021).

A comprehensive blockchain-enabled mobility-as-a-service (MaaS) platform, along with related industries, was presented by Chinaei, M. H. et al. (2023). The authors defined crypto-tickets as a means of service ownership and devised a straightforward smart contract to be executed on the blockchain network. This contract enables customers to exchange service ownership while preserving their privacy.

The significance of gold ownership transfer lies in its ability to provide individuals and institutions with a means to secure their wealth, diversify their investment portfolios, and preserve value during times of inflation or financial crises. Additionally, gold ownership transfer plays a crucial role in global economies and international trade, as many countries engage in gold transactions to establish monetary reserves and strengthen their currencies. Hence, in this paper, we focus on molten gold ownership transfer. Table 1 briefly describes previous research in blockchain-based ownership transfer.

Table 1. A brief description of previous research

Paper	Practical Implications	Employed Methods
Munoz-Ausecha, et al., 2023	◇ Enables secure ownership transfer for IoT supply chain management. ◇ Supports data transfer among resource- constrained RFID tags cost- effectively	◇ Proposed scalable public blockchain- based protocol ◇ Conducted a security analysis verify
Vijayalakshmi, et al., 2022	◇ Enhances product privacy, anti-counterfeiting traceability, and information management ◇ Integrates ownership transfer process of RFID on blockchain for security	◇ RFID ownership transfer protocol with zk-SNARKs using Ethereum blockchain ◇ Generating proof of product code via zk-SNARKs algorithm for privacy and scalability

Paper	Practical Implications	Employed Methods
Shen, et al., 2022	◇ Enhances cloud data integrity verification without data retrieval ◇ Facilitates multi-ownership transfer in auditing for various scenarios.	◇ Homomorphic authenticators and compact multi-signatures for integrity verification ◇ Recording data generation and ownership transfer on immutable blockchains
Yang, et al., 2022	◇ Efficient group ownership transfer with blockchain, preventing disputes and counterfeiting. ◇ Requires fewer messages and less calculation time compared to existing protocols.	◇ Group ownership transfer protocol with blockchain ◇ Employed grouping proof to prevent transfer completion and counterfeiting
Bali, et al., 2022	◇ PharmaChain implementation reduces counterfeit drugs in pharmaceutical supply chain. ◇ Blockchain ensures transparency, traceability and authenticity of drug transaction.	◇ Real-time transfer of ownership in the blockchain ◇ Search feature by batchID, participant name, and medicine name
Janbandhu, et al., 2023	◇ Secure, transparent land registration with reduced time and cost. ◇ Eliminates errors, encourages transparency, and tracks lands efficiently.	◇ Proposed blockchain-based framework ◇ Validated with blockchain-based proof-of-concept system (PoC)
Syawaludin & Munir, 2021	◇ Improves land certificate ownership recording system using blockchain technology. ◇ Enhances data integrity, transparency, and reduces manual system problems.	◇ Hyperledger Fabric permissioned blockchain
Chinaei, et al. , 2023	◇ Blockchain enables secure ownership transfer in Maas Systems ◇ Smart contracts personalize transport ownership, replacing private vehicle concept.	◇ Define crypto- tickets for ownership ◇ Devise smart contract for ownership transfer

3. Molten Gold Ownership Transfer Process

In this section, we describe the traditional methods of molten gold ownership transfer, and their challenges and limitations. We discuss the importance of transparency, security, and efficiency of this process. We discuss the potential impacts of blockchain on molten gold market.

Traditional methods of molten gold ownership transfer are as demonstrated in Table 1 (O'Callaghan, 1993; Ben-David, et al., 2017):

Table 2. The traditional methods of molten gold ownership transfer

Method	Description
Physical Delivery	This is perhaps the most traditional method of transferring gold ownership. In this method, the gold is physically delivered from the seller to the buyer. It involves the transference of physical gold coins, bars, or bullions.
Direct Purchase	This method involves the buyer directly purchasing gold from the seller or a reputable dealer. The ownership is transferred through the issuance of a receipt or certificate of ownership, which represents the buyer's ownership of the gold.
Gold Storage Facilities	Some individuals or institutions prefer to store their gold in specialized vaults or storage facilities. In this case, ownership is transferred when the gold is deposited into the storage facility and the facility issues a certificate or receipt confirming the client's ownership.
Exchange-Traded Funds (ETFs)	ETFs are financial instruments that represent ownership of physical gold held by a trust or custodian. Transfer of gold ownership occurs when investors purchase shares of a gold ETF (Ben-David, et al., 2017).
Gold Certificates	Gold certificates are issued by certain banks or financial institutions, representing the owner's claim to a specific amount of gold held by the issuer. Ownership can be transferred by transferring the certificate to another individual or entity (Simmons, 1936).

