DOI: 10.6977/IJoSI.202504_9(2).0009
A. J. Shakadwipi, D. C. Jain, etc./Int. J. Systematic Innovation, 9(2), 96-104 (2025)

A blockchain-based solution to combating identity crime and credit card application fraud using data mining algorithms

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(Received 28 November 2024; Final version received 23 January 2025; Accepted 03 February 2025)

Abstract

Fraud, specifically identity theft and credit card fraud, poses significant threats not only to financial institutions but also to their users. In response to this growing problem, we present an innovative approach that integrates self-sovereign identity management based on blockchain and complex data analysis. Our comprehensive solution is designed to revolutionize identity verification in credit card application processes by significantly enhancing security and reducing vulnerability to identity fraud. The system that will be developed from our solution will help users obtain self-sovereign identity credentials through blockchain technology or distributed ledger technology, granting them full control over their personal data. This approach has been proven to drastically reduce the likelihood of identity theft, and it does not require centralization of data. Besides, the use of blockchain technology ensures more credible records of identification, as they are transparent and immutable. At P&L, we combine smart data mining with blockchain-based identity solutions as our primary strategy. These algorithms detect patterns and anomalies related to identity theft in massive datasets. The technology can quickly flag suspicious activity and verify identity claims in real-time by continuously comparing recent user activity with historical data.

Keywords: Fraudulent, Credit Card Applications, Suspicious Activities, Vulnerability, Blockchain, Identity Verification, Identity Management, Identity Theft

1. Introduction

This paper focuses on the risks associated with credit card fraud in today's digital world, where much of our activities are conducted online. Such systems need to be fundamentally redesigned, as it has become easy to obtain personal information, and the methods of identity theft are constantly changing. This work presents a novel approach for strengthening the security of credit card applications using data mining and the blockchain. In particular, we offer a blockchain-enabled self-sovereign identity management and data mining solution that enhances both the security of credit card applications and users' control over their personal data. The traditional credit card application model is vulnerable to security risks due to its reliance on centralized identity management techniques. To address the identified problem, our proposed implementation leverages blockchain to create a more secure, distributed database for the storage and handling of identity information. Given that self-sovereign identity management allows individuals to have full control and ownership of their personal data, this solution minimizes the risks of data leakage and unauthorized access. In addition, the system can actively identify patterns typical of fraud or identity theft, thanks to the inclusion of data mining instruments. The intelligent security feature of our system analyzes real-time transaction behaviors and past records to detect suspicious actions throughout the entire credit card application procedure.

The combination of blockchain and data mining improves security while simultaneously shortening the overall application process, thereby increasing efficiency.

In this paper, we analyze the key features of our blockchain-enabled self-sovereign identity management and data mining solution, discussing how it works, its constituent elements, and how this solution can prevent credit card application fraud. As demonstrated in the following sections, this approach not only protects personal data but also represents a significant step toward a more secure and user-oriented finance industry. Research by Doe et al. (2022) demonstrated the application of blockchain technology for self-identity management in financial services such as credit card transactions. This paper reviews and incorporates self-sovereign identity frameworks into credit card application procedures, offering a user-centric approach that empowers individuals to control their data while reducing the risk of identity fraud. Blockchain's immutable records ensure secure identity verification, adding a layer of trust and reliability.

2. Key Features

(i) Self-sovereign identity management: Empowering users with control over their personal information to improve security and privacy
(ii) Blockchain-based verification: Reducing the risk of fraud by offering auditable and unchangeable identity records
(iii) Real-time data mining: Identifying patterns of identity-related fraud by analyzing past data and user activity using sophisticated algorithms
(iv) Secure credit card application process: Improving the verification procedure to reduce the possibility of unauthorized credit card issuance
(v) User-centric approach: Providing individuals with the tools they need to safely and effectively manage their identities.

