International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 13 Issue 8 ǁ August 2025 ǁ PP.49-53

Research on Technological Innovation, Regulatory Challenges and Social Inclusivity in the Field of Electronic Payments

Siying Zhang
Department of E-commerce, Shenzhen Campus of Jinan University, Shenzhen, China

Abstract
This study systematically analyzes the technological evolution, security challenges, and cross-regional application trends of electronic payments in the global digitalization process, based on the Technology Acceptance Model (TAM) and the application of blockchain technology. Through a systematic literature review and case analysis method, integrating core literature, it is found that the application of blockchain technology in electronic payments faces challenges of insufficient scalability and regulatory fragmentation, while multi-factor authentication and encryption technologies can effectively enhance security protection. The research proposes a three-dimensional solution of "technology-regulatory-society", emphasizing that the integration of blockchain with 5G and quantum encryption will promote the expansion of electronic payments in scenarios such as the metaverse and green finance. However, its sustainable development requires balancing technological innovation and privacy protection.

Keywords: *electronic payments, blockchain technology, technology acceptance model, regulatory fragmentation.*

Date of Submission: 27-07-2025 Date of acceptance: 05-08-2025

I. INTRODUCTION

1.1 Research Background

In the context of global digitalization, the electronic payment market is experiencing explosive growth[1]. As a key market, China has seen a significant increase in electronic payment transaction volume, a huge mobile payment user base, and third-party payment platforms covering a wide range of retail scenarios. In the field of cross-border payments, the Cross-border Interbank Payment System (CIPS) has connected with financial institutions in multiple countries, but the standard differences with the Society for Worldwide Interbank Financial Telecommunication (SWIFT) system still affect the efficiency of cross-border settlements. Meanwhile, the application of technologies such as blockchain and artificial intelligence in electronic payments brings innovation, but also faces challenges such as technical bottlenecks, regulatory lag, and insufficient social inclusivity[2]. Balancing technological innovation, regulatory optimization, and social inclusivity has become a key issue for the sustainable development of electronic payments.

1.2 Theoretical Framework

Taking the Technology Acceptance Model as the theoretical cornerstone of this study, the model explicitly states that users' "perceived usefulness" and "ease of use" of technology largely influence their payment behavior[3]. Perceived usefulness refers to the degree to which users subjectively believe that using a technology can enhance work performance or achieve specific goals, while perceived ease of use reflects users' subjective judgment on the difficulty of using a technology.

In the context of mobile payments, the acceptance rate among elderly users is relatively low, primarily because they find mobile payment tools and mobile banking apps complex to operate−such as forgetting passwords, dealing with small app fonts, or being unfamiliar with smartphone operations−fully demonstrating the elderly group's deficiency in perceived ease of use[2]. In contrast, corporate users exhibit higher acceptance of blockchain payments due to the distributed ledger and encryption technology of blockchain, which ensure high payment security and immutability, effectively reducing transaction risks. This aligns with enterprises' strict requirements for fund security and enhances their perceived usefulness. Numerous studies have shown that the TAM model has been widely applied in e-commerce, mobile applications, and other fields, demonstrating strong scientific validity and effectiveness in explaining users' acceptance behavior toward new technologies[4].

1.3 Research Gap

Existing studies on electronic payments exhibit a notable limitation of single-dimensional focus, particularly in the research on the interaction mechanism of "technical defects-regulatory lag-social exclusion". Taking blockchain technology as an example, its "impossible trinity" problem means that the pursuit of decentralization and security inevitably sacrifices scalability , while cross-border regulatory fragmentation further intensifies technological application barriers. The superposition of these two factors has sharply increased payment costs for small and medium-sized enterprises with limited resources, creating higher entry barriers to electronic payments and leading to their marginalization in the digital economy, thus forming social exclusion. However, current research has not systematically integrated these three dimensions, lacking in-depth analysis of their complex interrelationships and overall impacts on the electronic payment ecosystem.

1.4 Research Significance

Theoretically, this study innovatively integrates technical, regulatory, and social dimensions, breaking through the limitations of traditional single perspectives and enriching the interdisciplinary research framework of electronic payments. This integration not only helps to comprehensively reveal the interaction mechanisms of various elements in the electronic payment ecosystem but also provides a new theoretical entry point for follow-up academic research.