Traditional systems often consist of four steps: documentation and verification, physical transfer, intermediary intervention, and manual registration. Additionally, these systems face several challenges and limitations (Ben-David, et al., 2017).

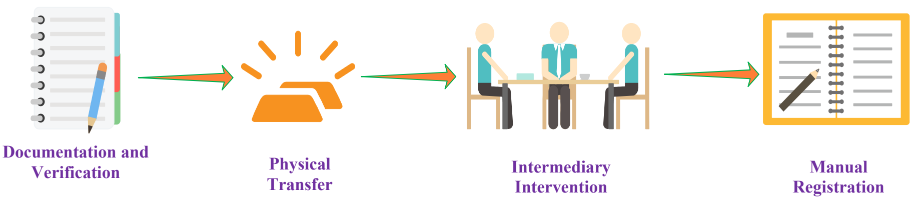

Fig 1. The steps of traditional methods of molten gold ownership transfer

Traditional methods of transferring ownership of molten gold typically involve the physical transfer of the gold from one party to another. This process can be challenging and costly, particularly when dealing with large quantities. Additionally, it often necessitates extra security measures to ensure the gold's safety during transportation. A lack of transparency can make it difficult to verify the authenticity and purity of the gold being transferred, increasing the risk of fraud or the exchange of counterfeit gold. Furthermore, these methods can be time-consuming, especially when multiple parties are involved or when cross-border transfers are necessary. Such complications can lead to delays in completing transactions and settling payments(Idrees, et al., 2021).

Traditional methods of transferring ownership of molten gold can incur significant transaction costs, including fees for storage, insurance, transportation, and the intermediaries involved in the transfer process. These expenses can diminish the overall value of the transaction.

profitability of gold transactions may be limited by accessibility, particularly for individuals or businesses operating in remote areas or countries with inadequate infrastructure for gold trading. This limitation can hinder the participation of smaller players in the gold market (Angell, 1934).

Lack of efficiency is another challenge associated with these methods. Manual processes can lead to errors and delays, resulting in inefficiencies in the gold market that increase costs and reduce liquidity. Furthermore, the reliance on manual processes and documentation complicates the automation and streamlining of the transfer process. This complexity can hinder the adoption of digital technologies and innovative solutions within the gold market. Traditional methods are often subject to various regulatory constraints, including compliance requirements, licensing, and reporting obligations. These constraints can add complexity and costs to the transfer process, particularly for international transactions (Selmi, et al., 2021).

Traditional methods can involve counterparty risk, particularly when engaging with unfamiliar or untrusted parties. This risk encompasses the potential for non-delivery, fraud, or default on payment obligations, which can lead to financial losses for the parties involved (Schlichting & Petrini, 2019).

As outlined above, transparency, security, and efficiency are essential components of molten gold ownership transfer. Transparency guarantees that the process of transferring gold ownership is clear, visible, and easily comprehensible to all parties involved. It fosters trust and confidence in the transaction. Being transparent involves offering clarity about ownership details, transfer terms, and any associated costs or fees. This clarity helps prevent misunderstandings, disputes, and fraudulent activities. Furthermore, transparent ownership transfer processes provide valuable information to regulatory bodies, allowing them to ensure compliance with legal and regulatory frameworks.

Gold ownership transfer involves valuable assets that must be adequately protected against theft, loss, or unauthorized access. The transfer process should incorporate robust security measures to safeguard the asset and ensure its integrity. This includes secure transportation methods, verification procedures, and secure storage facilities. Implementing stringent security measures enhances trust among the parties involved, mitigates the risk of theft or fraud, and protects the value of the transferred asset (Schlichting & Petrini, 2019).

Moreover, an efficient molten gold ownership transfer process ensures that the transaction is completed promptly and without unnecessary delays or complications. Efficiency helps save time, costs, and effort for both parties involved. By streamlining the transfer process, eliminating manual tasks, and utilizing technology solutions, efficiency can be achieved. This is particularly valuable when transferring gold assets across geographical boundaries or between various parties involved in the supply chain. An efficient transfer process also enhances liquidity by making it easier to buy or sell gold, thus boosting market activity.

