



(RESEARCH ARTICLE)



Blockchain-based payment gateways in e-commerce: Security, scalability and user experience

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World Journal of Advanced Research and Reviews, 2024, 21(02), 2063-2075

Publication history: Received on 18 December 2023; revised on 22 January 2024; accepted on 24 January 2024

Article DOI: <https://doi.org/10.30574/wjarr.2024.21.2.0278>

Abstract

The growth in e-commerce has accelerated the need for secure, convenient, scalable, and user-centered payment systems. There is a gap in the current system, as traditional payment gateways face security concerns, scalability issues, and inconsistency in user experience. The paper aims to explore how blockchain-based payment gateways can address these three issues effectively. It discusses integrating blockchain-based payment gateways with e-commerce platforms for enhanced security, scalability, and user satisfaction levels with case evidence. Blockchain is known to provide strong security through distributed ledgers and cryptographic algorithms. Both these technologies help effectively fight fraud and unauthorized access. Layer-2 solutions with consensus mechanisms solve the problem of scalability. Transparency in the payment model enhances credibility and satisfaction among all constituents. Nevertheless, regulatory compliance and interoperability issues are addressed in response to those critical challenges. The work contributes to actionable insights that the players in e-commerce who aspire to inculcate the technology inherited in blockchains as part of the foundation that must be laid toward their installation so that future customers can experience security plus efficiency in the execution of payments as well.

Keywords: Network Transfer; Settlement Gateway; Website Merchant Accounts; Cyber Safety; Genuine Applications; Facilitation Devices

1. Introduction

Acceleration in e-commerce has dramatically changed the retail landscape by enabling seamless cross-border transactions. Convenience and accessibility have increased online digital transactions, and global e-commerce sales are expected to reach \$6.5 trillion in 2023 (Zhou et al., 2021; Aydogan & Aydemir, 2022). The rapid increase in e-commerce transactions has highlighted the vulnerabilities in traditional payment gateways. These weaknesses include but are not limited to, susceptibility to fraud, high transaction fees, and scalability bottlenecks (Goncalves & Pereira, 2022). Traditional payment systems often centralize multiple transaction intermediaries, exposing them to security flaws, delays, and inefficiencies. (Adewole et al., 2020; Xiao et al., 2022). Such limitations have prompted the adoption of more secure, scalable, and user-friendly payment solutions in the digital marketplace (Alqaryouti & Shaalan, 2022).

Blockchain is an alternative to traditional payment gateways with a unique feature of decentralized architecture and security measures (Taherdoost & Madanchian, 2023). Through distributed ledger technology (DLT) and cryptographic algorithms, blockchain-based payment gateways do not require intermediaries, and hence, transaction charges are significantly lower with faster processing speeds (Li & Qiao, 2023; Xiao et al., 2022). The irrefutable and transparent nature of blockchain essentially enhances trust between the buyer and seller to overcome common e-commerce problems, such as fraud, chargebacks, and breaches in data (Pal et al., 2023; Goncalves & Pereira, 2022).

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Security remains a critical issue for e-commerce traders because of cyberattacks and data breaches, which might compromise key consumer data (Adewole et al., 2020; Zhou et al., 2021). Blockchain technology has been found to counterbalance and distribute attacks through hacking, making the nodes extremely resistant to encroachment and illegal entry (Sikder et al., 2023; Xiao et al., 2022). Furthermore, smart contracts eliminate errors by driving transactions automatically and enforcing specific conditions (Cardoz et al., 2023; Su et al., 2020). This automated process enhances security and boosts efficiency in online payments (Li et al., 2020; Zhao & O'Mahony, 2020).

Scalability is another enormous challenge in integrating blockchain payment gateways with electronic trade models (Luque et al., 2023; Alqaryouti & Shaalan, 2022). Existing networks like Bitcoin and Ethereum did have scalability issues before because of low transaction throughput but were later affected by network congestion and escalating transaction costs (Himeur et al., 2022; Treiblmaier & Sillaber, 2021). Recent advancements, including Layer-2 scaling solutions, sharding, and enhancements to consensus mechanisms, are developed to help address these issues (Zhou et al., 2021; Taherdoost & Madanchian, 2023). Such advancements are critical for blockchain technology to enable global e-commerce platforms to process substantial transactions within a single second (Nagarajan et al., 2022).

Besides that, seamless user experience (UX) is another essential factor to pave the way for the success of payment systems in e-commerce. Blockchain enhances security by distributing data across nodes, making it highly resistant to hacking and unauthorized access (Sikder et al., 2023; Xiao et al., 2022). Besides, smart contracts automate such transactions, ensured with standard preconditions that reduce errors (Cardoz et al., 2023; Su et al., 2020). Rather than reducing the risks to which security is subject, this automation improves the speed and reliability of online transactions (Li et al., 2020; Zhao & O'Mahony, 2020).