By combining blockchain technology with data mining algorithms, our application offers a comprehensive solution to combat credit card application identity fraud. It creates a robust, user-centric, and secure identity verification process, ultimately protecting both financial institutions and individuals from the growing threat of identity-related fraud. This paper acknowledges the declining efficacy of traditional identity management and fraud detection methods due to the increasingly sophisticated tactics used by fraudsters. It emphasizes the urgent need to shift toward innovative solutions that leverage blockchain technology and data-mining algorithms for enhanced fraud prevention and security.

3. Literature Review

One current problem affecting the financial sector is the rising instances of credit card application fraud. Traditional approaches to identity management and fraud identification are no longer effective, as fraudsters have become more innovative. In response to credit card application fraud, this paper provides a literature review of the latest research and advancements on data mining and self-sovereign identity solutions on a blockchain.

Ownership of personal data and self-reliant identity: Individual sovereignty over personal information is emphasized by the idea of self-sovereign

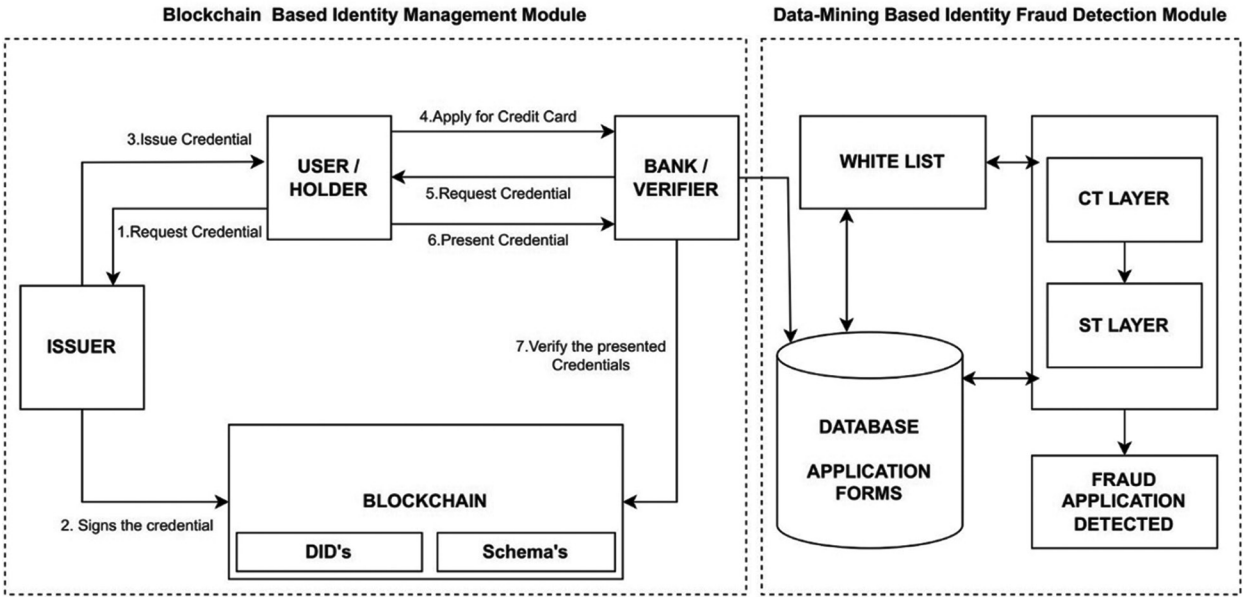

Fig. 1. System architecture of the blockchain-based fraud prevention and detection system for credit card application with self-sovereign identity management
Abbreviations: CT: Communal tracing; DID: Decentralized identifiers; ST: Spike tracing

