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Managing Data Complexity in Blockchain-Based Workflow Systems

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ABSTRACT

Blockchain-based workflow systems provide transparency, security, and data integrity. However, increasing data volume, variety, and velocity create complexity that can affect workflow efficiency, system scalability, and resource utilization. **This study aims** to develop a framework for managing data complexity while improving workflow efficiency through integrated data management and workflow optimization. **A conceptual design** approach is adopted by developing a layered architecture consisting of the data, blockchain, and application layers. The framework is conceptually evaluated through data complexity analysis based on volume, variety, and velocity and their effects on workflow efficiency and resource management. The proposed framework integrates data classification and prioritization, where high-priority data are processed on the blockchain, while low-priority data are stored off-chain. Data pruning, compression, smart contracts, and priority-based task scheduling are incorporated to reduce redundancy, optimize storage capacity, improve data access speed, and accelerate workflow execution. **The integration of data management** and workflow processes also helps minimize potential bottlenecks. Compared with previous studies, the framework provides a more integrated approach by combining data complexity management and workflow optimization within a single model. **Conceptually, it has the potential to improve efficiency**, scalability, and system effectiveness. In addition, the framework establishes a structured basis for future prototype development, simulation, and empirical testing across diverse blockchain workflow scenarios and operational conditions effectively. However, prototype implementation and empirical evaluation are required to quantitatively validate its performance.

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1. INTRODUCTION

The rapid advancement of blockchain technology has driven significant transformation across various modern workflow systems, including supply chain management, healthcare, and financial services [1, 2]. Blockchain offers several key advantages, such as transparency, immutability, and decentralization, making it a promising solution for managing processes that involve multiple stakeholders [3, 4]. However, as the adoption of this technology continues to increase, blockchain-based workflow systems generate large volumes of

diverse data, leading to challenges related to data complexity. This complexity is commonly characterized by the dimensions of volume, variety, and velocity, which can adversely affect data management efficiency and the overall performance of the system [5]. These challenges become increasingly important as decentralized networks expand, transaction activities increase, and diverse data sources require efficient storage, processing, integration, and synchronization across participating blockchain nodes.

Despite its numerous advantages, managing complex data within blockchain-based workflow systems remains a significant challenge. The decentralized nature of blockchain often leads to data redundancy, increased storage requirements, and transaction processing latency. Furthermore, the integration of workflow mechanisms with blockchain-based data storage can introduce inefficiencies, particularly when handling dynamic and large-scale datasets [6, 7]. These challenges may negatively impact the performance, scalability, and overall effectiveness of blockchain-based workflow systems [8]. As transaction volumes and data diversity continue to increase, these limitations can create additional computational demands, reduce responsiveness, and complicate efficient coordination among distributed participants and interconnected workflow processes.

For previous studies, research has primarily focused on improving the scalability and security aspects of blockchain systems. However, most existing approaches do not specifically address the management of data complexity within workflow environments. To date, only a limited number of studies have proposed comprehensive frameworks capable of efficiently managing data complexity while simultaneously supporting seamless workflow execution in blockchain-based systems. This gap highlights the need for a more integrated and adaptive approach that can effectively balance data management and workflow optimization in decentralized environments [9].

This study aims to propose a framework for efficiently managing data complexity in blockchain-based workflow systems while improving process performance in decentralized environments [10]. The framework integrates data management strategies with workflow optimization to address large-scale, dynamic, and heterogeneous data, supporting more scalable, reliable, and sustainable blockchain systems [11]. Furthermore, this research contributes to the Sustainable Development Goals (SDGs), particularly SDGs 9 (Industry, Innovation, and Infrastructure) by promoting efficient digital infrastructure through blockchain technologies, and SDGs 16 (Peace, Justice, and Strong Institutions) by enhancing transparency, accountability, and trust in technology-driven systems [12]. The main contributions of this study are as follows:

- Developing a conceptual model for managing data complexity in blockchain-based environments.
- Proposing workflow optimization strategies tailored to blockchain-based systems.
- Designing an integrated framework that combines data management mechanisms with workflow efficiency optimization.

