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THE USE OF BLOCKCHAIN TECHNOLOGY AND SMART CONTRACTS IN ACCOUNTING

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Abstract *This study aims to examine the use of blockchain technology and smart contracts in accounting. Accounting is one of the sectors that is suitable for the use of different technologies because of both human and system errors. Blockchain technology, which is decentralised and not affected by malicious interference by parties, is the most likely technology to be used with accounting. Compared to traditional accounting records, owing to the three-entry accounting system, records can now be followed instantly rather than for specific periods. In addition, blockchain technology, which provides benefits such as the inability of personnel and auditors to manipulate records, enables various activities, from automating business processes in accounting to creating a more transparent accounting ecosystem thanks to smart contracts. In this vein, we aim to examine the potential benefits that this approach will provide to the field of accounting by researching smart contracts.*

Keywords: *Accounting, Blockchain, Smart Contracts*

INTRODUCTION

The unstoppable advancement of technology has resulted in the development of blockchain technology, a distributed network that prevents data tampering (Bonson & Bednarova, 2019). Blockchain technology, as a revolutionary paradigm that introduces a new perspective to secure information and data sharing, is becoming increasingly popular in many fields because transactions are carried out without the involvement of third parties and are shared in a distributed system. Blockchain technology, which is employed in numerous fields, including finance, health, public services, and the military (Krichen et al., 2022), is predicted to have a major effect on accounting in terms of instant information sharing (Schmitz & Leoni, 2019). For instance, when accounting records are shared by all nodes in the network after they are published on the public blockchain, reporting and auditing can be conducted more transparently. Furthermore, as the data transfer is automated, blockchain enables financial statements to be kept up-to-date (Yu et al., 2019). Smart contracts play a key role in the emergence of blockchain technology in accounting. Smart contracts allow financial transactions to be performed automatically by means of a set of rules. Therefore, organisations' dependence on intermediary institutions and auditors is reduced, as are additional fee costs (Özdogan & Kargın, 2018). By preventing potential data disputes in accounting, smart contracts contribute to making financial records, from receipts to documents, more accessible and verifiable. As a result of these advantages, smart contracts have become a crucial research topic in terms of cost and fraud prevention (Özkul & Alkan, 2020). This study aimed to examine smart contracts that have potential in the field of accounting.

LITERATURE REVIEW

Blockchain Technology

Blockchain is a distributed ledger technology based on cryptocurrencies that Satoshi Nakamoto introduced in his article "Bitcoin: A Peer-to-Peer Electronic Cash System" in 2008 (Ahram et al., 2017). It is a technology that maintains that transactions between network users are carried out consensually and consistently (Risius & Spohrer, 2017). In other words, blockchain refers to a distributed digital record system that consists of interconnected blocks. Transactions are introduced into the system as a new block, and because each block has an unbreakable password, external users cannot alter them (Atalay, 2018). In this regard, the following are the main characteristics of blockchain technology (Zheng et al., 2017):

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In conventional systems, transactions are approved by a central agency, such as a bank, which causes extra costs. Blockchain allows transactions to be conducted using a distributed network without the involvement of third parties.

- *Persistency* transactions in blockchain technology are verified more rapidly than those in traditional systems, and invalid transactions are rejected. It is not possible to remove or reverse transactions.
- *Anonymity* users can perform transactions on the blockchain without revealing their identity. Transactions can be held using the through system address.

In addition, the system's transactions can be accurately monitored and confirmed.

