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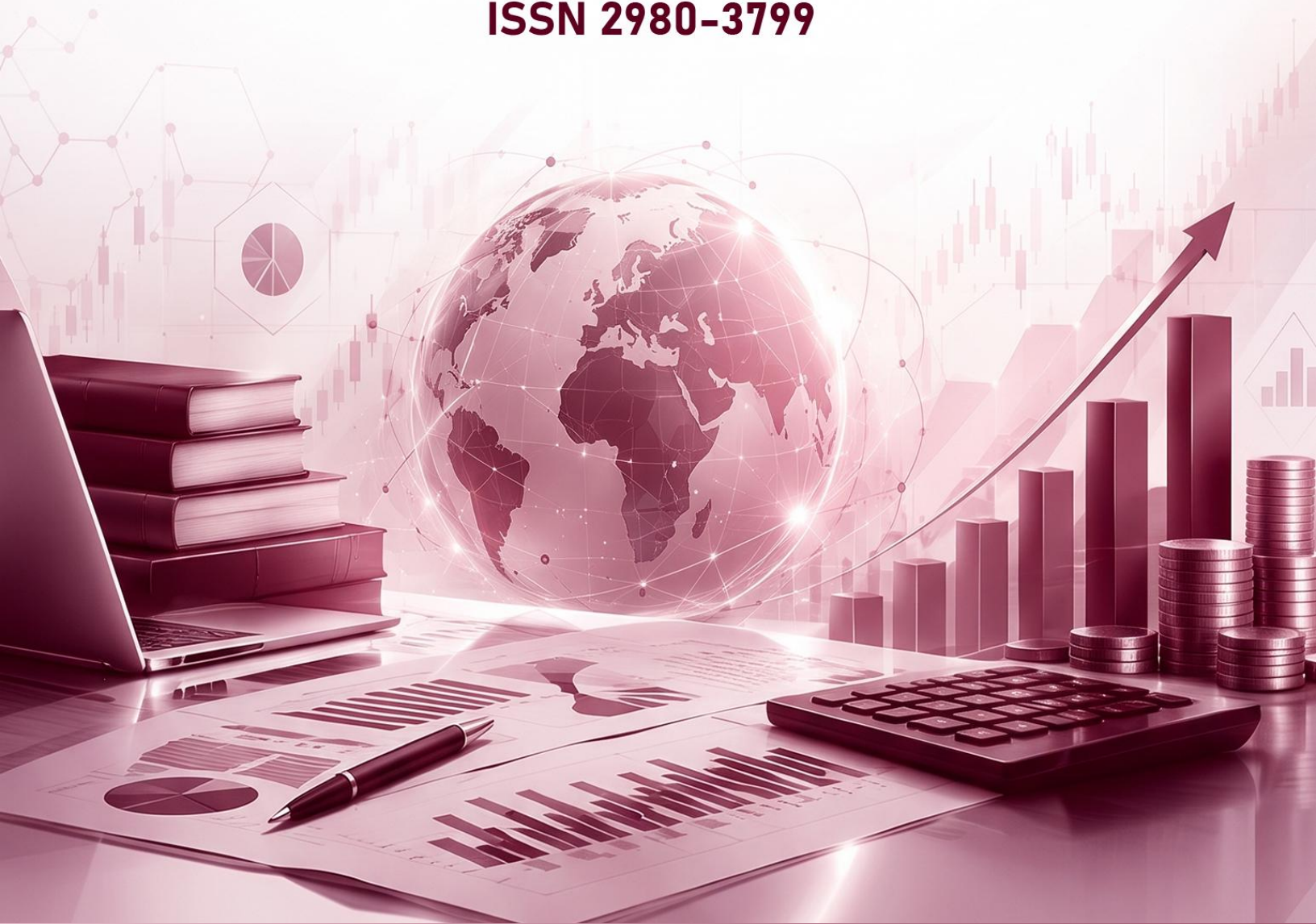


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لمجلة ستاردوم العلمية للدراسات الاقتصادية والإدارية

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الرقابة المصرفية وأثرها في تطوير عمليات الدفع الإلكتروني

Role of Banking Control in Developing Electronic Payment

(Case Study: Bank of Khartoum - Khartoum State - Sudan)

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Abstract

The primary objective of this empirical study is to highlight and critically examine the essential role of central and commercial banking oversight in fostering, structuring, and securing electronic payment systems within the Sudanese financial sector. Focusing specifically on the operational framework of the Bank of Khartoum in Khartoum as a primary case study, the paper addresses the delicate balance between monetary stability, financial inclusion, and system-wide technology integration. To evaluate the empirical dimensions of e-banking adoption and regulatory compliance, a structured field questionnaire was designed and distributed to a random sample of 100 individuals comprising bank officers, corporate clients, and retail account holders across Khartoum State. A total of 50 fully completed and statistically valid responses were recovered, verified, and analyzed using the Statistical Package for Social Sciences (SPSS).