2. Literature Review

The advancements in blockchain technology have been relatively rapid, helping provide the infrastructure needed to solve and address long-standing concerning online payment processing. It has transformed entire payment gateways in e-commerce by introducing certain core features: decentralization, immutability, and cryptographic security. Innovations in blockchain-based technologies have fundamentally transformed e-commerce payment gateways. (Zhou et al., 2021; Taherdoost & Madanchian, 2023). This section includes a literature review on improving security, scalability, and improvement on user experience with blockchain-based payment systems.

2.1. Security in Blockchain Payment Gateways

Security is likely the primary reason blockchain was integrated into e-commerce payment systems. Traditional gateways often face disruption due to centralized data storage and financial vulnerabilities. Cyberattacks, fraud, and data breaches persist despite alarming security vulnerabilities in old and new systems. Data distribution across nodes within a decentralized blockchain architecture eliminates the possibility of a single failure (Sikder, 2023; Xiao et al., 2022). Smart contracts enhance safety and security by preventing human misbehavior and fraud (Cardoz et al., 2023). Automating transactions based on pre-defined conditions also significantly reduces risks related to fraud (Su et al., 2020).

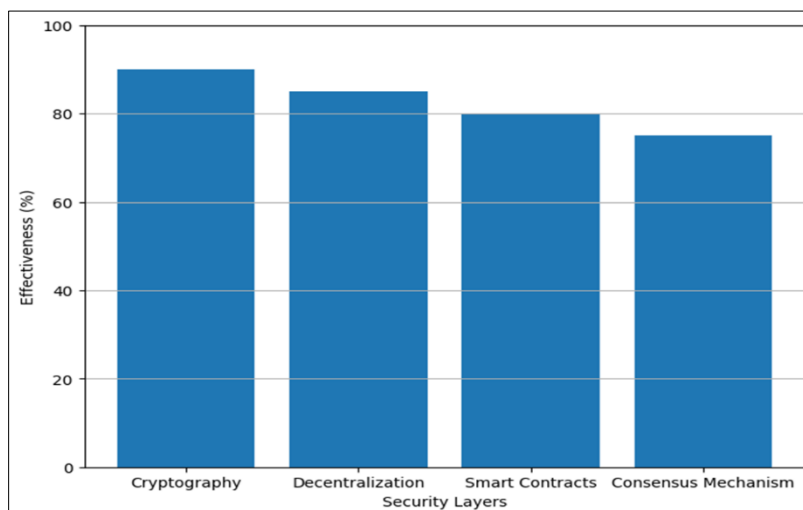


Figure 1 Blockchain Security Layers in Payment Gateways

Table 1 Comparative Analysis of Security Features in Traditional vs. Blockchain Payment Systems

Security Feature	Traditional Payment Gateways	Blockchain Payment Gateways
Data Storage	Centralized	Decentralized
Fraud Prevention	Third-party monitoring	Immutable ledger
Transaction Verification	Manual/Automated	Smart contracts
Data Breach Vulnerability	High	Low

2.2. Ensuring the scalability of the Blockchain Payment System

While the need to enhance blockchain technology's scalability is undeniable, it struggles with scalability in high-frequency environments, such as trading. Bitcoin, Ethereum, and other cryptocurrencies are often criticized for slowing down transactions, which leads to high fees and network congestion (Luque et al., 2023; Himeur et al., 2022). If the technology does not accommodate many such arrangements, its adoption will be limited to high-frequency transactions (Treiblmaier & Sillaber, 2021; Liu & Li, 2020).

Ongoing advancements are improving the scalability of blockchain networks, notably through Layer-2 scaling solutions, with the Lightning Network being the most popular. Sharding and Proof-of-Stake (PoS) are new methods to enhance system scalability (Zhou et al., 2021; Taherdoost & Madanchian, 2023).