These contributions are integrated into a unified framework that addresses data complexity and workflow efficiency through coordinated data management, storage optimization, and workflow automation mechanisms. The framework also provides a structured basis for improving scalability, resource utilization, transparency, and operational effectiveness in decentralized workflow environments. This fragmentation can create inconsistencies in data handling, increase resource demands, and reduce coordination between data management and workflow processes, particularly in dynamic decentralized environments with continuously changing workloads.

2. LITERATURE REVIEW

2.1. Blockchain in Workflow Systems

Blockchain is a distributed ledger technology that records transactions transparently, securely, and immutably [13]. In workflow systems, it automates, verifies, and documents processes involving multiple stakeholders without a central authority [14]. Its decentralization, transparency, immutability, and smart contracts improve trust, auditability, efficiency, and accountability while reducing manual intervention and delays [15, 16, 17]. Thus, blockchain provides reliable infrastructure for secure and traceable workflow management [18, 19]. However, the continuous generation and exchange of data in blockchain-based workflows can increase storage requirements, processing latency, and coordination complexity, particularly as the number of transactions and network participants grows [20, 21]. Therefore, effective data management is essential to maintain workflow performance, scalability, and operational efficiency in distributed environments.

Blockchain-based workflows are applied in supply chains, healthcare, and finance. They enable real-time product tracking, secure medical-record management, and automated, fraud-resistant financial transactions [22, 23]. Despite these benefits, the diversity, volume, and velocity of data generated across these applications create additional challenges for storage, integration, processing, and synchronization [24]. These challenges highlight the importance of integrating data management mechanisms with workflow optimization to support efficient and scalable blockchain-based systems. These applications support SDG 9 by strengthening digital infrastructure, SDG 16 by promoting transparency and accountability, and SDG 3 by improving the security, interoperability, and reliability of healthcare data [25, 26].

2.2. Data Complexity in Distributed Systems

Data complexity is a major challenge in distributed systems, including blockchain-based environments. It is commonly characterized by four dimensions: volume, referring to the amount of data generated and stored; variety, representing diverse data types and formats; velocity, describing the speed of data generation, transmission, and processing; and veracity, concerning data accuracy, reliability, and trustworthiness. These dimensions influence data management and system performance, particularly in decentralized environments where data is continuously generated and shared among multiple participants. In blockchain environments, complexity increases as the number of network nodes and simultaneously processed transactions grows. Each node maintains a copy of the distributed ledger, potentially causing data redundancy and increased storage requirements. Furthermore, diverse data formats from multiple sources create challenges for data integration, processing, and analysis [27].

These challenges become more pronounced in large-scale blockchain systems, where efficient data management is essential to maintain performance, scalability, and operational effectiveness [24]. Distributed systems also face scalability limitations, network latency, and difficulties in maintaining data synchronization across multiple nodes. Such issues directly affect blockchain-based workflow performance, particularly when processing large volumes of dynamic and continuously evolving data. As network scale and complexity increase, efficient coordination and consistency among distributed nodes become more difficult, potentially causing transaction processing delays, reduced system responsiveness, and decreased workflow efficiency [21].

2.3. Existing Approaches

Various studies have addressed blockchain challenges through data management and workflow optimization. Data management approaches include off-chain storage to reduce blockchain storage burdens and data pruning to remove irrelevant or obsolete data, improving storage efficiency and reducing redundancy while maintaining data integrity and accessibility [28, 29]. Workflow optimization techniques include efficient smart contracts, lightweight consensus mechanisms, and scheduling approaches to improve process execution [30]. Complementary technologies such as cloud and edge computing have also been integrated to support scalable data management and improve resource utilization [31].

However, existing approaches often focus on individual aspects, such as system performance or storage reduction, rather than comprehensively addressing data complexity within workflow environments [32]. Consequently, these solutions may be insufficient for managing the growing complexity of modern blockchain systems [33]. In particular, separate optimization of storage, scalability, or workflow execution may limit the ability of blockchain-based systems to respond effectively to increasing data volume, variety, and velocity. Therefore, an integrated and adaptive framework is needed to simultaneously manage data complexity and optimize workflow execution [34].