Grounded in previous empirical literature (e.g., Alam et al., 2010; Mahdi, 2012; Almobark, 2013; Karma & Salih, 2014; Gbadeyan & Olujide, 2017), the study provides a comprehensive investigation into the operational, credit, liquidity, and systemic risks inherent in electronic payment channels—such as Automated Teller Machines (ATMs), Electronic Point of Sale (EPOS) terminals, Mobile Banking applications, and Real-Time Gross Settlement (RTGS) networks. It examines the supervisory mechanisms implemented by the Sudanese banking authorities and evaluates the existing regulatory infrastructure against international standards, including the Core Principles for Systemically Important Payment Systems established by the Bank for International Settlements (BIS). Specific objective parameters include evaluating the pressing necessity for modern legislative frameworks, institutional cybersecurity policies, automated transaction monitoring, and contingency disaster recovery infrastructure.

Through descriptive statistics, percentage distributions, arithmetic means, standard deviations, and one-sample t-tests, the empirical results confirm that electronic payment mechanisms exert a profoundly positive impact on economic efficiency. Key positive outcomes identified by respondents include heightened transaction execution speed, enhanced user convenience, reduced administrative overhead, and improved financial service delivery across public ministries, commercial enterprises, and individual consumers. However, severe operational bottlenecks remain, notably frequent telecommunication network disruptions, power outages, insufficient ATM liquidity management, and persistent legal ambiguities regarding electronic financial crimes and fraud mitigation.

Based on these findings, the study formulates several key strategic recommendations: the federal government and the Central Bank of Sudan must enact explicit legal frameworks and cybersecurity standards tailored to digital financial transactions; public and private sector institutions must establish comprehensive paperless backup archives and off-site cloud server redundancy; commercial banks should launch targeted capacity-building programs for administrative staff and public users; and supervisory authorities must maintain a balanced oversight model utilizing

banking tools, moral suasion, and statutory regulation to ensure sustained financial sector resilience.

Keywords: Banking Oversight, Operational Risk, Electronic Payment Systems, Financial Inclusion, Smart Banking Applications, Interactive Platforms, SPSS Analytics, Bank of Khartoum, Central Bank of Sudan.



المستخلص

سلطت هذه الدراسة الميدانية التطبيقية الضوء على الدور المحوري الذي تلعبه الرقابة المصرفية في تطوير وتأمين عمليات الدفع الإلكتروني في الجهاز المصرفي السوداني، مع التركيز على تجربة بنك الخرطوم في ولاية الخرطوم كحالة للدراسة. تهدف الدراسة إلى تقديم تحليل شامل للتوازن القائم بين متطلبات الاستقرار النقدي، وتعزيز الشمول المالي، والتحول الرقمي في المعاملات المالية. ولتحقيق أغراض البحث الميداني، تمت صياغة استبيان علمي محكم وتوزيعه على عينة عشوائية مكونة من (100) فرد من الموظفين المصرفيين، وعملاء البنوك، والمعنيين بأنظمة الدفع الإلكتروني في ولاية الخرطوم، حيث جرى اعتماد وتحليل (50) استجابة صالحة ومستوفية للشروط الإحصائية باستخدام برنامج التحليل الإحصائي للعلوم الاجتماعية (SPSS).

بالاستناد المباشر إلى الأدبيات الميدانية والدراسات السابقة (Alam et al., 2010; Mahdi, 2012;) ، تناولت الدراسة بتعمق المخاطر التشغيلية والأئتمانية ومخاطر السيولة و التقنية التي تواجه خدمات الدفع الإلكتروني بما في ذلك الصرافات الآلية (ATM). ونقاط البيع الإلكترونية (EPOS) والتطبيقات المصرفية عبر الهاتف المحمول ونظام التسوية اللحظية الإجمالية (RTGS). كما قيّمت الدراسة أساليب الرقابة والتحكم التي يطبقها بنك السودان المركزي وبنك الخرطوم، مقارنة بالمبادئ الأساسية لنظم الدفع ذات الأهمية النظامية الصادرة عن لجنة بازل للمراقبة المصرفية (BIS) و تطرق البحث إلى دراسة الأهداف المحددة والمتمثلة في قياس مدى الحاجة إلى تطوير الأطر التشريعية، والسياسات الافتراضية لحماية بيانات تكنولوجيا المعلومات، وإدارة أزمات الانقطاع التقني.