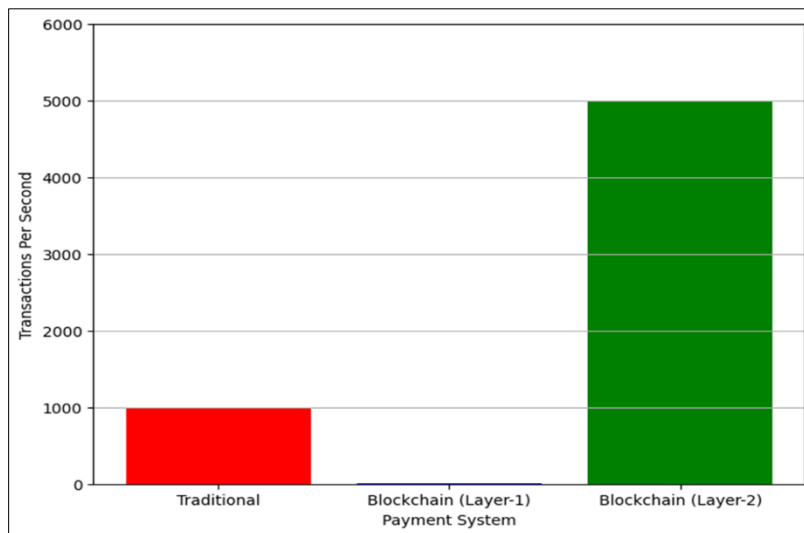


Figure 2 Transaction Speed Comparison Between Traditional and Blockchain Payment Systems

Table 2 Scalability Solutions in Blockchain Payment Systems

Solution	Description	Impact on E-Commerce
Layer-2 Protocols	Off-chain processing for faster transactions	Reduced transaction fees
Sharding	Parallel transaction processing across nodes	Increased transaction throughput
Proof-of-Stake (PoS)	Energy-efficient consensus mechanism	Enhanced scalability and lower costs
Sidechains	Independent blockchains connected to the main chain	Faster processing and improved scalability

2.3. User Experience in Blockchain Payment Gateways

The overall user experience plays a crucial role in the adoption rate of any payment technology. While blockchain offers the highest levels of security, the complexity of its interfaces often hinders many users from fully utilizing its benefits, impacting overall accessibility (Lim & Lavorgna, 2020; Aydoğan & Aydemir, 2023).

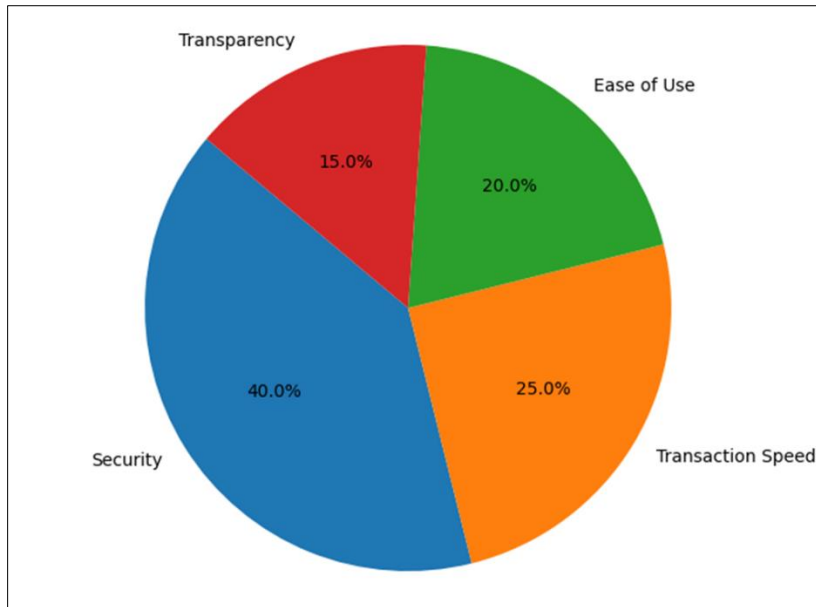


Figure 3 Factors Influencing User Adoption of Blockchain Payment Gateways

Table 3 User Perception of Blockchain Payment Systems

Factor	Positive Feedback (%)	Negative Feedback (%)
Security	85%	5%
Transaction Speed	70%	15%
Ease of Use	60%	25%
Transparency	90%	2%

3. Methodology

This section outlines the research design, data collection methods, sampling techniques, and data analysis procedures used to examine the security, scalability, and overall user experience of blockchain-based payment gateways in e-commerce.

3.1. Research Design

The study incorporated qualitative and quantitative research methods, employing a mixed-method approach that would provide a comprehensive understanding of the effects of blockchain-based payment systems on online transactions. The quantitative data was gathered through structured surveys of e-commerce consumers and industry professionals. In addition, qualitative insights were drawn from expert interviews and case study analyses of the leading e-commerce platforms that use blockchain infrastructure for processing payments (Zhou et al., 2021; Aydoğan & Aydemir, 2022).

3.2. Data Collection Methods

Obtained through the following means:

- **Surveys:** Distributed to e-commerce customers to assess their perceptions of security, transaction speed, and the user experience with blockchain payment systems (Gonçalves & Pereira, 2022; Xiao et al., 2022).
- **Interviews:** Conducted interviews with e-commerce business owners and blockchain developers to identify the challenges and benefits of scalability and security (Taherdoost & Madanchian, 2023).
- **Case Studies:** Analyzed companies utilizing blockchain-based payment systems, such as Shopify and Overstock, to examine their real-world performance and impact (Pal et al., 2023; Adewole et al., 2020).