2.4. Research Gap Analysis

Based on the review of previous studies, it can be concluded that a significant research gap still exists in managing data complexity within blockchain-based workflow systems. Most studies have primarily focused on scalability, security, or specific optimization aspects, while failing to comprehensively integrate data complexity management with workflow efficiency [35]. Consequently, there is a need for a holistic framework that can effectively address data complexity challenges while ensuring seamless and efficient workflow execution in decentralized blockchain environments [36]. The following Table 1 presents a comparison of previous studies. This comparison highlights differences in data management, workflow optimization, storage efficiency, scalability, and automation capabilities. It also demonstrates the limited integration of complementary mechanisms, emphasizing the need for a unified framework that addresses these interconnected requirements comprehensively within decentralized workflow environments.

Table 1. Comparison of Previous Studies on Blockchain-Based Workflow Systems and Data Management

Criteria	Study A	Study B	Study C	Study D	Proposed Framework
Data Complexity Management	×	×	✓	×	✓
Workflow Optimization	×	×	×	✓	✓
Blockchain Scalability Support	✓	×	✓	×	✓
Storage Optimization	✓	×	✓	×	✓
Off-chain Storage	×	×	✓	×	✓
Smart Contract Integration	×	×	×	✓	✓
Priority-based Data Classification	×	×	×	×	✓
Data Pruning & Compression	×	×	✓	×	✓
Integrated Data & Workflow Management	×	×	×	×	✓
Validation Status	Existing Implementation	Existing Implementation	Existing Implementation	Existing Implementation	Conceptual Framework

Table 1 shows that the proposed framework offers broader coverage by integrating data management, workflow optimization, blockchain scalability, storage optimization, off-chain storage, smart contracts, data classification, and data pruning within a unified framework. In this comparison, a check mark (✓) indicates that a criterion is addressed either fully or partially, while a cross mark (×) indicates that the criterion is not addressed.

Most existing studies address isolated blockchain challenges, such as scalability, security, data management, or workflow optimization [37]. In contrast, the proposed framework combines data classification, priority-based management, off-chain storage, data pruning, smart contract automation, and workflow optimization in a unified architecture [38]. This integration addresses the research gap by jointly improving data management and workflow performance in complex blockchain-based systems [39, 40, 41].

3. METHODOLOGY AND PROPOSED FRAMEWORK

3.1. Research Methodology

This study employs a conceptual approach combined with a literature review to develop a framework for managing data complexity in blockchain-based workflow systems. The research process consists of four stages: literature review to identify challenges and existing solutions, synthesis to define functional requirements and architectural components, comparative analysis to identify research gaps and contributions, and conceptual evaluation to assess the framework's consistency, feasibility, and potential effectiveness. Comparative analysis focuses on data management and workflow optimization approaches, providing the basis for designing an integrated framework to address data complexity.

To evaluate the proposed framework, this study uses a data complexity-based scenario focusing on data volume, variety, and velocity and their effects on workflow efficiency, storage utilization, latency, throughput, scalability, and resource utilization. The framework is currently assessed conceptually by examining its architectural, workflow, and data management consistency, as well as the alignment between the proposed mechanisms and the identified system requirements, while these evaluation criteria provide a basis for future prototype testing, simulations, and real-world validation.

3.2. System Architecture

The framework proposed in this study is designed to manage data complexity while simultaneously improving workflow efficiency in blockchain-based systems through a layered architecture approach [42]. This approach aims to separate the system's core functions, thereby enhancing flexibility, scalability, and ease of integration with other technologies. The proposed architecture consists of three main layers: the data layer, blockchain layer, and application layer. The data layer is responsible for data management, including data collection, storage, and preprocessing [43]. Since the data entering the system may originate from multiple

sources and exist in various formats, classification and normalization mechanisms are required to reduce data complexity and improve processing efficiency [44].

Furthermore, the blockchain layer serves as the system core for transaction recording, data validation, and information integrity and security [45]. It stores data hashes and essential metadata to reduce storage burden, while the application layer enables user interaction and workflow automation through smart contracts [46, 47]. The layers interact sequentially, with the data layer collecting and preprocessing data, the blockchain layer validating transactions and enforcing security, and the application layer automating workflows and monitoring tasks. This integration supports efficient data exchange while maintaining transparency, integrity, and scalability [48, 49, 50].

