

**Original scientific paper**

## **REVOLUTIONISING THE DOCUMENT WORKFLOW USING BLOCKCHAIN IN BANKING SECTOR**

**Ervin Domazet<sup>1</sup>, Gunter Merdzan<sup>2</sup>, Violeta Cvetkoska<sup>2</sup>,  
Daniela Mechkaroska<sup>3</sup>, Serdar Serdaroglu<sup>4</sup>, Bilal Sucubasi<sup>5</sup>**

<sup>1</sup>Faculty of Engineering, International Balkan University, Skopje,  
Republic of North Macedonia

<sup>2</sup>Faculty of Economics, Ss. Cyril and Methodius University in Skopje,  
Faculty of Economics - Skopje, Skopje, Republic of North Macedonia

<sup>3</sup>University of Information Science and Technology “St. Paul the Apostle”, Ohrid,  
Republic of North Macedonia

<sup>4</sup>Faculty of Economics, International Balkan University, Skopje,  
Republic of North Macedonia

<sup>5</sup>Halkbank AD Skopje, Republic of North Macedonia

ORCID iDs:	Ervin Domazet	<a href="https://orcid.org/0000-0001-7743-469X">https://orcid.org/0000-0001-7743-469X</a>
	Gunter Merdzan	<a href="https://orcid.org/0000-0002-1894-9623">https://orcid.org/0000-0002-1894-9623</a>
	Violeta Cvetkoska	<a href="https://orcid.org/0000-0002-0472-5522">https://orcid.org/0000-0002-0472-5522</a>
	Daniela Mechkaroska	<a href="https://orcid.org/0000-0002-3567-8335">https://orcid.org/0000-0002-3567-8335</a>
	Serdar Serdaroglu	<a href="https://orcid.org/0000-0002-1357-4201">https://orcid.org/0000-0002-1357-4201</a>
	Bilal Sucubasi	<a href="https://orcid.org/0000-0001-9171-0128">https://orcid.org/0000-0001-9171-0128</a>

**Abstract.** *Blockchain is a distributed ledger technology that can revolutionise the banking sector by increasing transparency, reducing costs, and enhancing security. However, the success of any banking service lies in the efficiency of serving it, which depends on the smoothness of internal documents and process flows. This paper proposes a novel method that uses blockchain infrastructure to address the efficiency, security, and privacy of workflow processes in the banking sector. Our approach combines Alfresco DMS and CMIS with the orchestration tool Camunda for workflow management and secures them with a notary using the Factom Blockchain. This method provides a secure, efficient, and reliable way for banks to process transactions, store documents, and manage their processes. It will enable banks to process transactions faster, reduce costs, minimise the risk of fraud, increase customer satisfaction, and fully consider blockchain technology's advantages.*

**Key words:** *document management, workflow, automation, process management, blockchain, banking*

Received December 1, 2023; revised January 30, 2024 and February 29, 2024; accepted March 03, 2024

**Corresponding author:** Gunter Merdzan

Faculty of Economics, Ss. Cyril and Methodius University in Skopje, Faculty of Economics - Skopje, Skopje,  
Republic of North Macedonia

E-mail: [gjunter.merdzan@eccf.ukim.edu.mk](mailto:gjunter.merdzan@eccf.ukim.edu.mk)

## 1. INTRODUCTION

The finance sector is an essential building block of any country, especially the ones that tend to develop further. The finance sector funds most future investments (including infrastructure, capital, and financial). It is the epicentre of any economy, where commercial banks constitute a critical portion. Any government or commercial bank's success depends on how its services are provided and the digitisation level of the internal processes and process flows [1]. Both concerns need to be addressed better within the traditional banking system. The exponential growth of technological improvements affects the banking sector directly and indirectly. These have forced many commercial and government banks to invest in their digital solutions. Their driving force is primarily to efficiently use their scarce resources, including capital, workforce, and client bases.

When looking from a bird's eye, a bank is a black box, which is a magic combination of deposits and loans. The magic lies in how contracts are being processed internally. Predefined workflows or process flows are processing contracts. The bank's internal rules and the country's ongoing regulations strongly define and regulate these. The internal efficiency of handling these processes directly affects the success of any bank.

The architecture of a traditional banking sector is characterised by its centralised nature. The data that is stored and processed is kept in central databases. These architectures tend to be enclosed systems and avoid transparency as much as possible. This is because any bank's asset is the data it holds. Traditional approaches have forced enclosed systems and avoided transparency to secure the data. The modern methods of banking sectors are based on transparency and the decentralisation of services. The new architectures must address security concerns and provide the needed guarantees when enabling these. These guarantees did not exist on the traditional relational and non-relational databases simply because persistence storage was based on CRUD operations: create, read, update, and delete. Decentralising and transparency are directly related to how you deal with especially update and delete operations on persistent storage.

Revolutionary blockchain technology has enabled modern applications to think about decentralisation. This is because blockchain handles persistence storage, where all operations are based on CR operations: create and read. The update and deletion of information are handled by creating a new block in the chain with the specific operation type. Banks should adopt blockchain because of its features such as decentralisation, storing information electronically in digital format, transparency, and many others that could help them address the challenges of the traditional centralised banking system. This technology can be considered to facilitate the internal document and process workflows within a bank. This paper focuses on a novel blockchain method that addresses the efficiency, security, and privacy of such workflows. The proposed method will enable further developments in the financial sector to consider blockchain technology's advantages fully.

Studies in the literature indicate the importance of blockchain technology in banking. According to most of these studies, banks that apply blockchain to their work will improve security, reduce costs, and increase efficiency with blockchain technology. This could lead to faster and more secure transactions with fewer errors. Additionally, customers would benefit from improved privacy and data protection [2 - 5]. Meanwhile, Jena [6] notes that facilitating conditions, performance expectancy, and initial trust were significant antecedents to bankers' intentions to use blockchain in banking transactions. This could lead to increased customer

satisfaction and loyalty. Moreover, it could also reduce the cost of banking operations and improve the overall efficiency of the banking system.