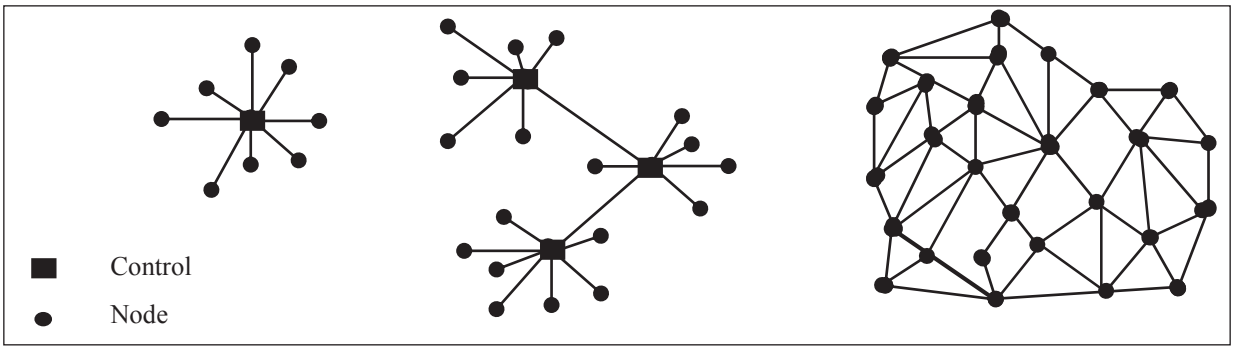

Fig. 1: Centralised, Decentralised, and Distributed Networks (Gamage et al., 2020)

In addition to its advantages, such as the ability to process transactions without the use of an intermediary and the simultaneous storage of data by stakeholders rather than through the use of a single centre, blockchain technology faces several challenges that limit its use. The following are the primary disadvantages of blockchain (Gao et al., 2018; Zheng et al., 2017):

- Scalability—the increase in the number of transactions on the blockchain may cause it to slow down. For instance, the Bitcoin blockchain can manage 7 transactions per second. Therefore, numerous transactions cannot be processed at the same time.
- Although the blockchain enables transactions to be anonymous, privacy leakage can lead to the leakage of users' identities due to their IP addresses.
- For the majority of attacks involving transactions in the blockchain, a consensus mechanism is used. Controlling more than 50% of the miners can result in majority attacks. In this case, inaccurate and defective blocks can be included in the chain.

A blockchain is a system that allows all users to complete a transaction. However, these methods can be divided into three categories based on various criteria: public, consortium, and private (Puthal et al., 2018). These three categories are as follows:

- A public blockchain permits each user to monitor and execute transactions. Thus, it is also known as a permissionless blockchain. Through the system, mining operations are accessible to all participants.
- A private blockchain is a type of blockchain that is employed to facilitate data exchange between single or multiple organisations. Transactions and mining are conducted by people assigned by the organisation. Without an invitation, a person cannot use the system. This approach is also called a permission blockchain.
- A consortium blockchain is a partially centralised blockchain. There is no single individual responsible for verifying transactions and blocks. Instead, a set of predefined nodes decides who will perform the mining.

Blockchain Architecture

The concept of blockchain refers to the structure of data or a system. As a data structure, a blockchain is composed of connected blocks, each of which contains a representation of the previous block. Each block contains the hash of the previous block. Thus, the general and block structures of the blockchain have various components. These components are crucial for comprehending the blockchain architecture (Xu et al., 2017). The following are the key elements of the blockchain architecture (Manu et al., 2020):

- Nodes are users and computers that are part of the blockchain system (shown in Fig. 1). All have a copy of the distributed ledger on the blockchain.
- Transaction is a primary function of a blockchain system.
- Block- is the data structure used to record transactions.

- A chain is a collection of blocks organised in a particular order.
- Miner- are nodes that perform block validations.
- The consensus algorithm is a set of regulations and rules used to determine who will carry out blockchain transactions.