3.3. Data Complexity Management and Workflow Optimization

The proposed data complexity management model addresses distributed and dynamic blockchain data through classification, prioritization, and pruning or compression strategies. Data are classified based on importance, access frequency, and size. High-priority data are stored on-chain for security and integrity, while low-priority data are transferred off-chain to reduce storage overhead and network load. Pruning and compression further optimize storage resources and system performance.

To improve workflow efficiency, the framework integrates priority-based task scheduling and smart contracts for automated process management. Tasks are processed according to data importance and resource availability, while smart contracts enforce predefined rules without third-party intervention. Data redundancy reduction further minimizes unnecessary duplication, supporting faster, more reliable, and transparent blockchain-based workflows. These mechanisms also improve coordination among distributed processes, reduce processing overhead, minimize delays during task execution, and enable more consistent resource allocation across varying workload conditions within decentralized environments.

3.4. Framework Workflow and Conceptual Evaluation

To provide a clearer understanding of how the proposed framework operates, the system workflow is illustrated in Figure 1. The flowchart presents the structured stages of data management and workflow execution within a blockchain-based environment. It also depicts the decision-making processes involved in data classification, storage mechanism selection, and workflow automation, thereby facilitating a better interpretation of the proposed framework and its underlying algorithms.

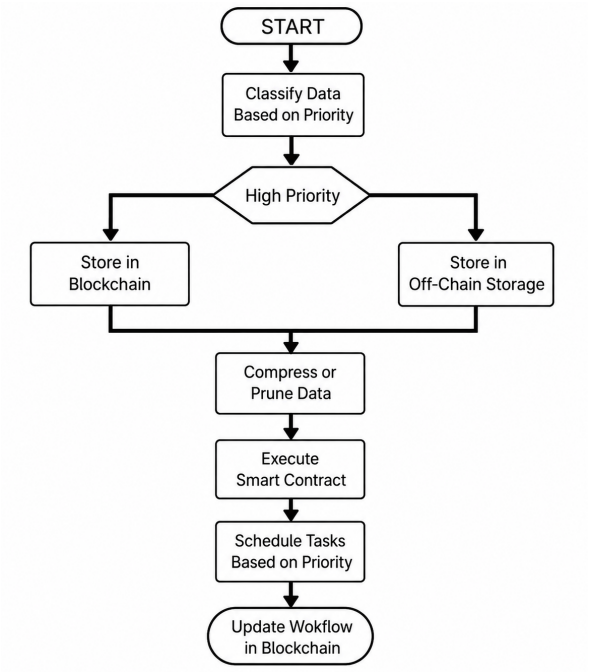


Figure 1. Workflow of the Proposed Blockchain-Based Framework

As shown in Figure 1, the process begins with priority-based data classification, followed by a decision on whether data are stored on-chain or off-chain. High-priority data are stored on-chain for security and integrity, while low-priority data are moved off-chain to reduce storage overhead. The system then applies data compression or pruning before smart contracts automate workflow processes. Finally, tasks are scheduled by priority, and workflow updates are recorded on the blockchain to ensure transparency, traceability, and efficiency.

The UML diagram in Figure 2 illustrates relationships among users, workflows, smart contracts, blockchain services, and data storage, including information exchange from data submission and validation to transaction recording and process monitoring. These interactions demonstrate how components contribute to coordinated workflow execution, secure data management, automated process control, and transparent monitoring across decentralized environments. Furthermore, the architecture supports accountability, traceability, scalability, and collaboration among stakeholders throughout the workflow lifecycle.