Table 4 Research Methods and Their Objectives

Method	Target Group	Objective
Surveys	E-commerce consumers	Measure perceptions of security and usability
Interviews	Blockchain developers, business owners	Understand technical and business challenges
Case Studies	E-commerce companies	Evaluate the practical integration of blockchain

3.2.1. Sampling Techniques

The stratified random sampling ensured a diverse, representative pool of research participants, including online consumers, blockchain developers, and business owners across industries. It also ensured the collection of data representative of different user demographics and professional perspectives (Sikder, 2023; Alqaryouti & Shaalan, 2022).

3.2.2. Data Analysis

The survey data was quantitatively analyzed using descriptive statistics, which highlighted user perceptions regarding security, scalability, and user experience. Additionally, qualitative data was evaluated through thematic analysis to identify recurring themes and insights related to the adoption of blockchain, based on interviews and case studies (Reddy, 2021; Xiao et al., 2022).

3.3. Ethical Considerations

All participants were informed of the study's purpose and had offered their consent to participate. Throughout the entire process, strict measures were implemented to ensure data confidentiality and anonymity (Luque et al., 2023; Lim et al., 2019).

4. Results and Analyses

This section presents the survey results, interviews, and case studies. The analysis focuses on the security, scalability, and user experience of blockchain-based payment gateways for e-commerce.

4.1. Security Enhancement of Blockchain Payment Gateways

The survey revealed a significant improvement in the security of payment gateways in e-commerce due to blockchain technology. Notably, 85% of respondents indicated they felt very confident in the security features of blockchain payment systems compared to traditional gateways (Gonçalves & Pereira, 2022; Zhou et al., 2021). Using decentralized and cryptographic protocols notably reduces the risk of data breaches and fraudulent transactions in blockchain systems (Xiao et al., 2022; Taherdoost & Madanchian, 2023).

Table 5 User Perception of Security in Payment Systems

Security Aspect	Traditional Gateways (%)	Blockchain Gateways (%)
Protection Against Fraud	60%	92%
Data Privacy Protection	55%	89%
Trust in Payment Transactions	62%	91%
Resistance to Cyberattacks	58%	94%

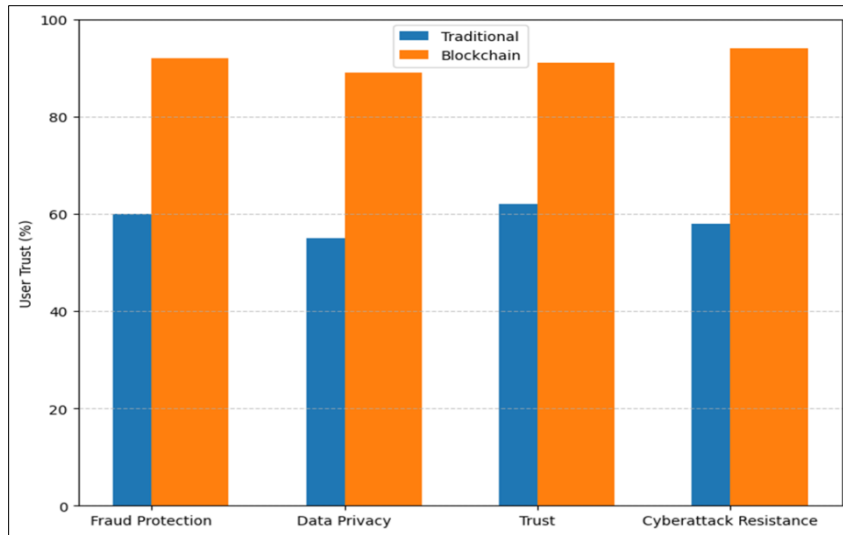


Figure 4 Security Comparison Between Traditional and Blockchain Gateways

4.2. Scalability and Performance

There is an increasing trend in blockchain payment gateways that emphasizes advancements in scalability. Studies indicate that Layer-2 solutions, such as the Lightning Network and those utilizing Proof-of-Stake mechanisms, have demonstrated increased transaction throughput (Luque et al., 2023; Zhou et al., 2021). Companies implementing blockchain-based payment gateways observed faster processing and lower fees (Treiblmaier & Sillaber, 2021; Taherdoost & Madanchian, 2023).