In summary, transparency, security, and efficiency in gold ownership transfer are vital to maintain trust, protect the asset, prevent fraud, comply with regulations, and facilitate smooth and timely transactions.

By employing blockchain technology in gold ownership transfer, the above mentioned requirements are satisfied. Hence, in the following we explore the blockchain technology, and its basic features in detail.

4. Revolutionizing Gold Ownership Transfer with Blockchain

In this section, we describe how the blockchain technology can deal with challenges and limitations of the traditional methods for molten gold ownership transfer. Our proposed solution has the following steps:

◇ Confirmation of gold: Before starting any kind of transfer, the authenticity and quality of molten gold must be confirmed. This can be done through an approved assay process that confirms the purity and weight of the gold.

◇ Tokenization: Molten gold can be tokenized on the blockchain and digital representations of physical gold can be created. Each token represents a specific amount or weight of gold and is uniquely identifiable.

◇ Ownership transfer: When the user wants to transfer the ownership of his gold, he can start a transaction in the blockchain. This transaction includes the wallet address of the sender and receiver and the number of gold tokens being transferred.

To implement the aforementioned steps, we need smart contracts to automate the ownership transfer process. Smart contracts are self-executing agreements with predefined rules and encoded conditions. They verify the transfer request, assess the sender's ownership rights, update the ownership records, and execute the transfer if all conditions are satisfied. Furthermore, ownership transfer depends on the consensus mechanism of the blockchain network, which ensures that all network participants agree on the validity of the transaction and its inclusion in the blockchain.

To design the blockchain-based molten gold ownership transfer system, we will first outline the user stories, as explained in the following section.

4-1. User Stories

The purpose of this section is to accurately describe the users involved in the process of transferring ownership of molten gold. We outline their requirements to inform the design of our proposed blockchain-based system. There are five users who are stakeholders in our proposed system. We present their requirements in their own words, as illustrated in Table 2:

Based on the user story and the specified requirements, we have identified the following three features to include in our design:

◇ Validation of Ownership Transfer: This feature is crucial for ensuring the accuracy of ownership transfers. To achieve this, a smart contract can be utilized to verify the ownership rights of the sender and validate the recipient's address. Specifically, a smart contract is responsible for checking digital signatures, verifying ownership records, and ensuring that transfers adhere to predefined rules and conditions. By effectively implementing this feature, it is possible to prevent unauthorized transfers and maintain the integrity of ownership records on the blockchain.

◇ Tokenization:This feature enables the creation of digital representations of molten gold, facilitating easy transfer and tracking on the blockchain. Prioritizing this feature requires the development of a mechanism for tokenizing molten gold, associating each token with its unique weight or quantity, and implementing a verification process to ensure the authenticity and quality of the gold.

◇ Transparent Ownership History and Auditability: Transparency and auditability are crucial for fostering user trust. By prioritizing this feature, we can concentrate on functional implementation, enabling users to access the ownership history and transaction records linked to each gold token.

By concentrating on these features, we can establish a secure, transparent, and efficient system for transferring ownership of molten gold through blockchain technology. In the following section, we will outline the design and implementation details of our proposed model.

4-2. Design and Implementation

After describing the user stories, we can design our proposed blockchain-based model, as illustrated in Figure 2.