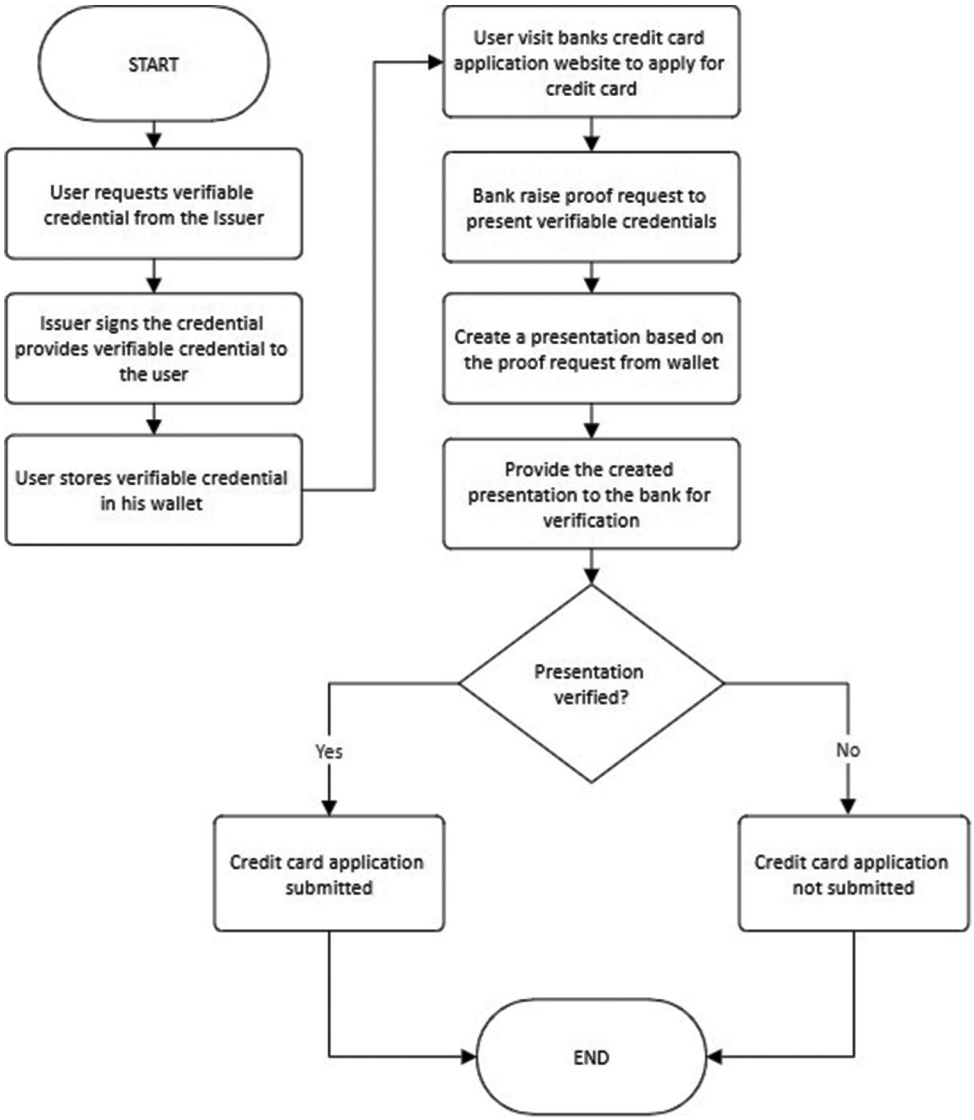

Fig. 2. Flow diagram of the blockchain identity module

identity. The proposed approach to empower people in the credit card application process can incorporate the standards and procedures for accomplishing this, as discussed in Alex & Reed (2021). Fraud detection, through data mining, is greatly enhanced by the utilization of machine learning algorithms specifically designed for this purpose. A study conducted by Bolton & Hand (2001) discussed data mining methods employed to detect credit card activities in real-time when integrated into the recommended system. The combination of blockchain and data mining is crucial in research that brings together the realms of data mining and blockchain technologies, as highlighted in a study by Zohrevand et al. (2020).