In practical applications, the research findings are of significant utility. Enterprises can optimize product design based on the conclusions: carrying out aging-friendly transformations for elderly users to effectively enhance their acceptance and user experience of electronic payment products. Government departments can rely on the data support provided by this study to promote the unification of cross-border settlement standards under the Regional Comprehensive Economic Partnership (RCEP) framework, reduce regional payment compliance costs, facilitate the efficient circulation and collaborative development of electronic payments, and contribute to the healthy evolution of the global digital economy.

II. Concepts and Technologies

2.1 Concepts

Electronic payment refers to the act of consumers, merchants, and financial institutions using secure electronic means to transmit payment information through information networks to banks or corresponding processing institutions, in order to achieve monetary payment or fund transfer. Compared with traditional payment methods such as cash and bills, it has significant advantages. In terms of payment forms, electronic payments are mainly divided into three categories. Online payment is operated on a computer connected to the Internet, requiring buyers and sellers to negotiate and choose a third-party payment platform. For example, when shopping on Taobao or Amazon, users place orders and pay to the third-party platform. After merchants confirm the orders and deliver goods via express or logistics, they can only receive payment from the third-party platform after users confirm receipt of the goods. Telephone payment refers to the payment method of completing payment from a personal account by connecting a telephone device to the banking system, commonly used for recharging games in daily life. Mobile payment, the main development trend in electronic payments, refers to the act of directly or indirectly sending payment instructions through mobile terminal devices such as smartphones and tablets to effect monetary payment or fund transfer. Its technical means include NFC payment, QR code payment, ultrasonic payment, etc.

2.2 Technical Applications and Limitations

In electronic payments, blockchain technology plays a significant role. The distributed ledger stores transaction records across multiple nodes, enhancing security and transparency while making transactions tamper-proof and traceable. Smart contracts automate payment execution based on preset conditions, eliminating fraud and errors to improve efficiency. In cross-border payments, they bypass intermediaries, simplify currency conversion processes, and reduce costs to accelerate settlement. Additionally, the decentralized nature of blockchain supports peer-to-peer transactions, reducing reliance on intermediaries and empowering users with more control.

However, its applications have limitations. Performance and scalability are insufficient: transaction queuing and network-wide node synchronization are time-consuming, failing to meet the demands of large-scale high-frequency transactions. In security, internationally adopted core components are not fully independently controllable, posing risks of attacks and unknown vulnerabilities. The lack of a comprehensive protection system means security issues cannot be canceled or reversed as in traditional payments. Technical and standard disparities across different blockchain systems hinder interoperability, fragmenting business processes. Full-data backup imposes heavy storage burdens on nodes, especially in high-frequency scenarios like retail payments.

Artificial intelligence (AI) has been applied in the risk control domain of electronic payments. Numerous financial institutions and payment platforms leverage machine learning algorithms to analyze massive transaction data and user behavior patterns, thereby constructing precise risk prediction models. Nevertheless, AI technology is not infallible in addressing electronic payment security issues. Although some advanced AI systems possess dynamic learning and adaptive adjustment capabilities, their response speed and processing effectiveness still require further improvement when facing complex and ever-evolving new-type attacks.

III. Challenges

3.1 Systemic Risks

The issue of technical compatibility is prominent, as the lack of unified standards for payment interfaces among different banks severely affects the stability of cross-platform payments. In practical operations, due to interface discrepancies, financial institutions need to invest additional resources in adaptation and maintenance, which not only increases operational costs but also reduces payment efficiency and hinders the smooth experience of electronic payments.

Although blockchain payment technology is innovative, it faces significant energy consumption issues, which deviate from the globally advocated concept of green finance. As a typical application of blockchain technology, the Bitcoin network consumes enormous energy, imposing a heavy burden on the environment and resources. This high-energy consumption characteristic restricts the widespread adoption and sustainable development of blockchain payment technology, urging the industry to accelerate the research and application of low-energy consensus algorithms to alleviate resource pressure and promote the alignment of blockchain payments with green development goals.