Table 3. The user story of molten gold ownership transfer process

Algorithm: GoldOwnership Contract

```
Data: owner, weight, goldId, buyer, amount, seller
Result: Manage gold ownership and transactions
Initialize:
  goldCount ← 0
Function meltGold(owner, weight) returns (goldId)
  if weight > 0 then
    goldId ← goldCount
    newGold ← {owner: owner, weight: weight, isMelted: true}
    golds[goldId] ← newGold
    transactions[goldId].append(owner)
    emit GoldTransferred(goldId, 0, owner)
    goldCount ← goldCount + 1
    return goldId
  else
    return "Invalid weight"
  end if
Function initiatePurchase(goldId) payable
  if goldId >= goldCount then
    return "Invalid gold ID"
  else
    if not golds[goldId].isMelted then
      return "Gold is not melted"
    else
      if msg.value <= 0 then
        return "Payment must be greater than zero"
      else
        if golds[goldId].owner == msg.sender then
          return "Buyer cannot be the owner"
        else
          frozenPayments[goldId] ← msg.value
          buyers[goldId] ← msg.sender
          emit PaymentFrozen(goldId, msg.sender, msg.value)
        end if
      end if
    end if
  end if
Function transferGold(goldId)
  if goldId >= goldCount then
    return "Invalid gold ID"
  else
    if not golds[goldId].isMelted then
      return "Gold is not melted"
    else
      if golds[goldId].owner != msg.sender then
        return "Only the current owner can transfer the gold"
      else
        if buyers[goldId] == address(0) then
          return "No buyer available"
        else
          newOwner ← buyers[goldId]
          golds[goldId].owner ← newOwner
          transactions[goldId].append(newOwner)
          payment ← frozenPayments[goldId]
          frozenPayments[goldId] ← 0
          buyers[goldId] ← address(0)
          payable(msg.sender).transfer(payment)
          emit GoldTransferred(goldId, msg.sender, newOwner)
          emit PaymentReleased(goldId, msg.sender, payment)
        end if
      end if
    end if
  end if
Function getTransactionHistory(goldId) returns (address[] memory)
  return transactions[goldId]
```

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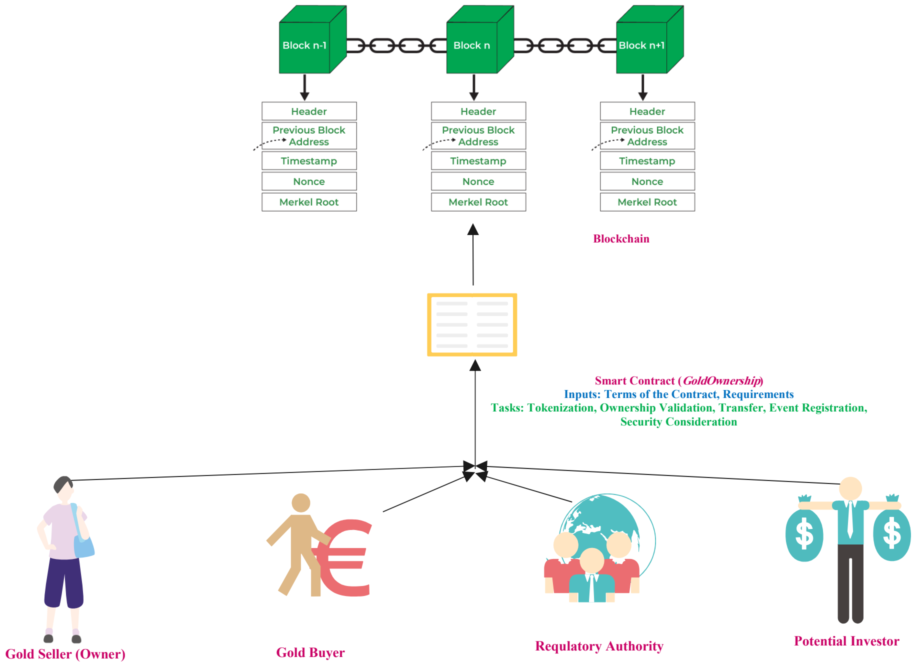

Fig 2. The proposed blockchain based model

We first explain the required components for designing the smart contract, which is demonstrated in Figure 2.

◇ **Contract structure:** The smart contract has a defined structure, including variables to store ownership records and a mapping to associate each gold token with its owner's wallet address. It also includes functions to facilitate ownership transfer and event notification to record important actions.

◇ **Tokenization:** The smart contract incorporates a mechanism to tokenize molten gold, thereby creating a digital representation of physical gold on the blockchain. Each token will be uniquely identifiable and linked to specific attributes, such as weight and quantity.

◇ **Ownership Validation:** Our proposed smart contract includes a function to verify ownership before allowing transfers. By validating the digital signature or checking the ownership records stored on the blockchain, it confirms whether the sender has legal ownership of the gold tokens they intend to transfer.

◇ **Transfer Carry out:** After the successful ownership verification, the smart contract transfers the ownership by updating the ownership records and transferring the gold tokens from the sender's address to the receiver's address. This transfer is done atomically and ensures that ownership is either completely transferred or not transferred at all.

◇ **Event Registration:** The smart contract emits events for important actions such as token creation and ownership transfer. These events provide a transparent and auditable history of ownership transfers and allow users to track and verify the legitimacy of transfers.

◇ **Security Considerations:** The smart contract will include necessary security measures to prevent unauthorized access and address potential cases.