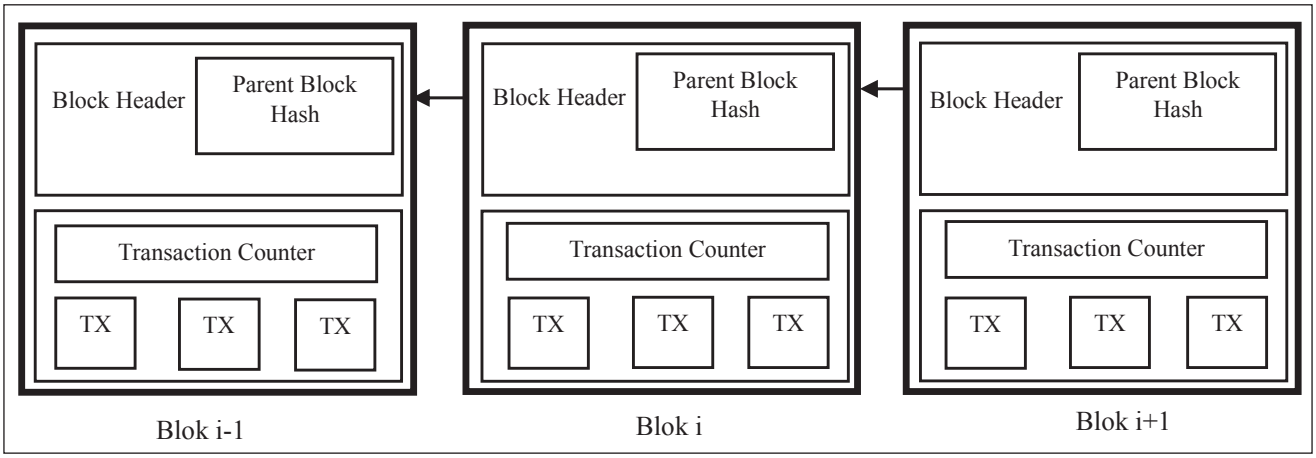

Fig. 2: A Blockchain Example with a Sequence of Blocks (Zheng et al., 2017)

Blocks are the fundamental data structure of transactions and are one of the components of the blockchain ecosystem. Blocks consist of a block header, which confirms the block's validity, and metadata, which identifies the block (Manu et al., 2020). The 'Genesis Block' is the first block in the blockchain, and all subsequent blocks are dependent on it (Ismail & Materwala, 2019). Every block in a chain includes the following components (Ismail & Materwala, 2019; Zheng et al., 2017):

- The block version specifies the block validation protocol in use.
- The Merkle tree root hash algorithm is used to calculate each transaction in the block. To create a single hash value, hash values are added together in binary. The Merkle tree value is the only hash value that was obtained.
- The timestamp indicates the creation time of the block.
- nBits- is the maximum permissible block hash value.
- The nonlinear field is a 4-byte field that begins at 0 and increases with each hash computation.
- The parent block hash: Each block includes the previous block's hash to guarantee the distributed ledger's immutability (Fig. 2).

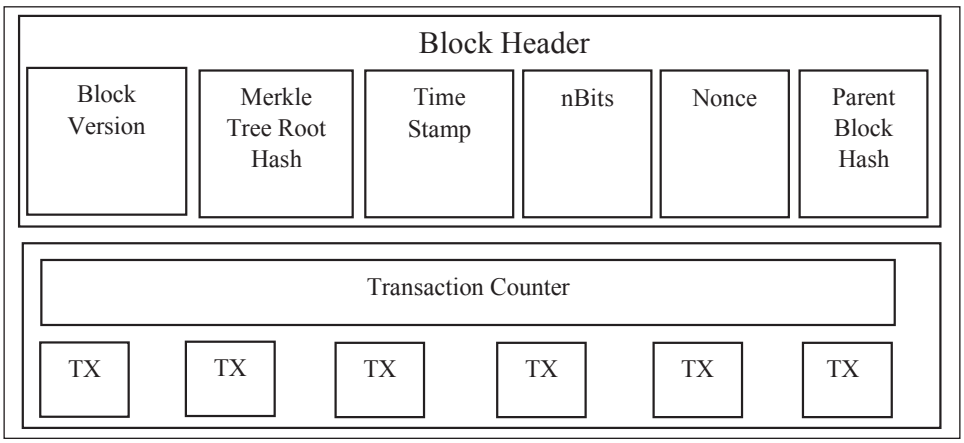

Fig. 3: Block Structure (Zheng et al., 2017)