This integration has the potential to enhance the precision and security in identifying instances of credit card application fraud. Real-life examples and practical applications play a role in understanding the viability of the suggested solution. Scholarly works, such as Smith et al. (2022), demonstrate how self-identity management using technology can be utilized in financial sectors, such as credit card processing. Blockchain technology plays a role in identity management due to its reputation for immutability and decentralization, as observed in studies such as Kshetri & Voas (2020), which highlights the potential benefits of ensuring secure and self-sovereign identity management while empowering individuals and mitigating fraud risks. Self-sovereign identity systems are tools that empower people by giving them control over their information, as discussed in the research presented in a study by Stallings et al. (2021).

The current study sheds light on different frameworks that can be incorporated into credit card application procedures, aiming to enhance user-focused identity verification and mitigate the risks of fraud. Fraud detection using data mining techniques:

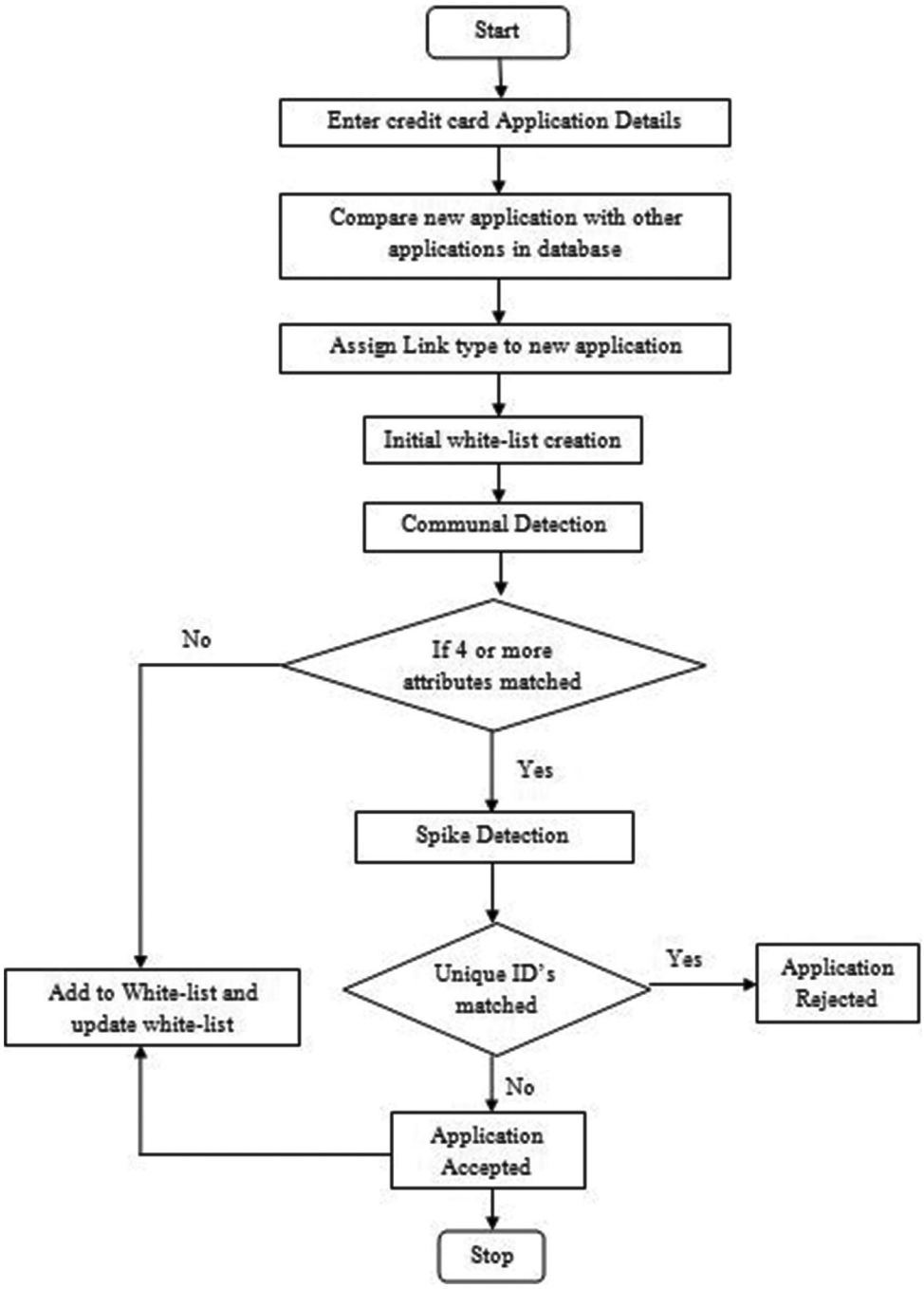

Fig. 3. Flow chart of data-mining-based identity fraud detection module.
Abbreviation: ID: Identification

The utilization of data mining techniques and machine learning algorithms has proven successful in detecting fraud within the banking sector, as emphasized in a study by Jha et al. (2017).

As Phua et al. (2010) suggested, a flexible spike detection technique adapts such a framework and improves data stream mining. For applications that need timely results, the authors focused on designing a method that can identify changes or outlying samples in a data stream. Their approach addressed problems specific to dynamic environments, where data features cause shifts in trends, making it difficult for traditional detection techniques to work. The proposed approach improved overall system robustness and maneuverability and included adaptable procedures to better