Mafike and Mawela [7], in their systematic literature review of 45 papers about blockchain design and implementation techniques, considerations, and challenges in the banking sector, suggest that platform selection scalability and resilience are some of the critical technical considerations for implementing blockchain technologies. However, there needs to be more literature on technical considerations and platform selection when implementing blockchain technology in the banking sector. The authors argued that more research is needed to understand these considerations and platform selection better to ensure the successful implementation of blockchain technologies in the banking sector. They recommend that future research focus on developing frameworks and models for selecting platforms and assessing the scalability and resilience of blockchain technologies in the banking sector.

Our paper proposes a novel approach that combines Alfresco DMS [8], CMIS [9], and Camunda [10 - 12] for workflow management. This is secured by a notary using the Factom Blockchain [13, 14]. Alfresco, an open-source document management system, is widely used by big corporations, while Camunda is quickly becoming the industry standard process orchestration tool. Factom blockchain protocol allows efficient blockchain interaction. This combination of technologies has significant potential for the financial sector. It provides a secure, efficient, and reliable way for companies to manage transactions, store documents, and streamline processes. Blockchain transparency, immutability, and audibility also benefit companies, increasing operational efficiency and enhancing their reputation. The banking industry can benefit from blockchain's decentralisation, electronic information storage, transparency, and other features. This will address the challenges posed by traditional centralised banking systems. Adopting this novel method will enable banks to process transactions faster, reduce costs, and minimise fraud risks, ultimately increasing customer satisfaction by making transactions more secure and transparent.

The contribution of this paper to the literature is to provide insights into the considerations and platform selection for the successful implementation of blockchain technologies in the banking sector. These insights will help banks make informed decisions when deploying blockchain technologies and maximise the benefits of their investments. We also expect that this paper can be used as a reference for stakeholders in the banking sector.

In this regard, Section 2 provides detailed background information, while Section 3 explains the current state of the finance sector and the use of blockchain. Section 4 presents an overview of the literature and our proposed approach in Section 5. Practical implementations are listed in Section 6. Section 7 evaluates our approach, discusses our conclusions, and provides future considerations.

## 2. BACKGROUND

The post-pandemic era has highlighted the importance of robust digital infrastructure, including hardware and software architectures. The efficiency of any team or department within a bank depends on how the workflow is managed. There are many software solutions for document management and managing the running processes within a bank. This section will elaborate on these and provide detailed background information.

## 2.1. Document Management Systems

Inefficient management of documents within any institution can easily result in chaos. Traditional banking mostly uses paper-based document management and supports it with digital archives. On the other hand, modern banks use digital archives or, in other words, Document Management Systems (DMS) as the source of truth and support it via hard copies.

Increased usage of DMS within banking sectors increases the efficiency of their internal processes. This gives the ability of higher governance over business-critical content. The functionalities which most of the available DMS solutions provide can be stated as follows:

- Storing and Managing
- Sharing and Organisation
- Tracking and Accessing
- Versioning and Workflows
- Process Management and many more

Banks can also develop their own DMS solutions or use already available ones. There are many available DMS solutions that banks can use for their internal needs, among which open-source solutions are generally preferred [1]. Many DMS providers, including PaperSave [15], ClickUp [16] and M-Files [17] are in the market. All of these are specialised in some specific functionality and operate their business on top of that. They do not share their code base and are not meant for large enterprises.

The document management software from Alfresco is already open-source and gives all the functionalities mentioned above as a Java web application. Another significant advantage of Alfresco is that it provides the CMIS (Content Management Interoperability Services) API interface, which allows a broad range of REST API calls to be made to the content management system. This, in return, gives huge flexibility to large enterprises, further customising it based on real requirements.

## 2.2. Business Process Orchestrations

The methodology of processing internal contracts within a bank determines its efficiency and success. Digital solutions for designing and executing business processes are crucial in modern banking. The general nomenclature for these types of solutions is the Business Process Orchestration (BPO). Some banks have algorithms for orchestrating their internal flow, even though a bank's primary aim is not to be an IT development company. Many specialised custom software tries to address the issue of BPO, among which the industry-wide accepted solution is the Camunda platform.

Camunda has an open-source community edition platform, making it even more attractive for large enterprises. Camunda also specialises in orchestrating financial services, the benefits of which many well-known financial institutions already utilise. Camunda is designed to be agile, which reduces the time needed to design, connect, automate, monitor, improve, and optimise any business process. Camunda also strongly supports the Business Process Model and Notation (BPMN) specification [18, 19], including the latest version, 2.0 [20]. This specification helps businesses illustrate their processes in a standard manner using graphical notations [21].

Any business process can be easily modelled, designed, and executed. This is a standardised process within the literature. Any automation of business processes starts with the phase of elaboration. The needs are stated, and the requirements are well understood. On top of that, a custom design is made. The design and implementation may be subject to further

optimisations in the pilot phase. Orchestration takes place with a proper tool. Finally, the workflow is integrated seamlessly with the other parts of the running business.

### **2.3. The Blockchain**

Blockchain is a decentralised database across many nodes, enabling you to only insert and get chains at any time. A simple chain in this structure is a linked list of N-blocks of information. The way to update and delete a block is by inserting a new block in the chain with the specific operation type. Any block that is stored within a particular chain may have certain information. This information is the hashed and encrypted version of the data we store on our persistent storage, like relational databases. The usage of blockchain aims to verify the actual data and prevents unauthorised updates on the data itself.

The spectrum of blockchain usage includes the financial sector, insurance, accounting, notary, healthcare, and many others. This technology can primarily facilitate the internal document and process workflows within a bank, provided it is used correctly and efficiently.

#### *2.3.1. The Factom Blockchain*

Factom is a decentralised, open-source blockchain platform designed to provide a secure, transparent method for storing data. Blockchain technology utilises a distributed ledger that enables multiple parties to record and verify transactions without a central authority or intermediary. Factom is based on the Bitcoin blockchain, but it is designed to handle a much larger volume of transactions and to be more efficient than Bitcoin. It uses a unique data structure called a “chain of entries” that allows users to store large amounts of data more efficiently and securely. Factom has several potential applications, including document management, supply chain management, and identity verification. Many organisations and government agencies use it worldwide to secure and track important data.