In the following, we describe the implementation details of the smart contract, which is called *GoldOwnership*. This smart contract facilitates the ownership transfer of molten gold. It provides the basic capabilities to track ownership transfers of molten gold on the blockchain.

First, a new gold record is created using the *meltGold* function. If the gold weight is greater than zero, a new gold object is created with the owner, weight and melt state and stored in the contract data structure. In addition, the transaction history of this gold starts with the addition of the original owner and a gold transfer event is issued. The initiatePurchase function allows users to buy gold by paying an amount. If the conditions are met (the *gold ID* is valid, the gold is melted, the payment amount is positive and the buyer is not the owner), the payment amount is frozen, the buyer is registered and a payment freeze event is issued. The *transferGold* function is used to transfer ownership of gold. If the conditions are met (the gold ID is valid, the gold is melted, the caller is subordinate to the current gold owner and the buyer is registered), ownership of the gold is transferred to the new buyer, the transaction history is updated and the frozen amount is transferred to the current owner. Two events are issued for gold transfer and payment release. The *getTransactionHistory* function returns the transaction history of a specific gold. This structure enables users to manage gold ownership and transfer transparently and securely.

5. Evaluation

This paper proposed a model that allows the creation of digital tokens that can be exchanged on a blockchain platform. In this section, we analyze the functionality, cost, and security requirements of our proposed model.

5-1. Functional Analysis

This type of analysis focuses on verifying the functional aspects of the blockchain system, such as validating transactions, executing smart contracts, and ensuring that the system behaves as expected.

A scenario was designed and implemented to test the proposed system. In this scenario, User 1 is the owner and seller of the gold, and User 2 plans to purchase it. As shown in Figure 3, the steps to implement this scenario are as follows:

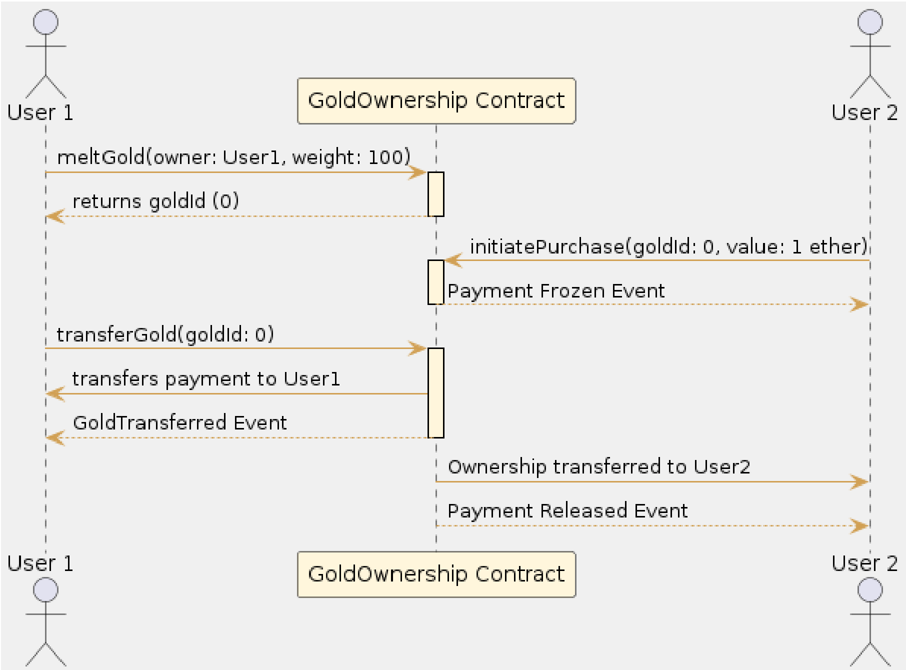

Figure 3. Sequence diagram for the proposed system

In this scenario, Users have the addresses "0xAb8483F64d9C6d1EcF9b849Ae677dD3315835cb2" and "0x4B20993Bc481177ec7E8f571ceCaE8A9e22C02db", respectively. Moreover, the weight of gold is "100 gr", and the payment amount is "10 eth". The test scenario steps are shown in Table 3.