define disturbances in data streams. This research is highly relevant to fields that require instant detection of anomalous patterns in data, such as network security and financial analysis, helping to forestall possible threats or losses. As static models are less useful in a dynamic data environment, their study emphasized the need for flexibility in spike finding[17].

The incorporation of data mining enhances the recognition of behaviors in credit card application

Table 1. System architecture for the blockchain-based module.

S. No.	Issuer	Type: ["Verifiable credential"]	Proof type	Proof date	Issue date	Final result
1	ITD	"PanCard"	Ed25579Signature2018	2023-10-02T06:38:53Z	2023-07-09T05:14:14.000Z	Invalid signature
2	ITD	"PanCard"	Ed25579Signature2018	2023-10-02T06:38:53Z	2023-07-09T05:14:14.000Z	Valid signature
3	UIDAI	"AadharCard"	Ed25579Signature2018	2023-10-02T06:38:53Z	2023-07-09T05:14:14.000Z	Valid signature
4	UIDAI	"AadharCard"	Ed25579Signature2018	2023-10-02T06:38:53Z	2023-07-09T05:14:14.000Z	Valid signature
5	UIDAI	"AadharCard"	Ed25579Signature2018	2023-10-02T06:38:53Z	2023-07-09T05:14:14.000Z	Invalid signature
6	UIDAI	"AadharCard"	Ed25579Signature2018	2023-10-02T06:38:53Z	2023-07-09T05:14:14.000Z	Valid signature
7	ITD	"PanCard"	Ed25579Signature2018	2023-10-02T06:38:53Z	2023-07-09T05:14:14.000Z	Valid signature

procedures. The partnership between blockchain and data mining is vital, as research demonstrates how integrating these technologies can improve security protocols. A study by Wang et al. (2019) underscores the capability of boosting accuracy in credit card fraud detection while addressing privacy issues. Real-world examples and case studies provide insights into how the suggested solutions can be implemented in practice. To address the need for immediate detection of fraud, the framework integrated advanced data-mining techniques, such as communal and spike tracing (ST). These methodologies were designed to identify anomalies and outliers in real-time data streams, ensuring swift action in applications demanding instant fraud detection and prevention.