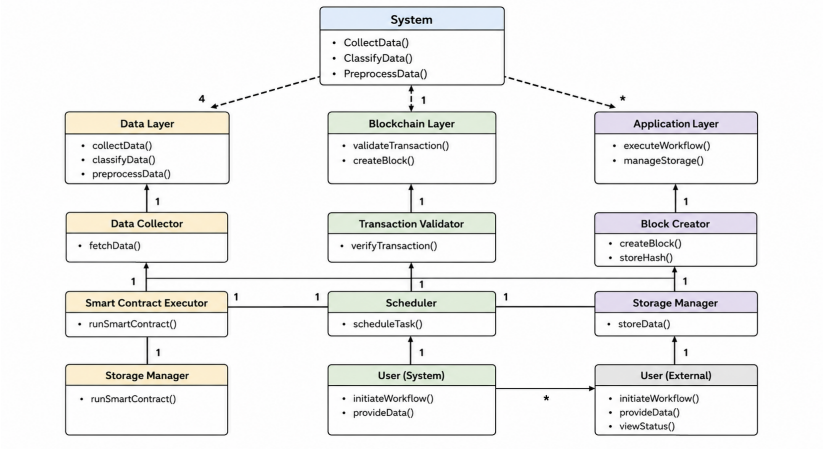


Figure 2. UML Diagram of the Proposed Blockchain-Based Workflow System

As illustrated in Figure 2, the proposed framework integrates data management and workflow optimization through a layered architecture. High-priority data are processed on-chain, while low-priority data are stored off-chain. Data pruning, compression, priority-based scheduling, and smart contracts improve storage efficiency and workflow coordination. Unlike previous approaches that address these concerns separately, the framework combines them into a single integrated solution. This integration enables coordinated interactions among users, workflows, smart contracts, blockchain services, and data storage, supporting secure data exchange, automated execution, transaction validation, monitoring, traceability, and efficient coordination across decentralized workflow processes.

Nevertheless, this study has several limitations. The proposed framework remains conceptual and has not yet been validated through real-world implementation or large-scale simulation. The evaluation is also limited to theoretical analysis and therefore cannot quantitatively measure system performance. Future research should focus on developing and implementing a system prototype, conducting empirical performance evaluations, and integrating emerging technologies such as artificial intelligence to improve the system's adaptability to dynamic data changes.

4. RESULTS AND DISCUSSION

4.1. Data Complexity Management

The conceptual analysis indicates that the proposed framework effectively integrates data management and workflow optimization within a unified blockchain-based architecture. The integration of data classification, priority-based storage, off-chain mechanisms, and smart contract automation demonstrates the potential to improve workflow efficiency while maintaining data integrity, transparency, and scalability. Furthermore, the framework supports better coordination between data handling and workflow execution by aligning storage decisions with data importance and task priorities. These mechanisms may reduce storage burden, data redun-

dancy, processing overhead, and potential workflow bottlenecks while providing a structured foundation for future prototype implementation, simulation, and empirical performance evaluation.

From the perspective of reducing data complexity, the proposed framework demonstrates significant advantages through the implementation of data classification and prioritization mechanisms. High-priority data are processed directly on the blockchain, while lower-priority data are redirected to off-chain storage. This approach significantly reduces storage burden and data redundancy within the blockchain network. Furthermore, the application of data pruning and compression techniques contributes to optimizing storage utilization and improving data access speed. As a result, the system becomes more adaptive in handling diverse data characteristics, such as large data volumes and high data velocity.

4.2. Workflow Optimization

From the workflow efficiency perspective, the use of smart contracts enables process automation in a consistent and transparent manner without requiring third-party intervention. The priority-based task scheduling mechanism further enhances workflow execution efficiency by ensuring that critical tasks are processed first. This leads to reduced processing time and improved overall system performance. In addition, the integration of data management and workflow optimization within a single framework provides better coordination among processes, thereby minimizing the potential for bottlenecks within the system.

The integration of these mechanisms also supports a more structured workflow execution process by aligning task priorities with automated decision-making. Smart contracts can enforce predefined workflow rules, while priority-based scheduling determines the order in which tasks are processed according to their importance. This coordination allows critical workflow activities to receive appropriate processing priority while maintaining consistent execution across interconnected processes. Consequently, the proposed framework provides a more organized approach to workflow management and has the potential to improve operational efficiency in blockchain-based environments.

Furthermore, the proposed framework links data management with workflow execution. Data classification and prioritization guide information management, while smart contracts coordinate tasks based on predefined conditions. This integration allows critical tasks to be prioritized and less critical information to be stored appropriately without disrupting workflow execution. It is particularly relevant to blockchain environments, where increasing data volume and transaction activity may affect coordination. Overall, the framework supports transparent and traceable data and workflow management, while providing a basis for future evaluation of execution time, transaction latency, throughput, and resource utilization.