Blockchain Applications

Although the basics of blockchain technology are based on distinct cryptocurrencies such as Bitcoin and Ethereum, over time, blockchain technology has given rise to a variety of applications (Yaga et al., 2018). The shift from blockchain 1.0 to 3.0 (Zhao et al., 2016) has resulted in the application of blockchain technology in fields as diverse as healthcare, advertising, energy, insurance, real estate, and finance (Chen et al., 2018; Puthal et al., 2018; Tama et al., 2017).

- *Finance:* Finance is one of the most effective industries for using blockchain technologies (Fig. 3). Blockchain technology simplifies business processes in the financial sector by generating reliable transaction records (Treleaven et al., 2017). Initially, cryptocurrencies were the most extensively used cryptocurrenite in the field of finance. Without the use of intermediaries, clearing and payment transactions are possible. Furthermore, many central banks have viewed cryptocurrencies as a way to broaden their portfolios (Gamage et al., 2020). In addition, the blockchain automates financial contracts and helps protocols be implemented in a more timely and cost-effective manner (Abou Jaoude & Saade, 2019).
- *Healthcare:* The health sector is among the most promising application fields for blockchain technologies. Patient records management is one of the proposed blockchain applications in the healthcare field; this method allows patients' previous medical records to be stored in a decentralised system (Puthal et al., 2018). Current recording systems pose a risk of unauthorised copying and theft of patient data (Tasatanattakool & Techapanupreeda, 2018). Nevertheless, owing to blockchain technology, patient identities and health records can be safely stored between stakeholders. Health supply chain management and remote patient monitoring are also potential blockchain applications in healthcare. While supply chain management prevents counterfeit and substandard drugs from entering the market, remote patient monitoring ensures that patients are monitored outside of the hospital (Agbo et al., 2019).
- *Insurance:* Manually executing transactions in existing insurance systems frequently increases fraud risk. Therefore, blockchain can solve many problems in the insurance industry through various applications (Raikwar et al., 2018). Consumers will be able to benefit from insurance services if the necessary conditions exist, without the need for human intervention, through smart contracts. This approach reduces operational costs and saves time (Kar & Navin, 2021). For example, AXA's travel insurance utilises contracts to access the global air traffic database, detects flight delays of more than two hours, and provides that the consumer's compensation is paid automatically (Brophy, 2019).
- *Real Estate:* Transactions in the real estate sector are typically managed by a variety of intermediaries, including title deed organisations, notaries, and experts, making the transactions costly and time-consuming. Transactions are simplified by blockchain technology (Puthal et al., 2018). For instance, with smart contracts, property rights can be provided digitally, or the payment of the property can be made with cryptocurrencies to obtain the land registry (Konashevych, 2020). The Swedish Cadastre Chamber began using blockchain technology in 2016 to more transparently record land ownership rights. They launched a platform built on a smart contract that covers banks, sellers, buyers, insurance, and real estate authorities. The purpose of this platform is to verify the authenticity of the buyer's and seller's title documents as well as to monitor all transactions, including payments, in real-time (Pankratov et al., 2020).
- *Government:* Current public institutions depend on a centralised system and are vulnerable to manipulation and fraud. All document savings, edits, and deletions are executed through a center. Blockchain technology offers solutions to these issues (Verma & Sheel, 2022). The use of digital identity rather than traditional identity for transactions in government institutions is one of the blockchain applications. In this scenario, the individual will be able to conduct transactions at public agencies by modifying their identification in a general and private manner depending on the transaction. This approach eliminates the abuse of personal data (Abou Jaoude & Saade, 2017). Digital voting is also another possible application. Digital voting, which is based on a permanent distributed ledger, is supposed to be preventive toward occurrences such as theft and manipulation of votes in elections. It will be efficient at keeping the votes of voters safe and counting them more transparently after the election (Gamage et al., 2020).