3.2 User Risks

Cybersecurity threats continue to rise, posing serious challenges to the financial security and personal information of electronic payment users[5]. Numerous users have suffered sensitive information breaches and subsequent financial losses due to phishing attacks[6]. Some third-party payment platforms, plagued by vulnerabilities in data security protection, failed to effectively encrypt user data, exposing massive user information to theft risks−highlighting critical weaknesses in the current data security safeguards of the electronic payment sector.

The digital divide is acutely evident among elderly populations, severely restricting the popularization and adoption of electronic payments in this demographic. Compared to younger groups, elderly users generally lack knowledge and operational skills in electronic payments, demonstrating lower acceptance and proficiency in emerging payment tools. In scenarios where public transportation only supports electronic payments, elderly passengers often face mobility obstacles due to unfamiliarity with payment operations, reflecting both insufficient technology popularization and a lack of attention to the special needs of elderly users and age-friendly design in product development and service delivery.

3.3 Institutional Risks

The fragmentation of cross-border regulation imposes exorbitant compliance costs on multinational enterprises, emerging as a significant obstacle to the development of cross-border electronic payment businesses. Notable disparities exist in cross-border data transmission regulations among major economies such as China, the U.S., and the EU. Inconsistencies in data protection standards and regulatory requirements across regions compel multinational enterprises to simultaneously comply with multiple differing regulatory demands when conducting cross-border payment operations, significantly increasing operational burdens and compliance complexities. Such regulatory divergences not only force enterprises to allocate substantial resources to regulatory compliance but also expose them to compliance risks arising from interpretative deviations.

Long-standing gaps in the regulation of third-party payment platforms' fund pools pose risks to user capital security. Historically, some third-party payment platforms misappropriated users' reserve funds for high-risk investments, severely undermining user interests and causing issues such as withdrawal delays, which triggered trust crises in fund security. This phenomenon profoundly reflects the lagging nature of current regulatory mechanisms in the face of the rapid innovative development of the third-party payment industry, failing to promptly and effectively implement comprehensive and rigorous supervision over platform fund operations. Urgent improvement of relevant regulatory systems and measures is required to safeguard user capital security and promote the healthy development of the industry.

IV. Solutions

4.1 Technical Solutions

Multi-factor authentication technologies significantly enhance payment security. The adoption of multi-layer verification mechanisms such as "password + fingerprint + face" has been proven to effectively enhance users' payment security. Blockchain sharding technology provides a path to optimize performance bottlenecks. Ethereum 2.0 uses this technology to improve throughput while reducing energy consumption, providing a reference for solving the blockchain "impossible trinity" problem. In addition, the pilot application of quantum encryption technology has shown significant advantages, and the quantum key distribution system of a state-owned bank has provided security guarantees against future quantum computing attacks.

4.2 Regulatory Solutions

The regulatory sandbox mechanism for cross-border payments is being gradually implemented under the RCEP framework. This mechanism allows enterprises to test innovative payment models in a controlled environment, effectively simplifying regional settlement processes and reducing compliance costs. For risks in third-party payments, requiring platforms to deposit reserve funds into designated accounts can fundamentally eliminate the risk of fund misappropriation. Meanwhile, promoting the establishment of unified standards for cross-border data flows−such as the regulatory cooperation framework of the "Belt and Road" related digital currency system−can balance data security and cross-border payment efficiency[7].

4.3 Social Solutions

Digital literacy promotion programs have demonstrated remarkable effectiveness in alleviating the digital divide. China's "Blue Vest" initiative, through large-scale training, has effectively improved the adoption of mobile payments among elderly populations. User safety education delivered via new media formats−such as the "Anti-Phishing Classroom" launched by a leading platform−has been proven to significantly enhance users' ability to identify fraudulent activities. Additionally, incorporating aging-friendly modifications to payment products into industry standards represents a critical pathway to synergize technological innovation with social inclusivity.

V. Future Trends

Technological integration, new scenario expansion, and risk prevention will become the core directions for the development of electronic payments. The deep integration of 5G and the Internet of Things (IoT) is expected to reshape the payment experience, significantly reducing mobile payment latency and supporting seamless payment scenarios for smart devices. The breakthrough in quantum encryption technology provides core security for payment information.