Table 2. Summary of Conceptual Evaluation of the Proposed Framework

Evaluation Aspect	Proposed Mechanism	Conceptual Result
Data Complexity	Data classification and prioritization	More adaptive management of heterogeneous and large-scale data
Storage Management	High-priority data stored on-chain and lower-priority data redirected to off-chain storage	Reduced storage burden and data redundancy
Data Optimization	Data pruning and compression	Improved storage utilization and faster data access
Workflow Automation	Smart contract automation	More consistent and transparent workflow execution
Task Processing	Priority-based task scheduling	Critical tasks are processed first, potentially reducing processing time
Workflow Coordination	Integration of data management and workflow optimization	Better coordination among processes and reduced potential bottlenecks
Data Integrity	Blockchain-based transaction recording and validation	Maintained data integrity and transparency
Scalability	Combination of on-chain and off-chain data management	Potential to support increasing data volume and velocity

Table 2 summarizes the framework's conceptual results across data complexity, storage, optimization, workflow automation, coordination, integrity, and scalability. Data classification, prioritization, and on-chain/off-chain storage reduce storage burden and redundancy, while pruning, compression, smart contracts, and priority-based scheduling improve storage efficiency, workflow execution, and coordination. Blockchain-based validation maintains data integrity and transparency, supporting scalability as data volume and velocity increase.

4.3. Integrated Framework and Conceptual Evaluation

Since the proposed framework has not yet been implemented in a real-world environment, the findings presented in this study remain conceptual and are derived from the proposed system architecture and theoretical analysis. Future implementation will quantitatively evaluate the framework by comparing key performance indicators, including transaction latency, workflow execution time, storage efficiency, throughput, and resource utilization, against existing blockchain-based workflow approaches. Such evaluations are expected to provide objective evidence regarding the effectiveness and scalability of the proposed framework.

Compared to existing methods, the proposed framework offers a more integrated approach. Previous studies have generally focused on specific aspects, such as improving scalability, enhancing security, or optimizing workflows independently. In contrast, the proposed framework combines data complexity management and workflow optimization within a single comprehensive model. This integration provides added value in terms of system efficiency and ease of implementation, as it eliminates the need to integrate multiple separate solutions.

The findings suggest that the primary contribution of the proposed framework lies not only in combining multiple blockchain technologies but also in integrating data complexity management with workflow optimization into a single conceptual architecture. Unlike previous approaches that generally address isolated issues such as scalability or storage optimization, the proposed framework provides a more holistic perspective by coordinating data prioritization, storage strategies, workflow automation, and resource management. This integration has the potential to improve overall system efficiency while reducing operational complexity in decentralized workflow environments.

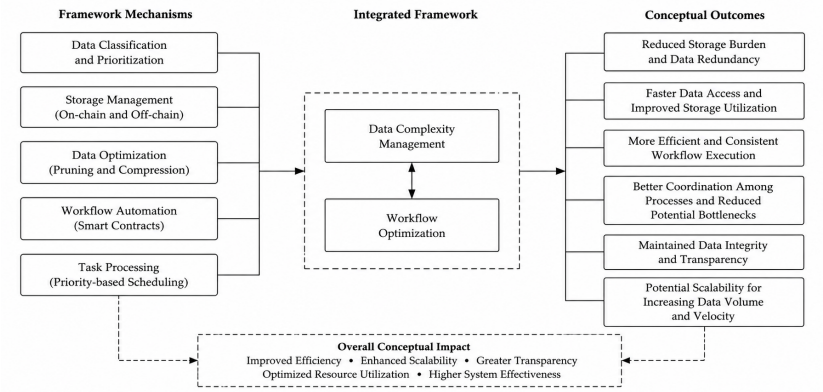


Figure 3. Conceptual Relationship Between Framework Mechanisms and Expected Outcomes

As shown in Figure 3, data classification, storage management, data optimization, workflow automation, and priority-based task processing are integrated into data complexity management and workflow optimization. This integration is expected to reduce storage burden and redundancy, improve data access and workflow efficiency, enhance process coordination, maintain data integrity and transparency, and support scalability as data volume and velocity increase. These outcomes remain conceptual and require further validation through prototype implementation and empirical performance testing.