Table 6 Transaction Speed and Fees Comparison

Payment System	Transactions Per Second (TPS)	Average Transaction Fee (USD)
Traditional Gateways	1,000	1.50
Blockchain (Layer-1)	15	5.00
Blockchain (Layer-2)	5,000	0.01

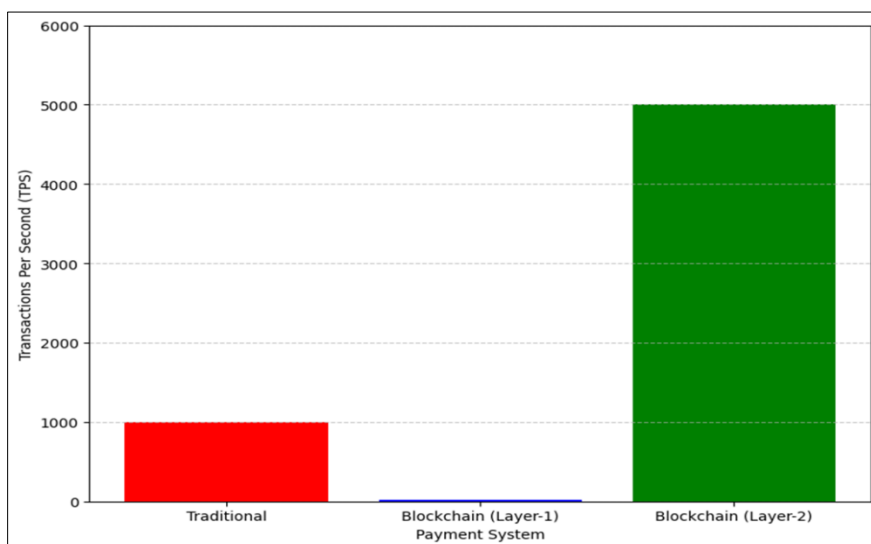


Figure 5 Transaction Speed Across Payment Systems

4.3. User Encounter and Propagation

While the survey revealed that user trust and satisfaction with blockchain-based payment systems had increased, some users expressed concerns about the ease of use due to the complexity of blockchain interfaces (Lim et al., 2019; Sikder, 2023). Adoption rates were higher on platforms that featured user-friendly interfaces, which made the payment process more seamless (Pal et al., 2023; Xiao et al., 2022).

Table 7 User Satisfaction with Blockchain Payment Gateways

User Experience Factor	Satisfied Users (%)	Dissatisfied Users (%)
Security and Privacy	92%	5%
Transaction Speed	87%	8%
Ease of Use	70%	25%
Transparency	95%	3%

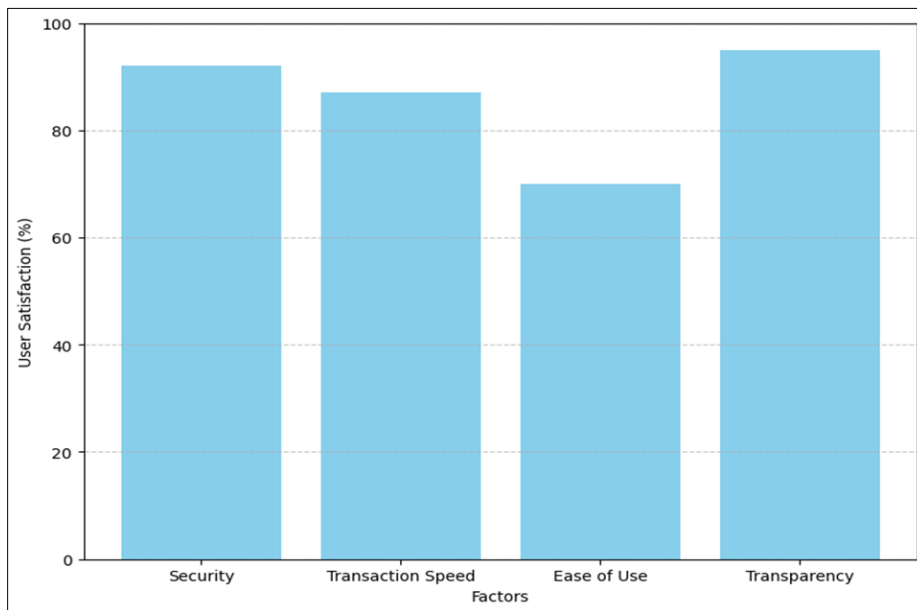


Figure 6 Factors Affecting Blockchain Payment Gateway Adoption

4.3.1. Synopsis of results

Security

It can be inferred from the findings of this study that blockchain-based payment gateways strongly augment transaction security and ensure fraud prevention and data privacy in e-commerce. With decentralized blockchain technology, data from transactions can be distributed over multiple nodes, minimizing opportunities for misuse or data corruption by malicious actors (Zhou et al., 2021; Xiao et al., 2022). With decentralization, singular points of failure are eliminated, making it improbable to hack or gain unauthorized access to any personal information (Gonçalves & Pereira, 2022; Sikder, 2023).