Table 4. Test Scenario Steps

Steps	Description	Figure
Step 1: Melting Gold by User 1	**User 1 Melts Gold:** ◇ Select the **meltGold** function. ◇ Enter User 1's address (use **accounts[0]** for default) and the weight of the gold, for example, **100**. ◇ Click **transact** to melt the gold.	Figure A-1
	Expected Result ◇ A gold ID (e.g., **0**) should be generated. ◇ check the gold details using the **golds** function with the gold ID.	Figure A-2
Step 2: Initiate Purchase by User 2	**User 2 Freezes Payment:** ◇ Select the **initiatePurchase** function. ◇ Enter the gold ID (e.g., **0**) and the payment amount, for example, **1** ether (in Wei: **1000000000000000000**). ◇ Click **transact** to freeze the payment.	Figure A-3
	Expected Result ◇ The payment amount should be frozen, and User 2's address should be stored as the buyer. ◇ Check the frozen payment using the **frozenPayments** function with the gold ID. ◇ Check the buyer's address using the **buyers** function with the gold ID.	Figure A-4
Step 3: Transfer Ownership by User 1	**User 1 Transfers Ownership:** ◇ Select the **transferGold** function. ◇ Enter the gold ID (e.g., **0**). ◇ Click transact to transfer ownership.	Figure A-5
	Expected Result ◇ Ownership should be transferred to User 2. ◇ The payment amount should be transferred to User 1. ◇ Check the gold details using the **golds** function with the gold ID to see the new owner. ◇ Check the **frozenPayments** function to ensure the payment amount is 0.	Figure A-6

The test scenario was executed for two users, and the transaction history for different users is illustrated in Figure 4.

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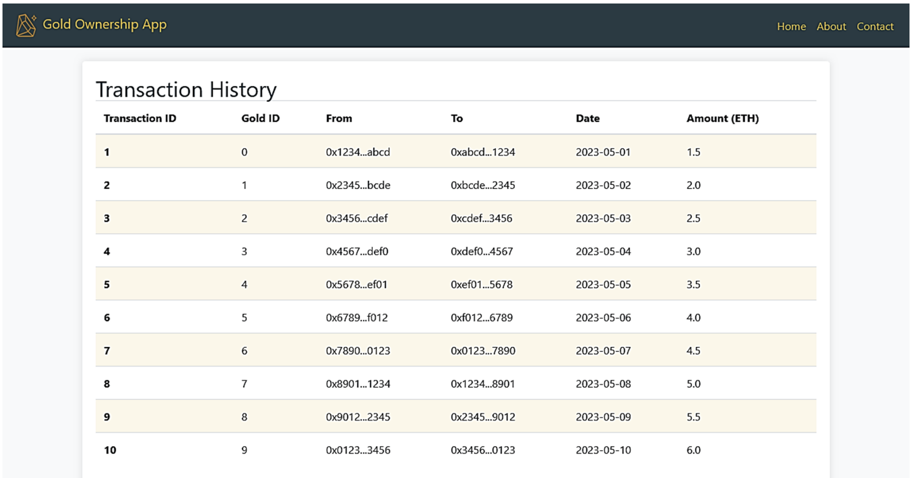

Transaction ID	Gold ID	From	To	Date	Amount (ETH)
1	0	0x1234...abcd	0xabcd...1234	2023-05-01	1.5
2	1	0x2345...bcde	0xbcde...2345	2023-05-02	2.0
3	2	0x3456...cdef	0xcdef...3456	2023-05-03	2.5
4	3	0x4567...def0	0xdef0...4567	2023-05-04	3.0
5	4	0x5678...ef01	0xef01...5678	2023-05-05	3.5
6	5	0x6789...f012	0xf012...6789	2023-05-06	4.0
7	6	0x7890...0123	0x0123...7890	2023-05-07	4.5
8	7	0x8901...1234	0x1234...8901	2023-05-08	5.0
9	8	0x9012...2345	0x2345...9012	2023-05-09	5.5
10	9	0x0123...3456	0x3456...0123	2023-05-10	6.0

Figure 4. Transaction history

5-2. Cost Analysis

Ethereum smart contract functions spend gas when triggered. The gas cost of a function is contingent on the function in the smart contract comprising its inputs, outputs, size of the Solidity code, and its complexity. These form the execution cost of the transaction. In addition, the cost of sending the transaction to the Blockchain is added to the execution cost to make up the transaction cost. The actual price paid by the Blockchain platform depends on the gas price that it sets. The gas price chosen by the platform is multiplied by the gas price of the transaction to compute the number of ethers to be paid. Higher gas prices guarantee faster transaction execution as it would be more compelling to miners for higher rewards. Miners have little interest in mining transactions with low gas prices and would hardly pick them.