The Factom blockchain is structured as a series of chains, each containing a series of entries. These chains are organised into a hierarchy, with the main chain at the top and the sub-chains below. Each entry in a Factom chain consists of a set of data and a cryptographic hash, a unique digital signature generated based on the data in the entry. The hash links the entry to the previous entry in the chain, creating a chain of entries secured by the cryptographic hashes. Factom uses a consensus algorithm called “Proof of Work” to ensure the integrity of the blockchain. This algorithm necessitates that computers on the network work to solve complex mathematical problems to confirm and include new entries to the blockchain.

Overall, the structure of the Factom blockchain is designed to provide a secure and transparent way to store and manage data while ensuring that the blockchain is decentralised and resistant to tampering.

## **3. LITERATURE REVIEW**

Throughout history, economics has studied human behaviour and developed institutions such as the legal system, corporations, banks, governments, and marketplaces. Today, blockchain technology is transforming the way value is exchanged. Digital platforms such as Blockchain can store information about ownership, ownership records, certificates, legal contracts, acts, and personal information for many different types of assets. According to

Mohite [22], blockchain technology provides open, secure, distributed, and low-cost capabilities that can empower smarter organisations. The first to experience this disruption would be the financial industry.

In our economic, legal, and political systems, blockchain technology helps keep track of contracts, transactions, and other important records. This system enables individuals, organisations, machines, and algorithms to engage in transactions without intermediaries such as lawyers, brokers, and bankers. Moreover, this allows for the free exchange of value. A blockchain-based transaction settlement patent has been filed, and numerous blockchain labs have been established since 2015 to enable and stimulate the research and development of related applications. Financial services will be transformed. Various industrial consortiums focused on blockchain have been established to advance the use and adoption of blockchain technology. These consortiums aim to promote the technology and its various applications.

The blockchain, a new technology for coordinating people, creates a secure, robust, transparent distributed ledger. A study by Davidson, De Filippi, and Potts [23] elaborates on blockchain economics, demonstrating that blockchain is more about innovation and technological change than money or information, rather a revolution in institutions, organisations, and governance. A blockchain can store information requiring public validation, such as money, contracts, property titles, and identities. Blockchains can also be viewed as an 'institutional technology for managing economic orders.

Commercial banks are using blockchain technology to advance digitalisation. This technology will revolutionise the banking industry in the coming years, allowing distributed databases to be managed securely without third parties or central authorities. With blockchain technology, many existing processes and systems will be replaced, bringing about significant changes in the banking and financial sectors. By enabling direct access to dematerialised assets and stored information, blockchains reduce fund management costs by ensuring payments and settlements are made simultaneously. Blockchain technology can reduce human intervention in organisational decision-making, eliminate intermediaries, and make business transactions more transparent.

As an emerging technology, blockchain has the potential to revolutionise banking operations by improving efficiency, reducing costs, and enhancing security [24 - 26]. Its diverse applications range from simple Know Your Customer (KYC) processes to complex operations like trade finance, payment systems, smart contracts, and syndicated loans. However, the shift towards a decentralised system poses regulatory challenges that require a harmonised framework to ensure seamless integration with existing banking structures. Despite these challenges, the economic impact of blockchain in banking could be as transformative as the influence of the Internet in recent times, heralding a new era in financial services that will benefit customers and institutions alike [26]. The evolving landscape of blockchain suggests a future where it is a technological innovation and a cornerstone in the redefinition of banking operations and services.

In their study, Gupta and Gupta [27] describe blockchain technologies and emphasise their applications in Indian Banking. It overviews blockchain technology's global impact and challenges in the banking industry. According to the study, blockchain will make banking transactions more secure, faster, transparent, and cost-effective by transforming the Indian banking sector. Authors note that blockchain technology can reduce transaction costs, improve efficiencies, eliminate intermediaries, and increase transparency.

To understand the potential of blockchain technology to support the financial system, Cocco, Pinna, and Marchesi [28] studied the performance of the Bitcoin system. This paper also identifies the significant limitations of the system, including its enormous energy consumption and high hardware costs. Their findings indicate that it is possible to handle financial processes more efficiently than is currently. This is indeed possible by addressing the limitations of Bitcoin and blockchain technology.

Approximately half of global banking executives believe blockchain technology will significantly impact in the next years [29]. We may be able to improve how we transact around the world with blockchain technology and ensure that financial systems are accessible around the world through the technology. While adopting blockchain technology should be considered, several obstacles must be addressed, including technical, regulatory, and other challenges. These challenges may be resolved over time [30].

Banks face a complex relationship with blockchain because, beyond streamlining traditional banking processes, blockchains are considered a threat to existing systems. The blockchain offers banks real-time access to unalterable data with consensus verification and can be used to verify data. Blockchain technology is expected to surpass Bitcoin in significance due to the financial crisis of 2008. Banks' use of blockchain technology can reduce costs, but new fintech startups will increase competition. As an enabling technology, blockchain is not yet fully exploited by the banking industry.

From the viewpoint of the banking industry, Hassani, Huang, and Silva [31] review the opportunities and challenges of implementing blockchain technology in banking using academic and industry research. Blockchain is changing the banking industry. Some examples include IBM's Hyperledger Fabric, Utility Settlement Coin, and R3's blockchain consortium, but there is also opposition to blockchain in banking. The paper reviews over 100 articles and highlights the opportunities and challenges of adopting blockchain technology in banking. The researchers find that blockchain technology can improve KYC processes, transaction speeds, security, cost reductions, and increase transaction volume. It is concerning, however, that this subject area lacks academic research. To analyse the economic impact of this new technology, Davidson, De Filippi, and Potts [23] use a case study called Backfeed. They believe this platform represents a spontaneous economy, a new type of organisation. The paper illustrates the Ethereum-based infrastructure protocol and platform Backfeed as a case study of how blockchain facilitates new economic organisations.