However, this study still has several limitations. The proposed framework is still conceptual in nature and has not been tested through real-world implementation or large-scale simulation. In addition, the evaluation conducted is still limited to theoretical analysis, so it has not been able to quantitatively measure system performance. Therefore, future research can focus on implementing a system prototype, conducting empirical performance testing, and integrating other technologies such as artificial intelligence to enhance the system's adaptability to dynamic data changes. Future validation should include simulation-based performance analysis, prototype implementation, and real-world case studies to quantitatively evaluate workflow execution time, storage efficiency, resource utilization, transaction throughput, and system scalability under various blockchain workload scenarios. Such validation will provide stronger evidence regarding the practical applicability and technical effectiveness of the proposed framework.

5. MANAGERIAL IMPLICATIONS

The proposed framework offers managers a structured approach to addressing data complexity in blockchain-based workflow systems. Through data classification and prioritization, organizations can distinguish between information that requires permanent on-chain storage and information that can be transferred to off-chain environments. The use of off-chain storage, data pruning, and compression may help reduce storage requirements, minimize data redundancy, and improve system scalability. These mechanisms can also support more efficient resource utilization while preserving the integrity, availability, and traceability of critical information required for operational and audit purposes [51].

The integration of smart contracts and priority-based scheduling provides additional implications for workflow management. Managers can use smart contracts to automate predefined procedures, enforce business rules, and reduce dependence on manual intervention. Priority-based scheduling can help organizations allocate processing resources according to the urgency, importance, or operational impact of specific tasks. As a result, the framework may contribute to more consistent workflow execution, reduced processing delays, improved coordination among participants, and greater transparency in decentralized business processes. Nevertheless, managers should also consider implementation requirements, including data governance, system interoperability, security controls, and the appropriate balance between on-chain transparency and off-chain confidentiality.

More broadly, the framework may support organizational efforts to develop sustainable and accountable digital infrastructure. Its emphasis on efficient data management, scalable blockchain operations, and automated workflow execution can contribute to SDG 9 (Industry, Innovation, and Infrastructure) by encouraging the development of more resilient and resource-efficient digital systems. In addition, the use of transparent and traceable blockchain-based processes may contribute to SDG 16 (Peace, Justice, and Strong Institutions) by strengthening accountability, procedural transparency, and trust among organizational stakeholders.

6. CONCLUSION

This study proposes a framework for managing data complexity while improving workflow efficiency in blockchain-based systems. Based on the analysis results and conceptual design, the proposed framework is able to integrate data management mechanisms and workflow optimization through a layered architectural approach. The application of data classification and prioritization, the use of off-chain storage, as well as data pruning and compression techniques can conceptually reduce data complexity and improve system efficiency. In addition, the utilization of smart contracts in workflow automation also enhances the speed, consistency, and transparency of processes in a decentralized environment.

The main contribution of this study lies in the development of an integrated model that combines data complexity management and workflow optimization within a single comprehensive framework. The proposed framework offers a more adaptive approach compared to previous methods, which generally focus only on specific aspects such as scalability or security. With the integration of data management and workflow, this framework is expected to provide a more effective solution in addressing the increasingly complex and dynamic challenges of blockchain systems.

From a practical perspective, this framework has the potential to be applied across sectors, such as supply chain, healthcare, and finance, to improve data management efficiency and business process performance. This study also supports the achievement of SDGs 9 on Industry, Innovation, and Infrastructure, through the development of efficient and innovative digital infrastructure, as well as SDGs 16 on Peace, Justice, and Strong Institutions, through enhanced transparency and accountability in blockchain-based systems. However, this study has limitations due to its conceptual nature; therefore, future research is recommended to implement the system in real-world settings and conduct empirical performance evaluations to validate the effectiveness of the proposed framework. Future investigations will include simulation environments and prototype-based implementations to measure key performance indicators such as transaction latency, storage optimization, workflow execution efficiency, throughput, and scalability. These quantitative evaluations will provide empirical evidence supporting the technical contribution and practical feasibility of the proposed framework.

7. DECLARATIONS

7.1. About Authors

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7.2. Author Contributions

Conceptualization: WA and FP; Methodology: ST; Software: NA; Validation: WA and FP; Formal Analysis: ST and WA; Investigation: NA; Resources: FP; Data Curation: FP; Writing Original Draft Preparation: NA ; Writing Review and Editing: ST; Visualization: FP; All authors, WA, FP, ST and NA have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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