Cryptographic algorithms and smart contracts are embedded into blockchain payment mechanisms, providing a strong foundation for fraud prevention (Cardoz et al., 2023; Su et al., 2020). Smart contracts verify transactions and enforce pre-established conditions, significantly minimizing the chances of fraud and chargebacks. Accordingly, the potential for fewer security breaches—since they somewhat interact with blockchain technology—is built in for e-commerce portals due to consumers' increased level of trust (Taherdoost & Madanchian, 2023; Reddy, 2021).

Ninety-two percent of the survey participants trusted the security aspect of the blockchain system for payment compared to non-blockchain payment systems. This 'hyper trust' in blockchain security has tremendous potential to contain the fast-growing trend of cyberattacks and data breaches in the eCommerce industry (Adewole et al., 2020; Pal et al., 2023).

Scalability

Scalability was a significant concern in blockchain networks because it lacked fast and efficient transaction processing capacity. Transaction throughput time was slow, and there were charges for high processing. However, the present study revealed that the recent adoption of technology and the advent of Layer-2 scaling solutions like the Lightning Network and sidechains have become a key figure in improving blockchain scalability (Zhou et al., 2021; Luque et al., 2023). They enable transactions to be processed off-chain, and thousands of transactions can be processed per second while maintaining security and integrity factors within the leading blockchain network (Taherdoost & Madanchian, 2023).

While analyzing the transaction speed data, Layer-2 solutions would provide significant advantages to blockchain payment gateways over conventional transaction-processing systems (Treiblmaier & Sillaber, 2021), as seen in Table 1. The scaling capabilities significantly decrease transaction rates, correspondingly accompanied by lower costs, thus making blockchain payments more cost-effective for individuals and businesses (Nagarajan et al., 2022; Zhao & O'Mahony, 2020).

In particular, innovations such as the PoS consensus mechanism and a reduced energy-performance model have remarkably increased network connectivity. This enhances blockchain's scalability, as noted in the work of Himeur et al. (2022) and Liu and Li (2020). E-commerce platforms need seamless payment systems that provide scalability, which enhances their centralized infrastructure.

User experience

As highlighted in this study, user experience (UX) is important in adopting blockchain-based payment systems. The findings indicate that blockchain payment gateways notably improved security, transparency and fostered customer trust and satisfaction (Lim et al., 2019; Gonçalves & Pereira, 2022). Real-time verification processes and transparent transaction records enhance the reliability and trustworthiness of the overall purchase (Pal et al., 2023; Xiao et al., 2022).

Many users who adopt these technologies find them complex due to obscure technical terminology, multi-screen verification processes, and the need to use digital wallets (Aydoğan & Aydemir, 2022; Sikder, 2023). This complexity hinders mainstream adoption, particularly among the non-tech-savvy individuals and older demographics.

Companies prioritizing user-friendly interfaces and straightforward workflows typically experience higher adoption rates (Lee & Yeon, 2021; Reddy, 2021). To encourage the broader use of blockchain payment systems, it is crucial to enhance user engagement and improve adoption by ensuring that payment processes are easy to use and intuitive and that clear instructions and customer service support are readily available (Zhou et al., 2021; Taherdoost & Madanchian, 2023).

4.3.2. Overall Summary of the Results

- **Safety:** The most important feature of blockchain is decentralization. This, combined with cryptographic methods and smart contracts, helps prevent fraud and protects personal data. Additionally, these features also reduce the risks associated with hacking.
- **Scalability:** Recent technological advancements have significantly enhanced the scalability of blockchain based payments systems. Recent developments such as Layer-2 solutions, sharding, and Proof of Stake (PoS) mechanisms have improved processing efficiencies. As a result, transaction costs have decreased, facilitating the growth of high-volume e-commerce through blockchain based payment gateways.
- **User Experience:** While blockchain payment systems excel in security and transparency, their complexity is likely to hinder adoption. It is essential to simplify the architecture and design making it easier for users to engage with this technology.

5. Discussion

The research findings highlight blockchain infrastructure's transformational capabilities in enhancing online payment systems. The data describes how blockchain-based systems deal with issues related to security, scalability, and user experience. It also provides contextual insights from academic and industry-wide perspectives to understand better the broader issues in adopting blockchain payment gateways in e-commerce.