Blockchain and Accounting

Accounting is an information system that includes the reporting, classification, summarisation, analysis, and interpretation of information on financial transactions that cause changes in an enterprise's resources and assets (Cemalcılar et al., 2002). It seeks to provide quantitative information about financial assets that helps in economic decision-making (Alexander & Nobes, 2004). As is well

known, financial statements are prepared and summarised periodically in the traditional accounting system. Auditors evaluate these prepared financial statements. Both the firm and the investors have to trust that the people who organise the financial statements provide accurate information to the auditors and that the auditors are impartial (Byström, 2019). In addition to conventional auditing methods, blockchain enables real-time auditing by providing instant transaction confirmation (Schmitz & Leoni, 2019). Dyball and Seethamraju (2022) highlighted the simultaneous recording of financial transactions on the blockchain, which allows auditors to check transactions and reports without waiting for the reporting period. Auditing is a key business process in accounting. Considering that businesses must halt commercial transactions due to auditor resignation, blockchain has the potential for continuous and comprehensive auditing (Pimentel et al., 2020). While the suspicion that the blockchain-based accounting system will disrupt the auditing industry is unfounded, it is predicted to assist in the auditing of financial records with less error and fraud (Tan & Low, 2019). Thus, blockchain technology presents a reliable means of monitoring trade and financial assets (Abida, 2024).

In accounting, blockchain technology, which ensures that transactions are recorded on a permanent and interlocked system rather than separately, can both prevent irregularities in records and reduce control costs by providing convenience in routine repetitive transactions (Bonson & Bednarova, 2019). The double-entry system of accounting is becoming triple-entry accounting as a result of blockchain. The triple-entry accounting system consists mainly of a debit recording, a credit recording, and a cryptographic signature that verifies the transaction's validity. All the data distribution, recording, and transaction verification steps are carried out with the assistance of impartial intermediaries (Garanina et al., 2022). Because all the transactions in the triple entry system are available in the distributed ledger, a new generation of "glass organizations" is formed, and users can access financial information without waiting for the publication of the enterprises' end-of-period financial statements (Spano et al., 2022). The triple-entry accounting system, which is based on a distributed ledger structure, led to the concept of the 'Worldwide Ledger (WWL)'. In this sense, all the financial information of the organisations is published at the international level and becomes accessible. Furthermore, by providing transparent access to records, WWL assists all partners and regulatory authorities in reviewing and understanding financial reports without the need for technical knowledge (Kablan, 2019). According to Centobelli et al. (2022), the information invariance feature of the triple-entry accounting system helps stakeholders such as banks, tax institutions, and managers confirm the consistency of financial transactions. In a different scenario, blockchain is expected to be effective at detecting and preventing tax evasion at the national and international levels (Rindaşu, 2019). Silva et al. (2021) focused on 'Distributed Consensual Accounting Records" (DCAR). Accounting records in DCAR are recorded in bulk after they have been approved by nodes (supplier, customer, supervisory, and administrative authorities) and thus are based on the parties' holistic trust rather than central trust. The fact that accountants play a significant role in the transition from traditional accounting to blockchain must also be considered (Fig. 4). In this process, accountants must have some knowledge of blockchain to carry out various tasks, such as document recording and financial statement preparation (Yu et al., 2019).