Previous literature indicates that the banking industry is aware of the potential benefits of blockchain technology, but there is some discussion regarding its practicality and ability to enhance customer service. However, numerous studies, including those by Davidson, De Filippi, and Potts [23] and Gupta and Gupta [27], have demonstrated the transformative possibilities of blockchain in banking. They highlight how it can reshape institutions and governance and its impact on the Indian banking sector. Furthermore, Hassani, Huang, and Silva [31] provide a comprehensive analysis of blockchain in banking, outlining both opportunities and challenges, focusing on how it can improve KYC processes and transaction efficiency. Also, Studies such as those by Yli-Huumo, Ko, Choi, Park, and Smolander [32], who provide a systematic review of current research on blockchain technology, and Wang, Ma, Dai, Imran, and Wang [33], focusing on blockchain-based data privacy in banking, highlight the multifaceted impact of this technology. Blockchain technology can streamline banking operations and improve customer experience, which could significantly shape the industry's future. Continued research and collaboration are essential to fully realising its potential in banking.

### 3.1. Blockchain and Commercial Banks

The FinTech movement has impacted financial markets, institutions, and services in a significant way by considering many new horizons. These include more efficient business models and increasing awareness through innovative applications and processes. Commercial banks use information technology in the financial sector to automate operations, introduce Internet finance and connect transactions, payments, and capital flow.

Financial innovations are generated by FinTech development for commercial banks, and commercial banks are significantly altering the economic landscape with their investment in technological and scientific improvements. Contactless services are becoming increasingly popular as artificial intelligence advances quickly, especially after the global COVID-19 pandemic. In digitalisation, technologies like the internet, big data, social media, blockchain, and digital currencies reshape our physical world based on digital infrastructure. According to Zuo, Strauss, and Zuo [34], investing in technology, utilising financial technology (FinTech), and undergoing digital transformation can help commercial banks become more efficient and effective, improving overall performance.

Commercial banks enable businesses and society to save and invest, protect themselves from risks, and create new jobs and businesses. Innovations, however, tend to move very slowly in the past. The technological and social improvements in the last decade have triggered banks to change their mindset regarding core improvements. The emergence of new technologies, business models, and access to capital has triggered a FinTech revolution. According to Rosati and Čuk [35], blockchain technology, as a part of FinTech, can revolutionise several activities and processes in the industry.

Developing nations and international institutions have closely followed blockchain development and explored its various applications. The improvements in the blockchain sector have attracted several major multinational financial institutions. It can fundamentally transform how finance and the economy are conducted today. Blockchain technology has potential applications in the banking sector. A multi-centre, weakly inter-mediated scenario can be formed to modernise commercial banks' payment clearing and credit information systems, improving the banking industry's efficiency.

Hassani, Huang, and Silva [31] predict blockchains will store 10% of GDP by 2025, disrupting the financial services industry. Many global banks are testing blockchain technology and developing global trade finance platforms, including BNP Paribas and HSBC. Blockchain technology has already been adopted by more than 12 public banks in China. The Bank of England is considering integrating blockchain technology with real-time gross settlement systems for relatively fast international monetary transactions. Santander Bank has implemented Ripple's xCurrent protocol.

After the crisis in 2008, banks mostly used lower interest rates to increase their reputations. Also, stricter regulations and compliance have been applied to common business workflows. FinTech is an inevitable trend that will reverse the banking industry's downward trend. Since then, the banking sector has implemented many changes, including creating new roles to manage the integration of technology systems and the implementation of numerous regulations. The banking industry is being transformed by information technology, big data, and highly skilled personnel, shifting from physical branches to virtual ones [36].

Commercial banks have a wide range of vital economic functions that can be processed using codifiable information and tools made possible by the digital revolution. They can become leaner companies by leveraging blockchain technology and other benefits from



Fintech. The technology used by banks allows them to work with older systems and focus on activities that generate higher returns, such as payment processing and advice services [37].

As discussed in the introduction, blockchains are decentralised, transactional databases allowing multiple network participants to validate tamper-resistant transactions. Blockchain systems make information available to all network participants and maintain data integrity and unchangeability. User privacy is protected by keeping a duplicate of a database duplicate. Blockchains are distributed networks that remove all centralised entities and give all participants (nodes) access. Cryptography authenticates transactions and keeps information private [35, 38]. Blockchains are well-known for their ability to process financial transactions and smart contracts. However, despite widespread attention, blockchain technology is still relatively new and faces many technical, non-technical, and regulatory challenges.

However, blockchain technology has numerous advantages for commercial banks, businesses, governments, and customers. Blockchain could help commercial banks offer more convenience to their borrowers, resulting in a lower cost of financial intermediation. Firms and households could obtain loans from blockchain-based banks without posting collateral, and loans could be approved immediately. They process mortgage applications much faster than other lenders without increasing default rates. Fintech allows banks to reduce staffing requirements and branch networks while allowing price discrimination to be more targeted. Compared to traditional banks, they charge higher interest rates to low-risk borrowers and are more likely to originate refinances. Also, small and medium-sized enterprises, less developed countries, and segments of the population that are underserved or unserved by traditional banks can benefit from commercial banks using new disruptive technologies.

In contrast, economists and empiricists are working to understand how digitalisation may lead to accumulating intangible capital that may compromise financial stability. There is no doubt that commercial banks using FinTech are creating innovations that disrupt traditional industry structures and blur industry boundaries. However, these innovations also pose significant privacy and regulatory issues and are challenging to police. Regulators and supervisors need to consider multisided platforms regulating these new financial activities. Regulatory authorities must check whether regulation provides a level playing field for interactions as big data and new delivery channels emerge as a new form of financial intermediation.

### **3.2. Possible Applications of Blockchain in Commercial Banks**

Banks' increasing interest in using blockchain technology in various business areas could lead to the transformation of processes and require understanding by all stakeholders within and outside the organisation [39]. Blockchain technology has been one of many disruptive technologies developed in the past few years. It has a wide range of potential applications in the banking industry, enabling parties who do not trust each other to agree on a peer-to-peer level. This process can be automated with the usage of "smart contracts".

Blockchain technology has many potential applications and can increase efficiency and reduce the cost of clearing and settling financial assets following a transaction. It has the potential to become a central technology in the financial sector, and the banking industry needs to invest in researching and testing blockchain applications [24]. Additionally, blockchain technology can help address the lack of trust among parties in the financial industry.