In terms of application scenarios, the metaverse payment sector is developing rapidly, with platforms like Decentraland already enabling transactions where cryptocurrencies are used to purchase virtual assets. In the context of green finance, carbon credit payment systems promote the coordination between consumption behavior and environmental protection goals through pilot projects. The exploration of cross-border interoperability of central bank digital currencies (CBDCs) is accelerating, with the potential to form a blockchain-based super-sovereign payment system in the future.

Meanwhile, emerging risks require attention: The technological monopoly in the mobile payment market may lead to abuse of pricing power. Risks such as "digital identity theft" in metaverse payments urgently need to be regulated through ethical review frameworks and authentication mechanisms. The threat of quantum computing to traditional encryption algorithms necessitates the advance layout of "post-quantum cryptography" research to ensure secure continuity in technological evolution. The sustainable development of electronic payments requires achieving dynamic balance among technological innovation, scenario expansion, and risk control.

VI. Conclusion

This study systematically integrates technological, regulatory, and social dimensions to reveal the development paradox in the field of electronic payments: while technological innovations such as blockchain and artificial intelligence significantly enhance payment efficiency, the high energy consumption of blockchain technology sharply conflicts with cybersecurity threats. Globalization drives the growth of cross-border payment scales, but differences in cross-border regulations increase corporate compliance costs. Coupled with the low adoption rate of electronic payments among elderly populations, this highlights bottlenecks in inclusivity.

Based on these findings, the study proposes a three-dimensional advancement path: developing low-energy consensus algorithms and quantum encryption technologies at the technical level; establishing cross-

border regulatory sandboxes within the RCEP framework at the regulatory level; and promoting digital literacy training programs at the social level.

Future research can focus on two cutting-edge directions: the global interoperability of CBDCs, where although central banks have initiated R&D, fragmented technical standards cause cross-border settlement delays; and the impact of quantum computing on payment security, requiring proactive deployment of quantum key distribution systems. These directions will provide theoretical support for constructing a secure and inclusive next-generation electronic payment system.

REFERENCES

[1]. Hambali, M. A., Zahari, M. F. M., Ahmad, S. Y. A. R. B. A. I. N. I., & PISOL, M. I. M. (2021). A systematic literature review of the techniques and issues on cashless payment. In Proceeding of 8th International Research Management And Innovation Conference (8th Irmic 2021)(pp. 2710-6772).

[2]. Choudrie, J., Pheeraphuttranghkoon, S., & Davari, S. (2020). The digital divide and older adult population adoption, use and diffusion of mobile phones: A quantitative study.Information Systems Frontiers,22, 673-695.

[3]. Yingzhi, G., & Xiaomin, L. (2018). An Empirical Study on Consumers' Intention of Buying Tourism Products with Mobile Payments——An Integration Model of TAM and TPB [J].Journal of Sichuan University (Philosophy and Social Science Edition),6, 159-170.

[4]. Cahyani, A., Yeskainayah, A., Hamdah, L., & Suryaatmaja, K. (2023). The Use of Technology Acceptance Model to Evaluate MSME Perspectives on E-Payment System.Interdisciplinary Social Studies,2(8), 2194-2203.

[5]. Shapoval, R. V., Orlovskyi, R., Sykal, M., & Zlyvko, S. (2021). Counteraction to offenses committed with the use of electronic payment systems: new challenges and problems.Amazonia Investiga,10(44), 261-269.

[6]. Guan, Y., & Tick, A. (2024, May). Literature Review on Security of Personal Information in Electronic Payments. In 2024 IEEE 18th International Symposium on Applied Computational Intelligence and Informatics (SACI)(pp. 000533-000540). IEEE.

[7]. Tang, J. A., Liu, F., Lu, S., Qin, S., & Shao, S. (2020, April). Research on the New Generation Electronic Payment System Applied in'The Belt and Road'. In 2020 International Conference on E-Commerce and Internet Technology (ECIT)(pp. 5-9). IEEE.