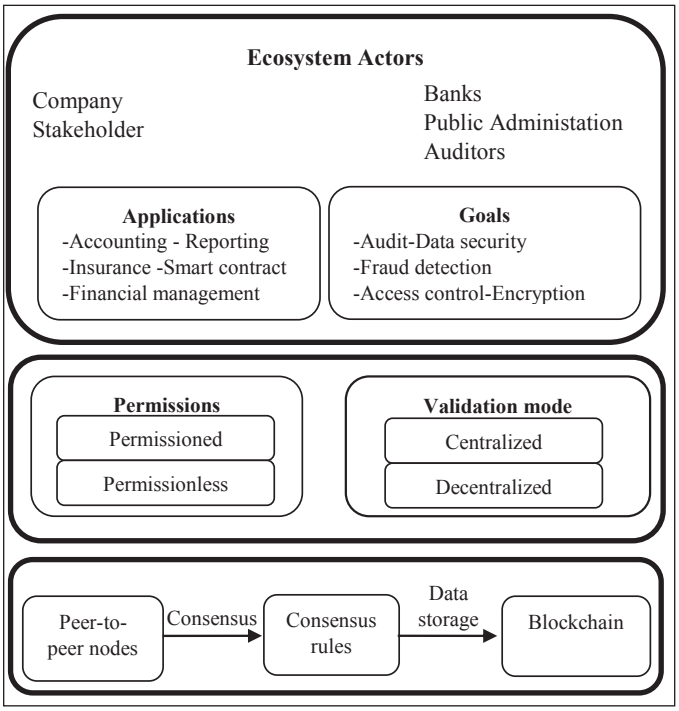

Fig. 4: Blockchain Architecture in Accounting from an Ecosystem Perspective (Centobelli et al., 2022)

Smart Contracts

Smart contracts are the most crucial factor in the rise of blockchain technology in accounting (Fullana & Ruiz, 2021). Because accounting records are stored in an unalterable chain and audit procedures can be conducted independently by eliminating the need for auditors, smart contracts are needed (Garanina et al., 2022). Research by Fortune 500 companies showed that companies will spend approximately $20 billion per year on smart contracts and blockchain technologies. The notion that smart contracts

fundamentally alter the way fraud is prevented is one of the key causes of this (ISACA, 2022). A smart contract aims for stakeholders to execute a specially coded agreement on the blockchain (Krichen et al., 2022). In other words, smart contracts are based on any contract terms being converted into computer codes and stored in the blockchain until the parties cancel or the contract terms are completed (Ozdogan & Kargın, 2018). For instance, Ahmet and Mehmet have integrated their commercial agreements into blockchain systems in the form of smart contracts. In this agreement, smart contracts help in the automatic fulfilment of both parties' obligations. The system will automatically pay Mehmet the $100 that Ahmet will pay him once the necessary conditions are met. In this case, because of triple-entry accounting and smart contracts, receivable and payable accounts, as well as payment transactions, will be automatically recorded in the system in an accurate and up-to-date manner (Suekıncı & Catıkkas, 2020). As shown in Fig. 5, the supplier first sends the product catalogue with product information (price, quantity, etc.) to the buyer via the blockchain network. This catalogue is stored on the blockchain to verify the supplier's trustworthiness. The buyer then sends her order using the blockchain, providing information such as product quantity and payment date, and a purchase contract is created without the intervention of a third party. Following that, the supplier negotiates a smart contract with the carrier to deliver the products to the buyer via blockchain, with terms such as shipping fee, product capacity, and delivery date. As a result, if the clauses in smart contracts are completed, payments from the supplier to the carrier and from the buyer to the supplier are made automatically (Zheng et al., 2020: 475–476). Smart contracts can help achieve significant savings in transaction costs in this direction. The following are the main advantages of smart contracts (Manu et al., 2020):