As a result, implementing blockchain technology by financial institutions interested in improving their financial operations completely transforms how the financial sector keeps and transfers assets, executes contracts, and manages risks. Many complex financial functions could be simplified with blockchain technology. According to Natarajan, Krause, and Gradstein [38], blockchain technology has four potential applications in the financial sector:

- money and payments, including digital currencies, authorisation, clearing, international remittances, cross-border payments, foreign exchange, and micropayments;
- financial services and infrastructure (capital markets, trading in securities, trade in goods, notary services – e.g., mortgages, crowdfunding, etc.);
- collateral registers and ownership registers;
- transformation and improvement of the internal systems of financial service providers.

The global financial system is inefficient and obsolete, which leads to many problems. This process is rife with problems, adding cost through delays and unnecessary fees, creating friction through redundant paperwork, and providing opportunities for fraud and crime. Bankers continue to be concerned about the rising regulatory costs, which remain a top concern for the industry. As a result, consumers end up paying the price. According to Tapscott and Tapscott [40], there are several things lead to conclude this:

- They are outdated and rely on a combination of industrial technologies and legacy paper-based processes;
- It is centralised, which makes it vulnerable to system failures and attacks;
- It excludes many people, depriving them of access to the necessary financial services.

Therefore, bankers have avoided mainly the creative destruction needed for economic progress and vitality. Blockchain, however, is emerging as the solution to this innovation bottleneck. In the banking industry, blockchain has the potential to disintermediate the following key services [40, 41]:

- Payments: Blockchain technology could make payments faster and cheaper than banks by establishing a decentralised ledger (e.g., Bitcoin).
- Clearance and Settlement Systems: Distributed ledgers have the potential to reduce operational costs and increase real-time transactions between financial institutions.
- Fundraising: ICOs (Initial Coin Offerings) are experimenting with a new model that separates traditional capital-raising services from the capital-raising process.
- Securities: Blockchain technology could make capital markets more efficient and interoperable by tokenising traditional securities like stocks, bonds, and alternative assets
- Loans and Credit: By removing gatekeepers, blockchain technology can reduce interest rates and make borrowing more secure in the loan and credit industry.
- Trade Finance: Blockchain technology can bring increased transparency, security, and trust to the global trade finance industry by replacing cumbersome, paper-based bills of lading.
- Customer KYC and Fraud Prevention: Blockchain technology enables financial institutions to share customer information more rapidly and securely through decentralised blocks for storage.

Financial activities can be improved and made efficient using Blockchain. Automating the clearing and settlement of transactions can increase the productivity of banks. However, several issues can lead to discrepancies and errors in commerce and daily operations. These issues include problems with clearing synchronisation, significant time spent identifying

uncleared bank transactions, and a lack of transparency between counterparties. Banks can use blockchain to speed up lending processes, reduce risks, and allow people to lend and borrow money.

There are several complicated processes involved in interbank payments. The result is low efficiency and an enormous amount of occupied funds. Blockchain technology can enable direct peer-to-peer payments, eliminating the need for intermediaries such as financial institutions and reducing transaction costs. Several financial institutions are piloting blockchain platforms to speed up cross-border transactions [24]. Blockchain technology may be able to address the issue in banking of lacking customer information by implementing a "know your customer" (KYC) process based on blockchain, as it would help maintain customer anonymity and minimise the costs of credit agencies collecting data [39].

Ineffective bank credit information systems tend to stem from data scarcity, poor quality, and unclear ownership of user data. Blockchain technology may offer some assistance. Even though everyone produces a tremendous amount of data on the Internet, large Internet companies monopolise this data, creating data islands. The blockchain can encrypt data and establish ownership of big data, laying the groundwork for future credit systems. Blockchain technology can automatically record large amounts of data from credit agencies and enable institutions to securely share encrypted versions of customers' credit status. This can allow credit data sharing between banks and eliminate the need for KYC processes [24].

Manual inspections and transactions that rely on paper documents are commonly utilised in supply chain finance. Integrating blockchain technology can automate these processes and replace them with digital smart contracts. This can lead to cost savings for banks and trade financing companies, increased transaction efficiency, and potentially higher trade income.

The development of commercial banks is gradually being led by digital technology. The digitalisation of commercial banks in the financial industry has received significant attention, so it is imperative to evaluate and measure bank digitalisation inputs and outputs.

Banks must adopt new marketing strategies that respond to customers' changing buying behaviours to remain competitive and retain their market share. This requires the creation of long-term and medium-term strategic plans, allocating financial resources, human resources, and technological capabilities, establishing digital platforms to upgrade products and services over time, effectively managing financial risk, and developing innovative marketing tools.

#### 4. BLOCKCHAIN BASED DOCUMENT WORKFLOW

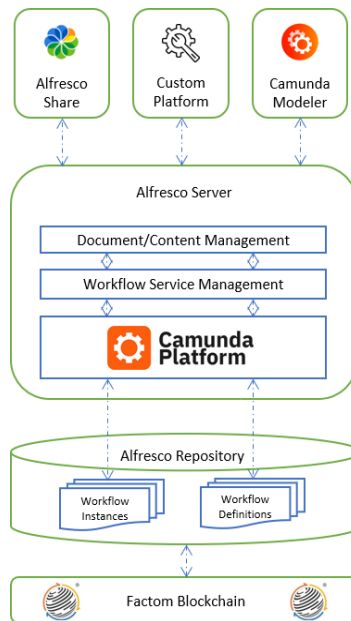
The approach presented in this paper is unique, as it combines the Alfresco Document Management System (DMS) and Content Management Interoperability Services (CMIS) with the workflow management tool Camunda. To ensure the security of this system, a notary is used that leverages the Factom Blockchain. The following subsections provide a detailed explanation of this approach.