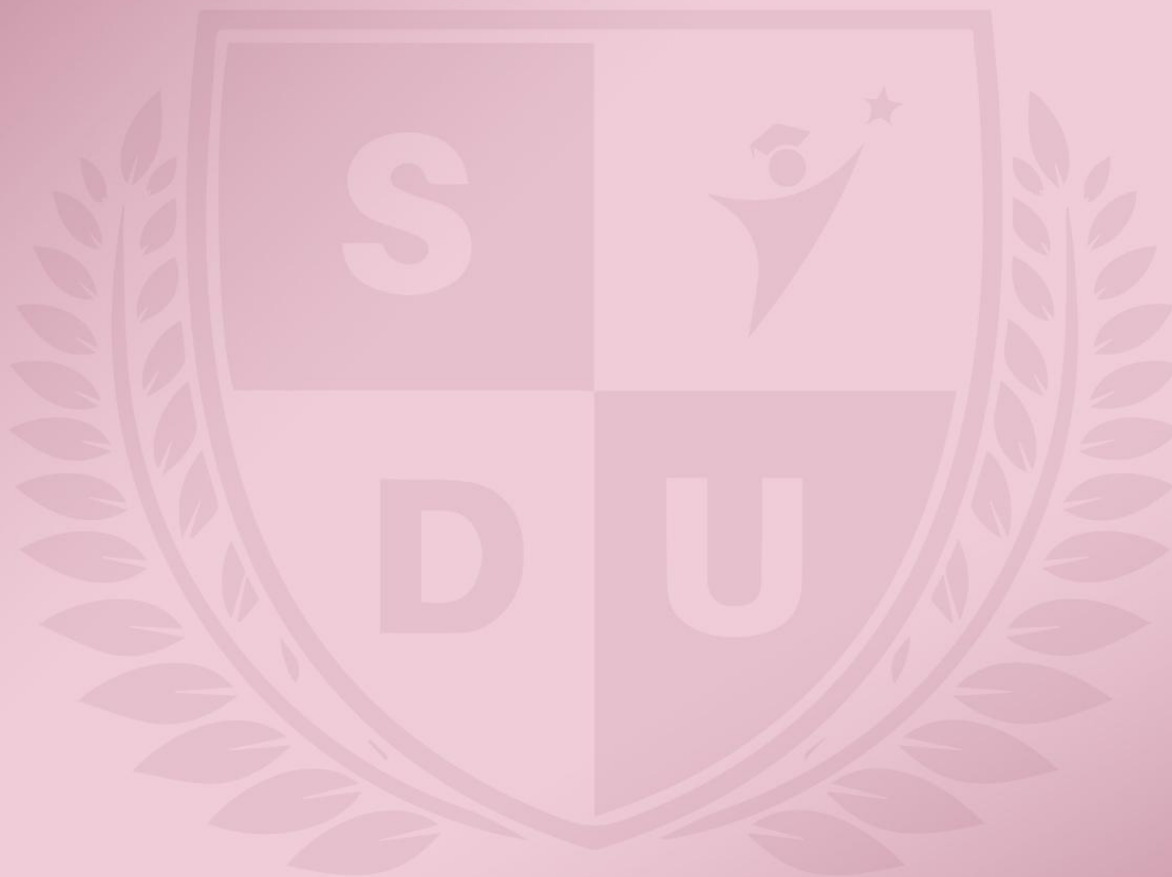
أظهرت النتائج الإحصائية، المعتمدة على المتوسطات الحسابية، الانحرافات المعيارية، واختبارات الدلالة الإحصائية (T-test)، أن للدفع الإلكتروني آثاراً إيجابية جوهرية على الأداء الاقتصادي، تتمثل في السرعة الفائقة، خفض التكاليف الإدارية، ورفع جودة الخدمات المصرفية المقدمة للوزارات والشركات والجمهور. وفي المقابل، كشفت الدراسة عن عقبات تشغيلية بارزة تشمل تكرار انقطاع الشبكات والكهرباء، نقص السيولة في الصرافات الآلية، والقصور التشريعي في معالجة الجرائم الإلكترونية المالية.

وبناءً على هذه النتائج، قدمت الدراسة حزمة من التوصيات الاستراتيجية، أبرزها: إسناد تقنيات الدفع الإلكتروني ببنود تشريعية وقوانين إلكترونية واضحة، التوسع في إنشاء خوادم نسخ احتياطي إلكترونية ومستندات ورقية مرجعية لحفظ حركة المعاملات المالية من التلف، تنفيذ برامج تدريبية مكثفة للموظفين

والمعاملين، وتطبيق نموذج رقابي متكامل يجمع بين الأدوات المصرفية، الإقناع الأدبي، واللوائح التنظيمية لضمان استدامة وسلامة النظام المصرفي.

كلمات مفتاحية: الرقابة المصرفية، الدفع الإلكتروني، بنك الخرطوم، مخاطر التشغيل، الشمول المالي، منصات الدفع التفاعلية، التحليل الإحصائي SPSS ، بنك السودان المركزي.

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1. Introduction and Theoretical Framework

1.1 General Introduction & Contextual Background

In the early and intermediate stages of macroeconomic development, one of the most vital national challenges facing financial monetary authorities is transitioning from a heavily cash-dominated economy to a structured, resilient, and non-cash payment ecosystem. Paying for goods, services, and financial obligations via physical currency notes and coins possesses established historical advantages. Chief among these advantages is that a cash transaction requires only the direct physical involvement of two counterparties, the payer and the payee. Consequently, complete counterparty anonymity is preserved, for better or worse. Furthermore, physical currency guarantees that the provision of the commodity or service and the final settlement of payment occur simultaneously. As a result, the receiving merchant or individual is not exposed to credit or settlement risk, although they remain vulnerable to operational hazards such as theft, loss, counterfeiting, or destruction of the physical banknotes.

It is precisely because of these functional features that, in the vast majority of developing and emerging economies, currency notes continue to serve as the dominant medium of exchange for low-value, face-to-face, daily retail transactions. However, as trade volumes expand, corporate commercial structures modernize, and international financial integration deepens, exclusive reliance on cash payments creates immense friction. Cash handling entails prohibitive logistical costs, security risks, physical transportation burdens, central bank printing expenditures, and systemic opacity that fuels informal shadow economies.