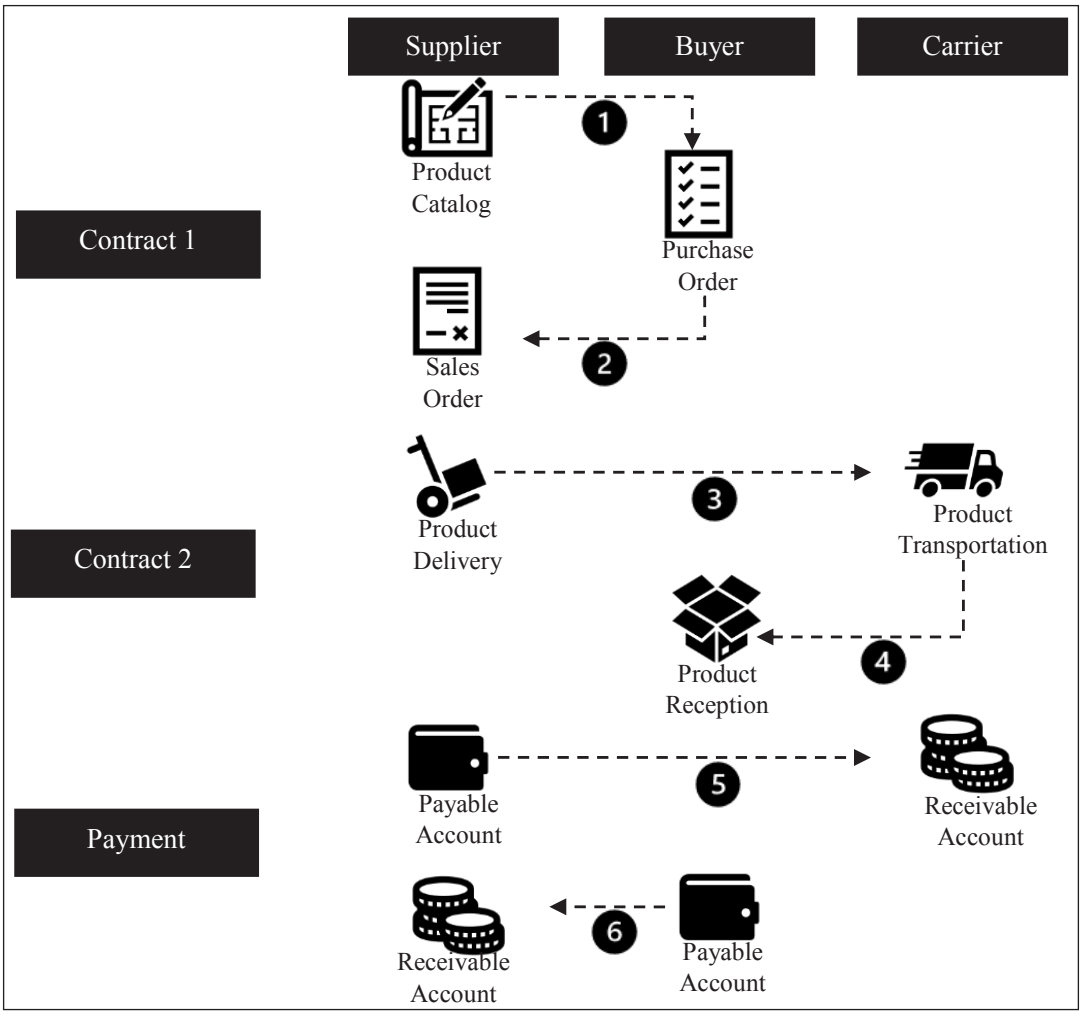

Fig. 5: An Example of a Smart Contract Between a Buyer and a Supplier

- Reduced costs by eliminating the need for intermediaries.
- It accelerates execution by allowing the contract to be executed automatically.
- Remove intermediaries and reduce the cost of money transfers.
- It creates a transparent ecosystem.
- Contract clauses cannot be changed because they are encrypted on the blockchain.