##### 4.1. The High-Level Architecture

The automation of processes is a crucial aspect of modern-day businesses. A detailed overview of this process has been presented in Figure 1. The Camunda Modeler is an

efficient tool that can be used to design any workflow with ease. Among the various workflows that can be automated, the payment workflow in a bank branch office is a simple and practical example. The Camunda BPMN Workflow Engine simplifies the automation, optimisation, and orchestration of processes from the other side. The novel architecture presented in Figure 1 combines DMS with a process orchestrator, further secured by blockchain. This architecture offers a secure and efficient way to manage and streamline business processes.

Alfresco server provides a robust and efficient document management system that can be accessed through its Share web platform or customised web, tablet, or mobile applications. The platform offers powerful functionalities that can be integrated into a company's layout and forms through the CMIS REST API. This allows companies to have bespoke layouts and forms tailored to their requirements while leveraging Alfresco's advanced capabilities. With Alfresco, businesses can easily manage their documents, automate workflows, and collaborate seamlessly with their teams. Alfresco's cloud-based platform ensures that all data is secure and accessible anywhere.



**Fig. 1** Our proposed architecture.

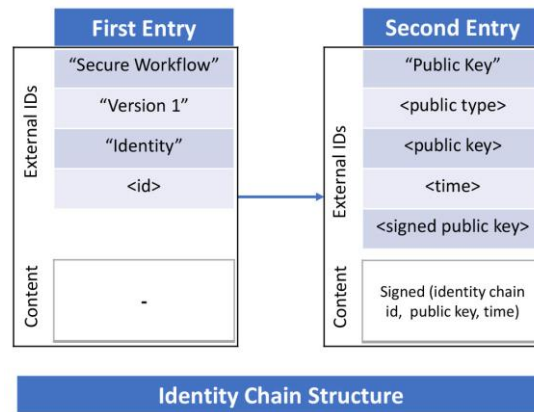
Camunda Modeller is a powerful and user-friendly tool that allows banks to design and model highly customised workflows that meet their needs and requirements. With this tool, banks can define the workflow steps and activities that must be completed for each process and create detailed workflow diagrams that serve as a visual guide. Once the workflow definitions are created using the Camunda Modeller, they are stored in the Alfresco Repository. This powerful document management system enables efficient and secure storage, retrieval, and sharing of workflow information and documents.

To ensure maximum security and transparency, our approach involves storing hashed information of the data in the Factom Blockchain alongside the workflow information stored in Alfresco's relational database at each action point. Whenever a user takes a specific action at a workflow step, the system records all the relevant information, including the hashed data, in the Alfresco Repository and the Factom Blockchain. Camunda Platform, our powerful workflow automation tool, then orchestrates every workflow step, ensuring that each user is assigned specific tasks and activities at each process stage. This helps streamline workflows, reduce errors, and increase efficiency while ensuring that all data and information are kept safe and secure.

The next section will elaborate on the chain and block structure of the Factom blockchain.

#### 4.2. Factom Blockchain Architecture

The proposed system comprises two distinct types of factom chains, namely Identity and Workflow. The main objective of the Identity chain is to securely store the hashed details of creators and task executors of any given workflow. Figure 2 illustrates the proposed structure that this chain would follow. The Identity chain has been designed to contain two entries, where the first entry would consist of four external identifiers and empty content. The external identifiers are "Secure Workflow", "Version 1", and "Identity", while the fourth identifier would be a dynamic variable that is unique to each user. This variable would be derived from the alfresco database.

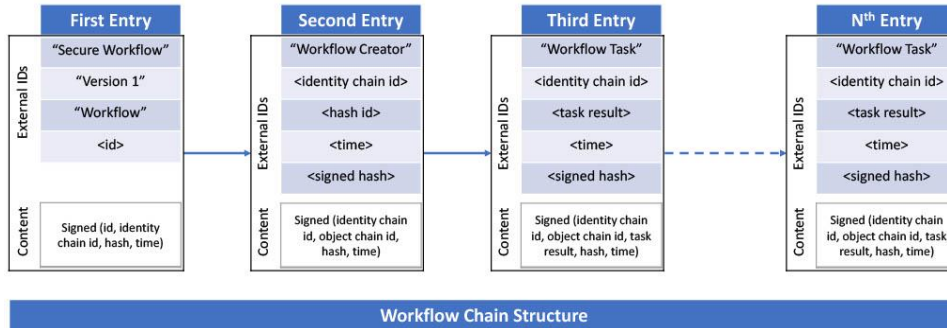


**Fig. 2** Identity Chain structure of the proposed system.

The second entry of the Identity chain type has five external identifiers. We have one static "Public Key" identifier; the remaining ones are variable. The next four external identifiers are the public key, its type, the timestamp, and the signed public keys. Public and private keys can be generated using a Factom Wallet [42]. The content field of the second entry is a signed hash of the combination of identity chain ID, public key, and current timestamp.

Figure 3 shows the second chain type. This type stores the details of any workflow that Alfresco and Camunda have initiated. When creating and initiating the workflow, at least two entries are being added to a new entry, which is characterised by the following

four external identifiers; “Secure Workflow”, “Version 1”, “Workflow”, and the dynamic variable ”id” which is the unique workflow id from Alfresco database. The second entry stores details about the creator/initiator of the workflow.



**Fig. 3** Workflow Chain structure of the proposed system.

A new task is added to this chain as the workflow process is executed by proceeding tasks. All these entries are being identified by the “Workflow Task” external identifier. Additionally, the dynamic variable “task result” stores the action the task executor takes. Depending on the business logic of the process to be automated, the possible values of this field can be “accepted”, “rejected”, etc. All entries have their content field, which holds a signed version of a special data combination that aims to increase the security of the whole system.

The Factom blockchain is a reliable source of truth and will be utilised as a notary. Although it is not the primary database, it is recommended to store details of any critical operation related to workflow execution on the blockchain. This will allow for easy verification of workflow steps at any time and ensure their accuracy. By storing this information on the blockchain, one can rest assured that the data is secure and tamper-proof, providing a trustworthy record of important operations.