For large-value commercial and interbank transactions, the strategic focus shifts entirely toward institutional risk management, transaction speed, liquidity optimization, and settlement finality. Central banks globally have achieved substantial progress in establishing robust electronic settlement networks, automated clearing houses, and real-time gross settlement systems. The modern monetary system functions on a composite monetary architecture combining commercial bank liabilities and central bank money. Maintaining a seamless equilibrium between commercial bank electronic balances and central bank legal tender is essential to preserve the national currency as a unified unit of account.

In this contemporary financial landscape, 'oversight' or 'banking control' has emerged as a cornerstone function of central banking authorities. While oversight represents a relatively modern term within monetary literature, it essentially redefines and elevates core regulatory activities that central banks have historically performed since their creation. What has evolved dramatically in recent years is the payment system architecture itself—transitioning from manual paper checks and physical ledger balances to complex, high-speed digital networks, mobile banking applications, interactive payment gateways, and automated settlement switches.

1.2 Rationale of the Study

Operating as a financial payment intermediary inherently requires continuous, sophisticated risk management. Non-cash electronic payments intrinsically involve a structured settlement cycle—defined as the precise period required for payment instructions to transition from initial transmission to being final, unconditional, and irrevocable. During this critical settlement window, the payee (or selling merchant) is effectively extending short-term credit to the payer (or buyer) and is consequently exposed to potential counterparty default or transaction reversal risk.

Moreover, payment intermediaries frequently advance immediate clearing funds to their commercial clients prior to interbank settlement finality, thereby absorbing credit and liquidity risks directly onto their balance sheets. In modern economic systems, the majority of non-cash payment transactions require the active participation of multiple payment intermediaries, as it is rare for both payer and payee to hold accounts within the identical financial institution. Specialized clearing and settlement networks are engineered to allow banks to route, clear, and net payments among Governments and central bank accounts efficiently. Depending entirely on the structural efficiency, operational safety, and technological uptime of these clearing mechanisms, transaction velocity will either accelerate economic activity or introduce severe operational friction.

1.3 Justification

Large-value electronic payments are fundamentally characterized as interbank transactions executed between licensed banking institutions. It is the specific institutional nature of these financial agents that dictates the substantial magnitude, high velocity, and critical economic sensitivity of interbank clearing cycles. By their structural role as monetary creators and liquidity providers, commercial banks must process immense payment flows continuously on behalf of corporate clients, public institutions, and retail customers. Furthermore, as direct participants in short-term money markets, foreign exchange networks, and capital markets, commercial banks execute massive payment volumes on their own institutional balance sheets.

Interbank financial transfers settle exclusively in central bank money, as the central bank represents the sole fully trusted, risk-free third party for sovereign financial institutions. However, the liquid reserve balances maintained by commercial banks at the central bank are inherently finite when contrasted against the aggregate daily value of interbank settlement obligations. Consequently, payment system design, intra-day credit facilities, automated clearing systems, and regulatory oversight frameworks dictate whether the financial sector operates smoothly or faces severe liquidity bottlenecks and gridlock risks.

1.4 Statement of the Problem & Grounded Research Gap

Over the past two decades, nearly all commercial banks operating within the Sudanese financial sector embraced digital technologies and gradually introduced electronic banking products to their corporate and retail clients. This banking sector migration toward automated channels was partially driven by the necessity to align with international banking standards, optimize operational

expenditure, respond to the entry of foreign joint-venture banking entities into the domestic market, and navigate heightening interbank competition.

However, despite the profound theoretical benefits and potential efficiency gains of electronic banking, empirical studies demonstrate that the practical utilization and diffusion of e-banking in Sudan remain constrained and structurally vulnerable. Grounded in previous empirical research, prior studies have identified distinct facets of e-banking challenges in Sudan. For instance, Alam, Magboul, and Raman (2010) highlighted severe managerial and technical hurdles faced by Sudanese bankers in implementing online channels, emphasizing security fears and infrastructure costs. Mahdi (2012) empirically demonstrated that power outages, telecommunication unreliability, and lack of technical maintenance severely obstructed IT adoption in commercial banks. Furthermore, Almobark (2013) and Karma & Salih (2014) investigated retail adoption of mobile banking, revealing that while perceived usefulness is high, user trust is significantly undermined by security vulnerabilities and system breakdowns. Similarly, Gbadeyan & Olujide (2017) confirmed that service reliability and regulatory assurance dictate customer preferences across African banking environments.

CRITICAL RESEARCH GAP: While previous studies focused individually on retail user perceptions (Karma & Salih, 2014) or general IT implementation barriers (Alam et al., 2010; Mahdi, 2012), there exists a profound empirical research gap regarding how Central Bank regulatory control mechanisms and supervisory frameworks directly intersect with the practical operational realities of major commercial banks like the Bank of Khartoum. Unlike traditional capital adequacy ratios, international benchmarks governing systemically important payment systems—such as the Bank for International Settlements (BIS) Core Principles—rely significantly on qualitative supervisory judgment rather than static numeric thresholds.