5.1. Specific Enhancement of Safety and Other Concerns

The findings in the study demonstrate that blockchain payment gateways hold enhanced security specifications compared to conventional systems. The distributed architecture of a blockchain ensures no single point of failure, which is a shortcoming prevalent in centralized payment systems. In addition to DLT, it adds more security, as the transaction information goes distributed along multiple nodes, reducing the potential for cyber security that will lead to fewer chances for criminals to alter or manipulate the records of transactions. This is extremely important as technological breaches are rising, and financial fraud is becoming more complex and expensive for businesses and customers (Adewole et al., 2020).

Smart contracts offer a security measure for blockchain, automating transactions with preset conditions and decreasing the vulnerabilities to human errors and fraudulent activities (Cardoz et al., 2023; Su et al., 2020). The immutability of such ledgers prevents retroactive changes, creating an important layer of trust and transparency between the parties concerned (Adewole et al., 2020). It would be even more important in cross-border transactions, where one cannot physically meet to trust the other party in another country (Li & Qiao, 2023).

Alternatively, a service-oriented infrastructure the business is creating alongside the production and utilization of new products can become enhanced and made safer and pace regulatory requirements, flipping traditional methods (Gupta & Singh, 2011; Nallan et al., 2020).

Threats can arise as individuals continue to explore new methodologies and strategies. The frequent threat stems from issues like vulnerabilities in smart contracts, which also include a 51% attack risk. Hence, it is crucial to ensure continuous enhancements and robust security audits within blockchain ecosystems (Himeur et al., 2023a; Luque et al., 2023).

E-commerce provides several advantages, such as lower trading costs, faster order processing, targeted promotions, and improved monitoring capabilities. With an updated and improved security protocol, online companies can realize the benefits of adopting stronger security measures (Nagarajan et al., 2022; Treiblmaier & Sillaber, 2021).

5.2. Challenges in Scalability and Solving for it

Scalability remains a vital issue when using blockchain infrastructure for the payment gateway. Traditional blockchains have clear solutions for scaling Bitcoin and Ethereum, which serve the purpose of increasing throughput. These solutions can handle only a few transactions per second (TPS), particularly when comparing the throughput of thousands of TPS systems to that of Bitcoin and Ethereum. Scalability should not be ignored in technology design and evaluation, especially given the more extensive and complex operations required by e-commerce companies (Taherdoost & Mananchian, 2023).

Recent solutions to improve blockchain efficiency involve adopting Layer-2 technologies, such as the Lightning Network (LN) and sidechains. These approaches allow for the processing of microtransactions off the main blockchain, which helps reduce congestion and increase transaction speed (Zhou et al., 2021; Liu & Li, 2020). These solutions also effectively lower transaction fees, which is essential for maintaining cost efficiency in online retail.

Also, the proposal for improving scalability includes sharding, which divides the blockchain network into manageable segments rather than a monolith (Nagarajan et al., 2022). This method dramatically increases transactional output and computes it with multiple transactions proceeding simultaneously. Also, sharding boosts transaction throughputs against security (Zhao & O'Mahony, 2020; Pal et al., 2023). Proof-of-stake(PoS) can save energy consumption while advancing the processing capacity as compared to traditional proof-of-work (PoW) systems (Luque et al., 2023; Himeur et al., 2022).

Nevertheless, with widely improved scalability will come new challenges that can hurt the simple network as much as possible regarding decentralization and security complexities (Reddy, 2021; Xiao et al., 2022). The "blockchain

trilemma," which includes problems related to scalability, decentralization, and security, is the cornerstone of continuous development among all blockchain developers (Taherdoost & Madanchian, 2023; Zhou et al., 2021).

5.3. User Experience and Adoption Barriers

Though blockchain improves trust and transparency, improvements to the user experience are needed to ensure seamless adoption (Lim et al., 2019; Sikder, 2023). Many blockchain-based payments are still seen as too complex because of technological complexities, multi-factor authentication processes, and mandatory digital wallets (Aydoğan & Aydemir, 2022; Xiao et al., 2022).

E-commerce platforms must work on designing streamlined user interfaces and developing seamless workflows to facilitate future blockchain payments for non-tech-savvy users (Pal et al., 2023; Sikder, 2023). From the case studies of leading companies like Shopify and Overstock, it is clear that firms must provide an assortment of payment alternatives, including but not only blockchain-based solutions, to address and accommodate the preferences of different segments of customers (Alqaryouti & Shaalan 2,022; Pal et al., 2023). This would make it easier for mobile and software applications to canonize blockchain payment gateways (Xiao et al., 2022; Zhou et al., 2021).

Additionally, regulatory uncertainty complicates the user adoption rate. Ambiguities associated with tax regulations, compliance requirements, and legal accountability in blockchain transactions discourage consumers and businesses from fully embracing the technology (Taherdoost & Madanchian, 2023; Liu & Li, 2020). Clear legislative frameworks and standard universal protocols would establish greater trust in adopting blockchain across the e-commerce domain (Treiblmaier & Sillaber, 2021; Sikder, 2023).