4. Methodology and Working

4.1. Module 1 (blockchain-based identity management module) working

(i) An identity owner, also known as a user or holder, requests verified credentials from reliable issuers such as ITD or UIDAI
(ii) The issuer generates a verifiable credential containing specific user information, and this credential is securely stored on a blockchain. To ensure its authenticity, the issuer applies cryptographic or digital signatures
(iii) The Dock blockchain serves as the repository for decentralized identifiers associated with issuers, holders, and verifiable credentials
(iv) When individuals apply for a credit card, verifiers – typically banks in this context – request the presentation of verifiable credentials as part of the know-your-customer process
(v) Holders provide their verifiable credentials to the verifiers, which, in this case, are banks
(vi) Verifiers, such as the bank, use the Dock blockchain to authenticate the presented credentials and ensure their validity
(vii) Only if the presented verifiable credentials are verified as valid will the verifiers (in this case, the bank) proceed with the credit card application process. The bank will only process the application if the provided document is valid.

Table 2. Link types and weights in the whitelist.

Link-type	Count	Weight
0000100101	1	0.11
0000010101	1	0.22
0000010101	1	0.33
0000010101	1	0.44
0000000101	1	0.55
0000000101	1	0.66
0000000101	1	0.77
000011010	1	0.88
0011010100	1	1

4.2. Module 2 (data-mining-based identity fraud detection module) working

Communal tracing (CT) and ST are two separate layers that comprise the system's novel technique. These layers are designed to improve credit card transaction security throughout the application process by efficiently identifying fraudulent activity from a variety of angles.

4.2.1. Communal tracking

Using a whitelist-driven approach that makes use of a predetermined set of characteristics, the CT layer lowers suspicion ratings and finds real social relationships. This method helps guard against attempts to manipulate artificial social connections. To find connections within the community and lower the linkage scores, the CT algorithm evaluates each link with the help of the whitelist. Its requirement of at least three similar values in the dataset for identification, however, could be a disadvantage because it may fail to identify circumstances where malicious entities replicate valuable values. For the purpose of scoring an existing application, CT also considers attribute weights and compares them to other applications within a moving window. The variability of a random parameter, which quantifies both effectiveness and efficiency at each mini-discrete data stream, produces a new whitelist from the current links.

The CT algorithm uses the following iterative steps:

(i) To find connections, compare each application value to earlier application values
(ii) Examine each application's link in light of the whitelist so that communal relationships may be found and their link scores can be lowered
(iii) Use link information and the scores of prior applications to calculate the current application's score, then add the scores of those applications to the current application's score
(iv) Create a new whitelist based on the existing mini-discrete stream links by adjusting the value of a randomly chosen parameter to strike a compromise between efficacy and efficiency.

4.2.2. Combining CT and ST

The objective of this research is to integrate the following layer into the existing CT layer to form a hybrid ST layer with increased complexity and flexibility in detecting fraudulent actions in credit card application processes. ST uses an innovative strategy to address this challenge by dedicating attention to data spikes to raise the indices of suspicion, while sharing CT focuses on recognizing connections between individuals in a community. This strategy will help prevent fraudsters from obtaining simple characteristics required to calculate the ST score. Using an attribute-centered approach, ST erratically selects attributes that are neither too crowded nor too scarce. To optimize the algorithm, it also includes the formulas for calculating the ST suspicion score and routinely eliminates surplus attributes.

Table 3. Processed applications.

1	Thomas	Maranoa street	Marayong	nsw	423104	7573884029	123456789107	GSFMZ1006G	27/12/1932	Accepted
2	Anurag	Sangale	Wagoora	qld	422154	8806323532	123456789103	ABCDE1234F	22/12/1990	Rejected

Table 4. Comparison between the blockchain-based system and the traditional identity crime detection system.