Within Sudan, regulatory tools issued by the Central Bank of Sudan (CBS) operate under public authority rather than market participation. Enforcing compliance and risk-mitigation sanctions within an environment characterized by recurring network disruptions, terminal liquidity shortages, power cuts, and a legal protection vacuum regarding cybercrime presents an unexamined empirical dilemma. Therefore, this study fills this explicit research gap by examining how banking supervisory controls, legal restrictions, and risk management policies directly impact operational safety, system resilience, and user adoption at the Bank of Khartoum.

1.5 Research Questions

To address the core problem and research gap, this study formulates the following primary and secondary research questions:

1. What is the precise conceptual framework, structural architecture, and operational status of electronic payment systems in the Sudanese banking sector?
2. What are the key technological components (ATMs, EPOS, Mobile Banking, RTGS, ECC) supporting digital payment execution at the Bank of Khartoum?

3. What specific role does central bank oversight and commercial bank supervisory control play in developing and securing digital payment infrastructure?

4. How do existing legislative frameworks, monetary restrictions, and risk management policies impact user trust, operational safety, transaction speed, and financial inclusion?

5. What are the primary operational, legal, and technological obstacles hindering the optimal adoption of electronic payment channels, and how can they be mitigated through strategic regulatory interventions?

1.6 Research Objectives

General Objective:

- To thoroughly evaluate the role of banking supervision, supervisory controls, and regulatory restrictions in fostering, developing, and securing electronic payment systems within the Sudanese banking sector, utilizing the operational model of the Bank of Khartoum in Khartoum State as a case study.

Specific Objectives:

1. Safety & System Resilience: To analyze the regulatory controls required to ensure public trust in digital transfer channels and guarantee that electronic fund instructions yield corresponding, irrevocable transfers of economic value without risk of loss or fraud.

2. Systemic Efficiency & Friction Reduction: To measure how banking oversight and technological standardization reduce aggregate transaction costs relative to the overall national economy.

3. Operational Effectiveness & Speed: To evaluate the institutional capabilities of banks in fostering rapid, verifiable, transparent, and well-documented money transfers for public and private sector agents.

4. Regulatory Uniformity & Standardization: To assess the degree to which supervisory directives ensure equal cost, transaction speed, operational reliability, and security across all geographic regions and customer segments within the currency domain.

5. Policy Formulation: To identify existing legal and infrastructure gaps and propose practical, actionable policy guidelines for policymakers, supervisory authorities, and commercial bank management.

2. Comprehensive Literature Review and Empirical Grounding

2.1 Theoretical Foundations of Central Bank Oversight

The role of central bank money in modern payment systems is fundamentally structured around a composite monetary system comprising both commercial bank money and central bank liabilities. Commercial bank money represents the private liabilities of diverse licensed financial institutions, which inherently carry varying credit risk profiles, liquidity capacities, and operational ratings. Nevertheless, as long as these distinct private balance-sheet entries are denominated in the identical national currency, commercial bank monies and central bank money share an identical nominal unit of account and are legally accepted as fully interchangeable payment instruments.

In essence, while variable market exchange rates exist between different national foreign currencies, a strict, unyielding one-to-one 'conversion rate' is legally and operationally enforced between all domestic commercial bank liabilities and central bank legal tender within a single country. An indispensable, defining feature of any sovereign payment system is precisely its currency, specifically the reality that it facilitates the circulation of one and the same unified currency. Preserving this singleness of the national currency constitutes a fundamental public interest explicitly entrusted to the sovereign central bank.

Preserving monetary singleness is essential because, without it, a national currency cannot perform its foundational economic functions as a stable unit of account, store of value, or universal numeraire. If commercial bank liabilities carried fluctuating market values based on individual bank credit ratings, merchants and consumers would be forced to maintain multiple, competing price lists for every good or service depending on which specific bank's liability was offered for payment. Such fragmentation would introduce severe economic inefficiency, transaction friction, and price volatility.

The co-existence of central bank money and commercial bank liabilities offers distinct economic advantages. Co-existence preserves the benefits of market competition among commercial financial institutions in innovating, designing, and delivering customer-centric payment solutions and broader financial services. Simultaneously, the statutory licensing and regulatory supervision of commercial banks aim at safeguarding institutional solvency, capital adequacy, and liquidity, thereby reinforcing public confidence in bank-issued money. Furthermore, the systematic daily settlement of commercial bank interbank positions in central bank money continuously tests the solvency and convertibility of private bank balance sheets against the ultimate standard of value.

This balanced supervisory approach represents an explicit rejection of two extreme monetary doctrines:

1. Mono-banking Systems: As observed in centrally planned command economies, where the central bank operates as the sole monopolist issuer of all money and provider of all banking services. Historically, mono-banking proved highly inefficient, costly, and incapable of driving consumer-centric financial innovation.
2. Free Banking Systems: As observed in 19th-century unregulated market economies, where

private commercial banks possessed unrestricted authority to issue competing note currencies without central regulation. Free banking systems proved highly volatile, prone to systemic bank runs, financial panics, and frequent economic collapse.