Table 4 presents the transaction and execution costs of the aforementioned smart contract across various blockchain platforms. The gas costs have been converted to fiat currency (USD) to enhance readability. As previously mentioned, the actual cost of the transaction is contingent upon the gas price of the network.

Table 4. the proposed model gas costs in various Blockchain platforms in USD

smart Contract	Gas	Ethereum		Binance Smart Chain		Polygon		Celo		Fantom	
		Standard	Fast	Standard	Fast	standard	fast	Standard	fast	Standard	fast
GoldOwnership (Transaction cost)	1401859	26.3029	26.3029	0.8440	0.8440	0.0305	0.0366	0.0012	0.0012	0.0147	0.0159
GoldOwnership (Execution cost)	1266070	23.7255	23.7255	0.7619	0.7628	0.0276	0.0312	0.0011	0.0011	0.0123	0.0134

5-3. Security Analysis

As described by Shigemura and Rafael (2019), Oyente is a symbolic execution tool specifically designed to analyze Ethereum smart contracts. It adheres to the execution model of Ethereum smart contracts and operates directly on Ethereum Virtual Machine (EVM) bytecode, without relying on a high-level representation such as Solidity. This design choice is crucial, as the Ethereum blockchain only stores the EVM bytecode of contracts, not their source code.

We ran Oyente on the GoldOwnership smart contract. The results of the security evaluation for the mentioned smart contract are demonstrated in Figure 4, which indicates that the smart contract is secure against vulnerabilities.

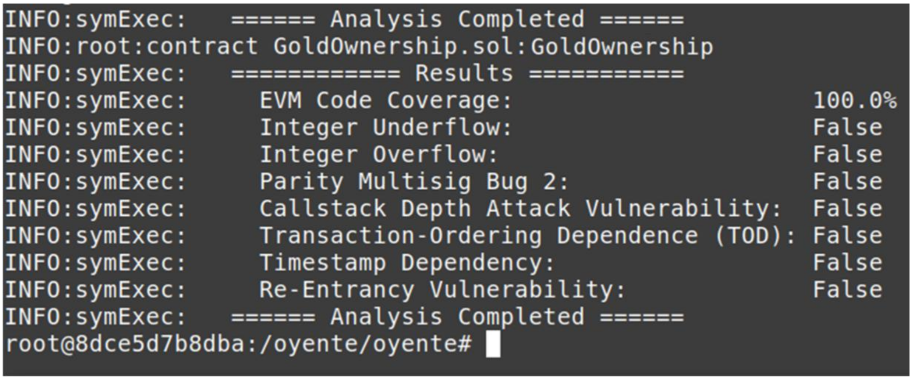

Fig 5. The Oyente result on GoldOwnership smart contract

6. Discussion

The transfer of molten gold ownership plays an important role in the global economy and international trade, as many countries trade gold to build foreign exchange reserves and strengthen their currencies. Therefore, this paper focused on the transfer of molten gold ownership.

Table 5 briefly compares the current literature with previous research on blockchain-based ownership transfer.

Table 5. Comparison of the current literature with previous research

Paper	Contribution	limitation	Evaluation		
			Cost	Security	Functional
Munoz-Ausecha, et al., 2023	◇ The paper presents a proof-of-concept system using blockchain technology and RFID tags for asset ownership transfer and inventory management. ◇ The authors used Ethereum Solidity smart contracts and web interfaces for user access to blockchain data.	◇ Centralized systems, paper forms, wet signatures lead to time consumption ◇ Lack of awareness about blockchain technology poses integration challenge	✓	✗	✗
Vijayalakshmi, et al., 2022	◇ Supply chain management importance realization. ◇ Integration of blockchain with supply chain management.	-	✓	✓	✗
Shen, et al., 2022	◇ Proposal of a blockchain- based accountable auditing protocol with multi-ownership transfer. ◇ Development of a novel tag structure for integrity verification and multi-ownership transfer	◇ No existing protocol for multi-ownership scenarios in literature. ◇ Lack of solutions for auditing and transferring data of multiple owners.	✓	✗	✗