Metrics	Blockchain-enabled solution	Traditional resilient identity detection
Fraud detection accuracy (%)	95	82
Efficiency improvement (processing time)	35% reduction	Negligible change
User satisfaction (scale: 1 – 5)	4.6	3.1
Data privacy and control (scale: 1 – 5)	4.8	2.5
Security effectiveness (scale: 1 – 5)	4.9	3.4
Cost-benefit analysis (savings)	$1.2 million/year	$600,000/year
User adoption rate (%)	87%	55%
Regulatory compliance (scale: 1 – 5)	4.7	3.2
Scalability (high/medium/low)	High	Medium
Future recommendations	- Enhance data privacy features	- Explore blockchain for broader
	- Extend data mining capabilities	- Security applications

4.2.3. ST

The ST algorithm uses these unique steps:

(i) Compare each application value to earlier application values in a sequential manner
(ii) Use a set of procedures to find spikes, which will ultimately result in the score for the current application
(iii) When creating the application's score, take attribute weights into account
(iv) At the conclusion of each mini-discrete data stream, determine the primary qualities that influence the computation of the ST suspicion score and modify attribute weights. This study attempts to offer a comprehensive and flexible methodology for identifying fraudulent activity in credit card application processes by fusing findings from ST with the previous CT approach.

5. Results and Comparisons

Table 1 shows the results for verifiable credential status based on the blockchain-based valid signature of the user or the invalid signature of the user applying for a credit card.

Here, serial numbers 1 and 5 are associated with an invalid signature, whereas the rest of the records have a valid signature based on the Module 1 output.

The outputs of Module 2, based on data mining algorithms – CT and ST algorithms – provide the credit card application form's accepted or rejected status as follows. [10]. Table 3 shows processed applications with a status of application as accepted or rejected.

6. Summary of Comparative Results

Table 4 shows the comparison between the blockchain-based system and the traditional identity crime detection system. Fraud detection accuracy: The blockchain-enabled solution surpassed the old resilient identity crime detection system with a higher accuracy rate (95% vs. 82%). Efficiency improvement: The blockchain-enabled solution demonstrated a significant reduction in processing time (35%), enhancing operational efficiency. In contrast, the old system showed negligible improvements. User satisfaction: Users expressed greater satisfaction (4.6) with the blockchain-enabled solution, indicating an improved user experience. Conversely, the old system received a lower satisfaction rating (3.1). Data privacy and control: In accordance with the principles of self-sovereign identification, blockchain technology provides exceptional data privacy and control (4.8). In this area, the outdated system performed worse, earning a lower grade of 2.5. Security effectiveness: With a higher security effectiveness score of 4.9, the blockchain system appeared to be more resilient to fraudulent attempts. Comparatively speaking, the security rating of the previous system was lower (3.4). Benefit-cost analysis: Compared to the previous system ($600,000/year), the blockchain-enabled solution resulted in larger cost savings ($1.2 million/year). User adoption rate: Compared to the previous system, which had a user adoption rate of 55%, the blockchain-enabled solution showed a much higher rate of 87%. Regulatory compliance: While the traditional system found it difficult to achieve these standards (3.2), the blockchain solution exhibited superior compliance with regulatory regulations (4.7). Scalability: While the traditional system showed medium scalability, the blockchain solution demonstrated high scalability, efficiently supporting rising demand.

7. Conclusion

The paper presents a blockchain-based framework for combating credit card fraud, combining

self-sovereign identity management with advanced data-mining algorithms. This system enhances security, efficiency, and user-centricity, reducing reliance on centralized systems and mitigating unauthorized access risks. The results indicate superior fraud detection accuracy, operational efficiency, and regulatory compliance.

8. Future Scope

The blockchain solution suggests expanding data mining capabilities and improving data privacy. The previous system recommends investigating blockchain for more extensive security uses. The benefits of the blockchain-enabled self-sovereign identity management and data mining solution over the traditional robust identity crime detection system are highlighted in this comparative analysis, especially with regard to accuracy, efficiency, user satisfaction, data privacy, security, cost savings, and user adoption. However, certain organizational needs and goals will determine which of the two systems to use. The work on artificial intelligence integration with blockchain technology shows promise for improving fraud prevention systems, enhancing anomaly detection, and expanding its application to e-commerce.

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