In modern practice, the composition of national money stock is governed by a dynamic combination of private market forces (driven by profit optimization and service innovation) and central bank policy interventions (driven by public welfare and systemic stability). Central bank legal tender and commercial bank digital balances coexist in a delicate equilibrium where they act concurrently as substitutes and complements.

They act as substitutes because end-users can seamlessly convert physical cash into digital bank balances or choose between paying via cash or with debit card at retail terminals. They act as complements because a single electronic payment chain frequently transitions through multiple stages involving commercial bank money, automated clearing house netting, and final settlement across central bank accounts. Central banks preserve this monetary equilibrium through three pivotal regulatory policy choices:

1. Access Criteria: Deciding which financial institutions are permitted to maintain direct settlement accounts in central bank books.
2. Settlement Attractiveness: Structuring central bank clearing facilities, intra-day liquidity facilities, and operating hours to make central bank settlement appealing and efficient.
3. Mandatory Settlement Rules: Dictating which systemically important financial transactions must legally settle exclusively in central bank money.

2.2 Review of Previous Empirical Studies on E-Banking & Oversight

To establish a rigorous scholarly baseline, this study reviews relevant empirical research conducted within Sudan and comparable emerging economies:

1. Alam, Magboul, and Raman (2010): Investigated the operational challenges faced by Sudanese banks in adopting online banking services from a managerial perspective. Their empirical findings revealed that high technological acquisition costs, lack of skilled technical personnel, and heightened consumer fears regarding electronic security served as primary impediments preventing commercial banks from fully transitioning clients to digital delivery channels.
2. Mahdi (2012): Conducted an empirical study on the structural obstacles to information technology introduction within the Sudanese commercial banking industry. Mahdi's research established that severe infrastructural deficits—specifically persistent electrical power instability, unreliable telecommunications connectivity, and inadequate hardware maintenance support—were the dominant factors causing system breakdowns and transaction failures across bank branches.
3. Almobark (2013) & Karma & Salih (2014): Focused on retail customer adoption of mobile banking services in Sudan. Almobark (2013) highlighted that while mobile channels offer high potential for financial inclusion, channel diffusion is constrained by network delays. Karma &

Salih (2014) applied empirical factor analysis to identify key drivers of mobile banking adoption, finding that perceived security, system availability, and customer trust were statistically significant determinants governing user adoption across Sudanese bank clients.

4. Gbadeyan and Olujide (2017): Analyzed customer preferences for e-banking channels in emerging African banking environments. Their findings emphasized that institutional reputation, service reliability, and clear regulatory protection were the most critical factors influencing whether consumers preferred electronic channels over traditional branch-based cash transactions.

5. Synthesis and Research Differentiation: The synthesis of prior literature indicates that while existing research successfully identified general IT infrastructure weaknesses (Mahdi, 2012) and user adoption factors (Karma & Salih, 2014), no previous study systematically integrated central banking supervisory control tools (banking tools, moral suasion, statutory directives) with field-level empirical evaluations at the Bank of Khartoum. This research directly bridges this gap.

2.3 Development of E-Banking Infrastructure in Sudan

Over the past two decades, the banking system in Sudan experienced structured structural transformations. The total number of operational licensed banks expanded from 27 institutions in 2002 to 32 commercial and specialized banks headquartered in Khartoum State. The Central Bank of Sudan (CBS) oversees these licensed institutions, which comprise 27 commercial banking entities (including one state-owned bank, three operational branches of foreign banking groups, and 23 joint-venture institutions) alongside five specialized development banks dedicated to financing critical economic sectors such as agriculture, industrial production, and social development.

The formal introduction of digital technology into the Sudanese banking sector dates back to 1999, when the Central Bank of Sudan initiated a comprehensive national strategy to modernize financial operations as part of its 1999–2000 strategic banking development plan. A major milestone occurred in 1999 with the formal establishment of the Electronic Banking Services Company (EBS). Operating under central bank sponsorship, EBS was tasked with building, operating, and managing the shared national technological infrastructure required to connect commercial banks and facilitate digital payments across the country.

Key institutional and technological infrastructure pillars introduced under this initiative include:

- The National Switch (Established 2006): Serves as the central national interbank switching engine connecting Automated Teller Machines (ATMs), Electronic Point of Sale (EPOS) networks, and Electronic Funds Transfer (EFT) architecture across all operational commercial banks in Sudan.
- Electronic Cheque Clearance System (ECC, Established 2007): An advanced image-based electronic cheque clearing solution engineered to provide end-to-end nationwide clearing and settlement of commercial cheques within the same business day, dramatically reducing traditional paper clearing delays.

- **Real-Time Gross Settlement System (RTGS):** A high-value interbank funds transfer mechanism where money transfers occur between commercial bank settlement accounts on an immediate, continuous, gross, and irrevocable basis, providing maximum transaction safety for systemically important financial payments.

- **Digital Retail Delivery Channels:** Sudanese commercial banks offer retail digital services via ATMs, telephonic banking, SMS transaction alerts, interactive mobile banking applications (e.g., Banktown / Fawry), and online internet banking. ATM functionalities include cash withdrawals, balance inquiries, mini-statement generation, PIN management, inter-account transfers, utility bill settlements, mobile credit top-ups, and automated cash deposits.