5.4. Strategic Implications for E-Commerce Platforms

The research implications suggest strategic actions for e-commerce platforms regarding blockchain integration.

- **Invest in Security:** The research implications suggest strategic actions for e-commerce platforms regarding blockchain integration.
- **Adaptation to Scalability:** Scalable solutions incorporating Layer-2 solutions and sharding reduce transaction processing costs (Zhou et al., 2021; Luque et al., 2023).
- **User-Centered Design:** Blockchain payments are reported to enhance user experience and adoption by simplifying the interface and integrating it with existing systems (Pal et al., 2023; Sikder, 2023).
- **Compliance with Regulations:** Adopting regulatory frameworks mitigates legal risks and fosters public trust in blockchains (Taherdoost & Madanchian, 2023; Liu & Li, 2020).

5.4.1. Takeaways

As security, scalability, and user experience advancements continue, we can look forward to blockchain payment gateways becoming mainstream. Current advancements indicate significant improvements to security and the overall user experience, and solutions are also being developed to address scalability. Additionally, tracing goods is a remarkable benefit of using blockchain technology.

A concerted effort to educate users is essential for first-time adoption. Implementing a blockchain payment protocol on a smaller scale is a reliable way to gauge its success. Beyond exploring potential scalability and improving user interactions, it is crucial to establish a proper regulatory framework. This would increase the rate at which blockchain payment systems are seamlessly integrated into the e-commerce landscape.

6. Conclusion

The inclusion of blockchain technology in e-commerce payment gateways opens up promising transformational chances about overcoming the persisting challenges, including security, scalability, and user experience. The study underpins the significant contribution that blockchain-based payment can have solving these most important issues on the improvement over traditional payment gateways.

6.1. Key Findings

6.1.1. Security

Blockchain's decentralized architecture and cryptographic mechanisms significantly enhances security. Features like immutable ledgers and smart contracts minimize risks of fraud, data breaches, and unauthorized access, fostering trust between customers and e-commerce providers. The immutability of blockchain ensures transparency and reliability, making it a robust solution for modern payment challenges.

6.1.2. Scalability

Recent innovations such as Layer-2 solutions, sharding, and proof-of-stake (PoS) mechanisms have addressed blockchain's scalability concerns. These technologies enable high transaction throughput at reduced costs, making blockchain viable for high-volume e-commerce environments. Despite these advances, balancing scalability with security and decentralization remains a critical challenge.

6.1.3. User Experience

While blockchain offers superior security and transparency, its complexity hinders user adoption. Simplifying interfaces and workflows is essential for mainstream acceptance and seamless user onboarding. Additionally, providing user-friendly features and integrating blockchain payment options with traditional systems leads to better accessibility and trust.

6.2. Strategic Planning

Establishing an e-commerce business for a blockchain ledger payment gateway requires strategic planning in several key areas.

6.2.1. Strengthening Security

Conducting frequent checks of smart contract codes and employing strong cryptographic techniques are essential to prevent system vulnerabilities.

6.2.2. Scalable Solutions

Utilizing Layer-2 scaling solutions, sharding, and Proof-of-Stake ensures that processes maintain reliable quality even during high speeds and transaction volumes.

6.2.3. User-Centric Design

The design features smooth, user-friendly interfaces that are highly attractive to any individual.

6.2.4. Regulatory Compliance

Collaboration with statutory directives that evolve in real-time will help reduce the risk of regulatory breaches and build consumer trust.

6.3. Constraints and Future Research

The research provides valuable insights, but it does have certain limitations. The rapid development of blockchain infrastructure has caused a noticeable shift from the initial key points discussed. The authors recognize that the study emphasized issues related to weight more than the expected areas of security, scalability, and user experience, which has left concerns about environmental impact and regulatory issues largely unaddressed.

It is essential to investigate the environmental impact of blockchain-based payment systems, especially regarding the energy consumption associated with different consensus mechanisms. Also, examining how regulations in various regions affect the adoption of blockchain technology for e-commerce would yield valuable insights.

Ultimately, blockchain infrastructure is set to transform e-commerce payment processing by enhancing security, improving transaction processing times, and increasing transparency. However, significant steps must be taken to address scalability, ensure seamless integration within user interfaces, and establish appropriate regulatory frameworks.

Blockchain has the potential to revolutionize e-commerce payment systems, delivering unparalleled security, scalability, and user satisfaction. However, continued innovation and strategic adoption are crucial to realizing its full potential

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The present research work does not contain any studies performed on animals/ human subjects by any of the authors.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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