## 5. PRACTICAL IMPLEMENTATIONS

Blockchain technology in the banking sector can streamline and automate many processes related to document workflow. One example of how blockchain could be used in this context is by creating a decentralised, distributed ledger that securely stores and tracks the movement of essential documents such as loan agreements, mortgage contracts, and other financial documents. By storing these documents on a blockchain, banks can create an immutable record of their existence and movement, which can help to reduce the risk of fraud and errors. As a result, using blockchain in the banking sector can improve the efficiency and security of document workflow processes and potentially lead to significant cost savings for financial institutions. In addition to storing and tracking documents, blockchain technology could automate specific document workflow processes.

Using blockchain technology, the proposed solution for the finance sector can reduce the risk of human error in the document workflow process. By storing these documents on a blockchain, banks can create an immutable record of their existence and movement, which can help to reduce the risk of errors caused by manual data entry or other manual processes.

In addition, smart contracts could automate specific processes within the document workflow, such as releasing funds to a borrower once a loan agreement has been signed and all necessary documents have been submitted. This helps eliminate the need for manual processes, which can reduce the risk of errors caused by human intervention.

The ability to detect fraud in the document workflow process can be facilitated by using blockchain technology. For example, if an unauthorised person attempts to alter a document stored on the blockchain, the change will be immediately detected due to the distributed nature of the ledger. This can help to prevent fraudulent activity from going undetected, as any changes to the document will be immediately visible to all parties on the network.

By storing these documents on a blockchain, banks can create an immutable record of their existence and movement, which can help to prevent unauthorised access or tampering with the documents. The decentralised nature of the blockchain also makes it more secure against attacks, as there is no central point of control that malicious actors can target. In addition, blockchain networks typically use robust encryption techniques to protect the data stored on the network, which helps to enhance security further.

The solution described in this paper could be automated and provided as a SaaS (software as a service), especially to the banking sector. The combined service could include document workflow, process automation, and blockchain integration. Using the finance sector as the pilot, this service's scope could be extended to cover all sectors that care about their efficiency, security, and digitisation.

## 6. CONCLUSION AND FUTURE WORK

When blockchain technology was invented, its effects were overestimated. However, over time, they have been underestimated. This technology can provide a technological solution for almost all data-critical sectors. Combining blockchain with leading document workflow and process orchestration tools makes digitising end-to-end processes securely and efficiently possible in many sectors. This combination can bring about significant changes in the market and can be easily adapted to sectors that require high security levels.

Banking sectors should consider moving towards distributed and transparent architectures as the world becomes more transparent. Shortly, the finance sector will likely focus more on digital branches than physical ones. Although this process may start slowly since it is considered the most centralised and closed sector, it will likely move quickly once the benefits are realised.

This paper provides a detailed overview of the traditional and modern finance sectors. It delves into the leading document management systems, process orchestration tools, and blockchain integrations. For instance, Alfresco is an open-source document management system that many large corporations rely on, while the Camunda process orchestration tool is fast becoming the industry standard. Additionally, the Factom blockchain is a protocol that enables efficient interaction with the blockchain.

Combining these three crucial technologies has significant potential for the financial sector. With its features like decentralisation, digital storage, transparency, and more, blockchain technology can help banks address the challenges the traditional centralised banking system poses. This paper proposes a novel method based on blockchain infrastructure that addresses financial workflow efficiency, security, and privacy.

Our proposed method can facilitate further developments in the financial sector and leverage blockchain technology. The proposed blockchain-based method can provide a secure and transparent system that can be used to record financial transactions. This will allow users to access and monitor financial data in real-time and prevent malicious actors from tampering with the system. Additionally, it will help reduce operational costs for financial institutions. This method can also offer improved security for users' financial data and provide a reliable and efficient platform for financial transactions. Overall, blockchain technology can be beneficial in improving the transparency and security of financial transactions. We plan to implement and offer our proposed system as a SaaS solution to the community, especially in the finance sector.

#### REFERENCES

- [1] S. Jordan, S. S. Zabukovšek, and I. Š. Klančnik, "Document Management System – A Way to Digital Transformation", *Naše gospodarstvo/Our economy*, vol. 68, no. 2, pp. 43–54, Jun. 2022. doi: 10.2478/ngoe-2022-0010.
- [2] M. Garzón-Goya, C. Delgado-Vera, K. Lagos-Ortiz, and F. Jurado-Larrea, "Trend of the Use and Investment of Blockchain Technology in the Banking Sector in Ecuador", In Proceedings of the International Conference on Technologies and Innovation, 2022, pp. 178–190. doi: 10.1007/978-3-031-19961-5\_13.
- [3] H. Rjoub, T. S. Adebayo, and D. Kirikkaleli, "Blockchain technology-based FinTech banking sector involvement using adaptive neuro-fuzzy-based K-nearest neighbors algorithm", *Financial Innovation*, vol. 9, no. 1, p. 65, Mar. 2023. doi: 10.1186/s40854-023-00469-3.
- [4] A. Thommandru and D. B. Chakka, "Recalibrating the Banking Sector with Blockchain Technology for Effective Anti-Money Laundering Compliances by Banks", *Sustainable Futures*, vol. 5, p. 100107, Dec. 2023.
- [5] M. S. Zaid Saidat, "How Can Blockchain Revolutionize the Jordanian Banking Sector?", *Journal of Southwest Jiaotong University*, vol. 57, no. 3, Art. no. 3, 2022, Accessed: Jun. 16, 2023. Available at: <http://www.jsju.org/index.php/journal/article/view/1251>
- [6] R. K. Jena, "Examining the Factors Affecting the Adoption of Blockchain Technology in the Banking Sector: An Extended UTAUT Model", *International Journal of Financial Studies*, vol. 10, no. 4, Art. no. 4, Dec. 2022.
- [7] S. Mafike and T. Mawela, "Blockchain Design and Implementation Techniques, Considerations and Challenges in the Banking Sector: A Systematic Literature Review", *Acta Informatica Pragensia*, vol. 11, Nov. 2022.
- [8] "Document Management System Software | Alfresco", Available at: <https://www.alfresco.com/ecm-software/document-management>
- [9] "Alfresco Docs - CMIS API reference", Available at: <https://docs.alfresco.com/content-services/latest/develop/reference/cmris-ref/>
- [10] "Process Orchestration: Guide to Benefits & Software | Camunda", Available at: <https://camunda.com/process-orchestration/>
- [11] "The Universal Process Orchestrator | Camunda", [Online] Available: <https://camunda.com/>
- [12] "Camunda Modeler: Design Business Processes and Decision Models", Available at: <https://camunda.com/platform/modeler/>
- [13] "Chains and Entries | Factom", Available at: <https://factom.pro/guides/chains-entries/>
- [14] "Factom@ PRO — Blockchain-as-a-Service platform", Available at: <https://factom.pro>
- [15] "PaperSave | PaperSoft", Available at: <https://www.pairsoft.com/about-us/papersave/>
- [16] "ClickUp™ | One app to replace them all", Available at: <https://clickup.com/>
- [17] "M-Files | Document Management Platform", Available at: <https://www.m-files.com/>
- [18] "BPMN Specification | Business Process Model and Notation". Available at: <https://www.bpmn.org/>
- [19] "BPMN Workflow Engine | Camunda", Available at: <https://camunda.com/platform-7/workflow-engine/>
- [20] "Business Process Model and Notation Version 2.0", Available at: <https://www.omg.org/spec/BPMN/2.0/PDF>
- [21] "The Basics of Business Process Modeling and Notation (BPMN) | IBM", Available at: <https://www.ibm.com/cloud/blog/bpmn>