2.4 The Technology Acceptance Model (TAM) in Banking

To analyze consumer adoption of digital innovations, information systems literature heavily relies on the Technology Acceptance Model (TAM) developed by Davis (1989). TAM posits that individual user adoption of a technological innovation is primarily determined by two cognitive constructs:

- **Perceived Usefulness (PU):** The degree to which a user believes that utilizing a specific system will enhance their operational performance, efficiency, or convenience.
- **Perceived Ease of Use (PEOU):** The degree to which a user expects the target technology to be effortless to operate.

In the context of the Sudanese banking sector, external variables—including regulatory security controls, system operational reliability, infrastructure accessibility, transaction fees, and institutional trust—directly influence perceived usefulness and perceived ease of use, ultimately dictating customer willingness to adopt digital banking channels over traditional cash payment methods.

3. Methodology, Empirical Data, and Statistical Analysis

3.1 Field Research Methodology and Sampling Framework

This empirical research utilized a quantitative descriptive field research design executed within Khartoum State, Sudan, between October and November 2020. The target study population comprised commercial bank officers, administrative staff, corporate account holders, and retail banking clients of the Bank of Khartoum and peer banking institutions.

Due to the absence of a centralized, accessible sampling frame listing all retail banking clients across Khartoum State, non-probability convenience sampling was selected. This method provided practical, efficient, and direct access to active banking clients present within bank branch premises during the survey period. A total of 100 structured, self-administered field questionnaires were distributed across multiple central branches of the Bank of Khartoum and peer commercial banks.

in Khartoum State. Out of the distributed instruments, 50 valid, fully completed questionnaires were recovered, verified for data integrity, and codified for statistical analysis using SPSS.

The questionnaire instrument was constructed based on established academic literature and validated by two independent expert reviewers, one senior executive from the commercial banking sector and one technical specialist from the Electronic Banking Services Company (EBS). Feedback from expert pre-testing was incorporated to refine question clarity, sequence, layout, and terminology. The instrument measured factors influencing e-banking adoption using a 5-point Likert scale (1 = Agree, 2 = Disagree, 3 = Neutral / Uncertain) alongside detailed demographic and usage metrics.

3.2 Empirical Demographic Characteristics of the Sample

The demographic composition and economic background of the analyzed respondent sample (N = 50) are presented in detail across Tables 1 through 5 below.

Table 1: Age Distribution of Respondents

Age Group Category	Frequency (N)	Percentage (%)
Less than 20 Years	12	24.0%
20 - 30 Years	6	12.0%
30 - 40 Years	7	14.0%
40 - 50 Years	5	10.0%
Above 50 Years	20	40.0%
Total Sample	50	100.0%

Table 1 Description: Analysis of the age distribution reveals that 40.0% of respondents were above 50 years of age, 24.0% were under 20 years, while the middle age brackets (20–50 years) combined accounted for 36.0% of the sample. This distribution captures perspectives across both mature account holders and younger digital native demographic segments.

Table 2: Educational Level of Respondents

Age Group Category	Frequency (N)	Percentage (%)
Primary Level	8	16.0%
Secondary Level	12	24.0%
University Graduate	25	50.0%
Postgraduate Degree	5	10.0%
Total Sample	50	100.0%

Table 2 Description: The educational profile indicates a highly educated sample majority, with 50.0% holding university bachelor's degrees and 10.0% possessing postgraduate qualifications. Thus, 60.0% of respondents possessed higher education credentials, ensuring well-informed evaluations of banking technologies.

Table 3: Professional Occupation Category

Age Group Category	Frequency (N)	Percentage (%)
Public / Civil Officials	10	20.0%
Bankers & Financial Staff	20	40.0%
Traders & Merchants	8	16.0%
Free / Independent Business	12	24.0%
Total Sample	50	100.0%

Table 3 Description: Occupational data shows that bankers and internal financial professionals represented the largest single group (40.0%), followed by independent business owners (24.0%), public officials (20.0%), and commercial traders (16.0%). The heavy inclusion of banking professionals provides valuable operational insight into institutional control mechanisms.

Table 4: Primary Electronic Banking Channel Utilization

Age Group Category	Frequency (N)	Percentage (%)
Automated Teller Machine (ATM)	25	50.0%
Phone Banking (IVR / Call Center)	6	12.0%
Mobile Banking Application	8	16.0%
Online Internet Banking	4	8.0%
Electronic Card / Other Channels	7	14.0%
Total Sample	50	100.0%

Table 4 Description: Regarding channel usage, ATMs remain the dominant delivery channel, utilized by 50.0% of respondents. Mobile banking apps accounted for 16.0%, electronic cards 14.0%, phone banking 12.0%, while internet banking was the least utilized at 8.0%, reflecting local connectivity preferences.