Accounting records and financial statements can be generated automatically using smart contracts. The automatic generation of financial statements diminishes errors and delays in reporting processes (Yu et al., 2019). Moreover, smart contracts that automatically follow accounting regulations and standards are expected to automate tax returns (Cakır & Ozcan, 2021; Ozkul & Alkan, 2020). Smart contracts make it easier for managers to keep track of business accounting records and business processes. In addition to payments, bank transactions, collection, etc., it facilitates the instant presentation of accounting data to creditors, stakeholders, managers, and auditors. Furthermore, establishing a transparent accounting ecosystem by providing verifiable data to investors and business partners is thought to be effective (Kazak & Erdemir, 2020). Smart contracts involve the exchange of money between parties as well as accounting information within the organisation. Furthermore, because accounting information is instantly shared between parties, real-time access to reports is permitted (Centobelli et al., 2022). Spano et al. (2022) highlighted that real-time reports shift power away from company management and toward shareholders and stakeholders. In addition, smart contracts help detect suspicious transactions in records, monitor enterprises' financial status, and facilitate enterprises' compliance with market regulations (Liu et al., 2019). In summary, smart contracts improve the traceability and transparency of accounting policies, as well as the comparability of accounting data (Yu et al., 2019). Furthermore, smart contracts can regulate accounting records by detecting inventory and asset damage. Therefore, when an enterprise's products are shipped with special sensors, these sensors report any damage to the products, and these damaged products are recorded in accounting records through smart contracts (Silva et al., 2021).

CONCLUSION

Research has shown that blockchain technology has a wide range of potential applications, ranging from digital voting in election processes (Gamage et al., 2020) to storing patient medical records in a decentralised network (Puthal et al., 2018). In terms of accounting, blockchain technology seems promising because it can benefit businesses in financial business processes, and these processes can be programmed and automated, particularly with the help of smart contracts. Therefore, smart contracts will not only provide more verifiable financial statements for managers but also assist in obtaining more transparent and reliable data for investors.

Accounting records that are automatically updated or triple-entry accounting systems are still in development. This situation highlights the issues with blockchain technologies that must be addressed in the accounting field, as well as many other fields. To use the triple accounting system, for instance, the parties must agree. Only one of the parties' attempts to integrate blockchain technology will impede the use of many applications (Ozkul & Alkan, 2020). Furthermore, the drop in the workforce expected as a result of the shift to blockchain technologies may result in the layoff of many accounting personnel. This demonstrates that employment is a barrier that must be resolved. Government legislation on the use of blockchain technologies will also be a barrier to its adoption (Dogan & Ertugay, 2019).

It is recommended that future research on blockchain applications and smart contracts focus on potential issues that may hinder their use. The fact that blockchain technology saves labour and time in accounting can cause accountants and auditors to focus on data mining and in-depth analysis. In that way, employees can become more aware of and skilled in blockchain technologies. Given the adoption of blockchain technology by consumers, qualified accountants will be in higher demand. Accountants who are knowledgeable about blockchain technology can encourage businesses to use it by providing them with information about it. As a result of the growing popularity of blockchain, accountants must expand their knowledge and skills to meet client demands (Schmitz & Leoni, 2019). Given the correlation between financial literacy and investor decision-making (Shroff & Paliwal, 2024), it is crucial for businesses and customers to possess a solid grasp of blockchain literacy to facilitate the seamless adoption of blockchain technology. Because, the correlation between self-efficacy and technology acceptance (Aggarwal & Patel, 2023) suggests that, during the adoption of a new technology, both knowledge and experience play a significant role alongside the opportunities presented by the technology.

In the literature, discussions about whether blockchain applications disrupt the accounting profession continue. Therefore, more applied research will be beneficial in terms of gaining a thorough understanding of blockchain technologies in accounting. Although theoretical information is useful in determining the system's advantages and disadvantages, applied research is required to examine how

the blockchain works in accounting. It is hoped that studies conducted jointly by academics and businesses will be more constructive in this regard.

CRediT Authorship Contribution Statement

Mehmet Kaygusuzoğlu: Conceptualisation, Methodology, Software, Visualisation, Validation, Investigation, Data curation, Writing – original draft. *Yakup Durmaz:* Conceptualisation, Data curation, Writing – original draft. *Miraç Yücel Başer:* Conceptualisation, Writing – review & editing.

Data Availability

Data will be made available on request.

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