- [22] V. Mohite, "Reducing Uncertainty in Trade and Deciphering Future Challenges in Banking Industry through Application of Blockchain Technology", In Proceedings of the Conference: Sustainable, Smart and Socially Responsible Organisations: The Roadmap to Business Excellence At: Indore, India 2018.
- [23] S. Davidson, P. De Filippi, and J. Potts, "Economics of Blockchain", Rochester, NY, Mar. 08, 2016.
- [24] Y. Guo and C. Liang, "Blockchain application and outlook in the banking industry", *Financial Innovation*, vol. 2, no. 1, p. 24, Dec. 2016.
- [25] N. H. Arrifin and U. Subramanian, "Blockchain in Banking", In Proceedings of the International Conference on Information Technology Systems and Innovation (*ICITSI*), Nov. 2022, pp. 58–63.
- [26] P. Vernekar, P. Anushree, A. K. Chowdhury, and S. Bhoomika, "Implementation of Blockchain in the Banking Sector", *Int J Sci Res Sci Eng Technol*, vol. 9, no. 6, pp. 261–265, Nov. 2022.
- [27] A. Gupta and S. Gupta, "Blockchain Technology Application in Indian Banking Sector", *DBR*, vol. 19, no. 2, pp. 75–84, Nov. 2018. [28] L. Cocco, A. Pinna, and M. Marchesi, "Banking on Blockchain: Costs Savings Thanks to the Blockchain Technology", *Future Internet*, vol. 9, no. 3, Art. no. 3, Sep. 2017.
- [29] McKinsey&Company, "A Brave New World for Global Banking: McKinsey Global Banking Annual Review", 2016. Accessed: Dec. 31, 2022. Available at: <https://www.mckinsey.com/br/sitecore/content/mckinsey/clientlink/a-brave-new-world-for-global-banking-mckinsey-global-banking-annual-review-2016>
- [30] F. Rega, N. Riccardi, J. Li, and F. Di Carlo, *Blockchain in the banking industry: an Overview*. 2018.
- [31] H. Hassani, X. Huang, and E. Silva, "Banking with blockchain-ed big data", *Journal of Management Analytics*, vol. 5, no. 4, pp. 256–275, Oct. 2018. doi: 10.1080/23270012.2018.1528900.
- [32] J. Yli-Huumo, D. Ko, S. Choi, S. Park, and K. Smolander, "Where Is Current Research on Blockchain Technology?—A Systematic Review", *PLOS ONE*, vol. 11, no. 10, p. e0163477, Oct. 2016.
- [33] H. Wang, S. Ma, H.-N. Dai, M. Imran, and T. Wang, "Blockchain-based data privacy management with Nudge theory in open banking", *Future Generation Computer Systems*, vol. 110, pp. 812–823, Sep. 2020.
- [34] L. Zuo, J. Strauss, and L. Zuo, "The Digitalization Transformation of Commercial Banks and Its Impact on Sustainable Efficiency Improvements through Investment in Science and Technology", *Sustainability*, vol. 13, no. 19, Art. no. 19, Jan. 2021.
- [35] P. Rosati and T. Čuk, "Blockchain Beyond Cryptocurrencies", in *Disrupting Finance: FinTech and Strategy in the 21st Century*, T. Lynn, J. G. Mooney, P. Rosati, and M. Cummins, Eds., in Palgrave Studies in Digital Business & Enabling Technologies. , Cham: Springer International Publishing, 2019, pp. 149–170.
- [36] X. Vives, "Digital Disruption in Banking and its Impact on Competition", Paris: OECD, 2020.
- [37] OECD, "Digital disruption in financial markets - OECD", Accessed: Dec. 29, 2022. Available at: <https://www.oecd.org/daf/competition/digital-disruption-in-financial-markets.htm>
- [38] H. Natarajan, S. Krause, and H. Gradstein, "Distributed Ledger Technology and Blockchain", World Bank, Washington, DC, Working Paper, 2017.
- [39] N. Cucari, V. Lagasio, G. Lia, and C. Torriero, "The impact of blockchain in banking processes: the Interbank Spunta case study", *Technology Analysis & Strategic Management*, vol. 34, no. 2, pp. 138–150, Feb. 2022.
- [40] A. Tapscott and D. Tapscott, "How Blockchain Is Changing Finance", *Harvard Business Review*, Mar. 01, 2017. Accessed: Nov. 29, 2022. Available at: <https://hbr.org/2017/03/how-blockchain-is-changing-finance>
- [41] CB Insights, "How Blockchain Could Disrupt Banking", CB Insights Research. Accessed: Dec. 29, 2022. Available at: <https://www.cbinsights.com/research/blockchain-disrupting-banking/>
- [42] "The Best Factom Wallets: Detailed List and Main Features", Available at: <https://wallets.com/factom/>