Paper	Contribution	limitation	Evaluation		
			Cost	Security	Functional
Yang, et al., 2022	◇ High- efficiency group ownership transfer protocol with blockchain integration. ◇ Prevention of disputes regarding transfer completion and counterfeiting.	◇ Incomplete transfer and product loss are inevitable in frontend supply chains. ◇ Disputes regarding transfer completion can occur.	✓	✓	✓
Bali, et al., 2022	◇ Blockchain technology can reduce drug counterfeiting in the pharmaceutical supply chain. ◇ The paper implements PharmaChain for real-time traceability and trackability of drugs.	◇ Only privileged actors can transact, enhancing security against counterfeit drugs.	✗	✗	✗
Janbandhu, et al., 2023	◇ World Bank supports land registration system improvement in various countries. ◇ Proposed blockchain-based framework for decentralized land management system	◇ Time consuming land registry process with physical document maintenance. ◇ Cumbersome title investigation due to multiple outdated records and departments.	✗	✗	✗

Paper	Contribution	limitation	Evaluation		
			Cost	Security	Functional
Syawaludin & Munir, 2021	◇ Land and building certificate ownership recording system using blockchain technology. ◇ Utilizes Hyperledger Fabric for decentralized, anti-tamper properties, and data integrity	◇ Loss of physical certificates ◇ Weaknesses and loopholes in manual system	✗	✗	✓
Chinaei, et al. , 2023	◇ Develops distributed architecture for MaaS using blockchain technology. ◇ Introduces crypto-tickets and smart contracts for ownership exchange.	◇ Traditional membership plans compared against blockchain- based ownership scheme ◇ Evaluation conducted through simplified simulation instance in MATLAB	✓	✓	✗
Our Paper	◇ Explore how blockchain technology can transform the ownership transfer of molten gold. ◇ It aims to highlight the potential benefits of using blockchain in the gold market and the issues it can address.	-	✓	✓	✓

7. Conclusion

Molten gold ownership transfer is a crucial component of financial and wealth management practices. Traditional methods for transferring ownership of molten gold are often inefficient, susceptible to fraud, and lack transparency. However, blockchain technology, with its decentralized, immutable, and transparent characteristics, presents a promising solution to these challenges. We explored the transformative potential of blockchain technology in revolutionizing the transfer of molten gold ownership. Utilizing blockchain for this purpose offers a secure and transparent method to track and verify ownership of gold assets. This system enables the creation of digital tokens that represent physical gold, which can subsequently be exchanged on a blockchain platform.

In this paper, we analyze the current challenges and inefficiencies in the transfer process of molten gold ownership. We explain how blockchain technology can enhance transparency, security, and efficiency in transactions involving molten gold ownership. Moreover, we discussed the potential impacts of blockchain on the molten gold market, including its ability to reduce fraud, improve liquidity, and expand accessibility. Additionally, we examined the role of smart contracts in automating the transfer of gold ownership and streamlining related processes. Finally, we evaluated the challenges and limitations associated with implementing blockchain technology in the gold market.

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Appendix

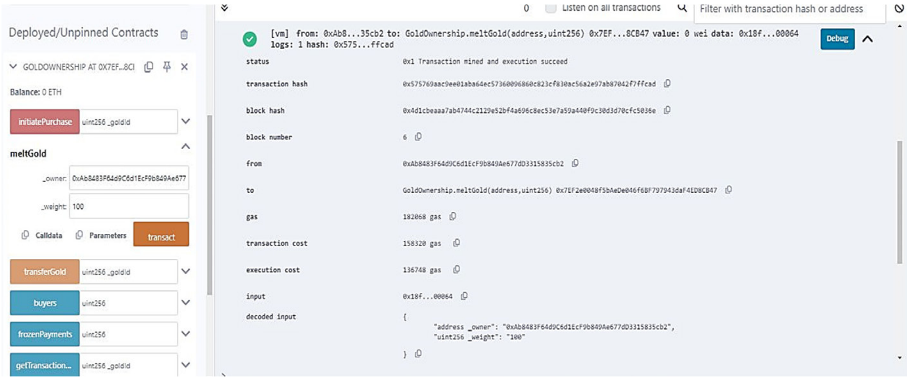


Figure A-1. Melt gold transact

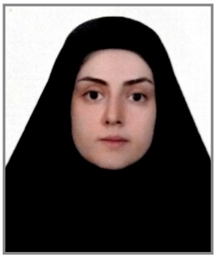
Figure A-2. Call melt gold

Figure A-3. Initiate Purchase

Figure A-4. Buyer check

Figure A-5. Transfer ownership

Figure A-6. Freez payment



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