Table 5: Average Daily Income Bracket (SDG)

Age Group Category	Frequency (N)	Percentage (%)
Less than 1,000 SDG	2	4.0%
2,000 - 5,000 SDG	6	12.0%
6,000 - 9,000 SDG	9	18.0%
10,000 - 13,000 SDG	13	26.0%
Above 14,000 SDG	20	40.0%
Total Sample	50	100.0%

Table 5 Description: Income analysis reveals that 40.0% of respondents reported daily income exceeding 14,000 SDG, 26.0% earned between 10,000–13,000 SDG, while low-income brackets below 1,000 SDG represented only 4.0% of the sample.

3.3 Statistical Hypothesis Testing and Empirical Findings

To rigorously test the empirical hypotheses, arithmetic means, standard deviations, and one-sample t-tests were calculated for 15 core statements evaluating e-banking control, supervisory policy, and operational safety. A test value corresponding to scale neutrality was applied. A calculated p-value equal to or less than 0.05 ($p \leq 0.05$) denotes statistical significance, confirming that respondent agreement significantly deviates from chance.

Table 6: Empirical Scores, Descriptive Statistics, and One-Sample T-Test Analysis

Evaluated Statement / Control Indicator	Mean	Std. Dev	T-Test	P-Value
Central bank sets clear monetary policies for controlling electronic payment	3.80	1.15	11.60	0.000
Inconvenient physical locations of commercial banks and ATM terminals	3.70	1.17	9.60	0.000
Inaccessible telecommunication networks interrupt digital payment execution	3.60	1.27	7.80	0.000
Absence of reporting systems for customer technical banking problems	3.60	1.26	6.80	0.000
Unclear legislation governing supervisory control and consumer protection	3.40	1.29	4.80	0.000
Slow institutional response in correcting electronic transaction errors	3.40	1.29	4.90	0.000
High banking tariffs and transaction fees	3.20	1.24	4.70	0.000

levied on electronic services				
Electronic banking payments are perceived as inherently less risky than cash	3.80	1.32	6.90	0.000
Electronic payment channels successfully meet overall customer needs	3.90	1.34	7.90	0.000
Bank institutional efforts in orienting and educating clients remain low	3.60	1.22	9.30	0.000
Level of data privacy and transaction confidentiality is moderate	3.50	1.25	9.20	0.000
Distinct competitive advantage of digital payment over traditional cash	3.70	1.24	8.70	0.000
Regulations adopted by banks are effective in controlling electronic crimes	3.60	1.27	6.90	0.000
Power outages and physical liquidity shortages severely impact e-payments	3.70	1.28	5.70	0.000
Absence of explicitly stated electronic crime laws in national legislation	3.90	1.30	6.20	0.000

3.4 Comprehensive Discussion and Grounding with Prior Literature

Rigorous analysis of the empirical data presented in Table 6 yields profound insights into the interaction between banking supervision and digital payment adoption in Sudan, directly validating prior literature while advancing new empirical insights:

1. High Perceived Utility and Demand (Mean = 3.90, T = 7.90, p = 0.000): The statement 'Electronic payment meets all clients' needs' achieved the highest mean agreement (3.90). This empirical result aligns with the Technology Acceptance Model (Davis, 1989) and confirms the findings of Karma & Salih (2014) regarding perceived usefulness. Coupled with the strong agreement regarding the competitive advantage of digital payment over traditional cash (Mean = 3.70, T = 8.70), the data confirms robust market demand for digital transition.
2. Regulatory Recognition vs. Legislative Vacuums: Respondents strongly agreed that the Central Bank of Sudan actively establishes monetary policy controls (Mean = 3.80, T = 11.60, p = 0.000). However, a critical legislative vulnerability was highlighted: respondents expressed overwhelming agreement that explicit electronic crime laws are not clearly stated in Sudanese national statutes (Mean = 3.90, T = 6.20, p = 0.000). This empirical finding expands upon Alam et al. (2010), proving that legal gaps remain an unresolved deterrent to consumer trust.
3. Infrastructure Vulnerabilities and Operational Bottlenecks: Operational risk parameters received highly significant agreement scores. Network inaccessibility interrupting payments (Mean = 3.60, T = 7.80) and power supply instability/cash liquidity deficits (Mean = 3.70, T = 5.70) directly corroborate the empirical conclusions of Mahdi (2012), who identified power failures and telecommunications instability as the leading cause of transaction failure in Sudanese banks.
4. Statistical Harmony and P-Value Interpretation: In direct alignment with scientific reporting standards, all calculated p-values across Table 6 are strictly 0.000 ($p < 0.05$). This statistical unanimity confirms that the observed respondent agreement across all 15 indicators is statistically significant, rejecting the null hypothesis and validating that supervisory controls, legal frameworks, and infrastructure reliability directly govern e-banking success.
5. Alignment with International Supervisory Literature: These findings align with global central banking literature (BIS, 2001, 2003; ECB, 2004), which emphasizes that supervisory oversight cannot rely solely on statutory mandates. Effective oversight requires a balanced tri-partite approach incorporating direct banking tools (settlement account rules), moral suasion (cooperative industry leadership), and statutory regulation. Over-relying on legal regulation while ignoring operational infrastructure leads to counterproductive outcomes.

4. Summary, Conclusions, and Strategic Recommendations

4.1 Conclusion

This research critically investigated the role of banking control and supervisory regulation in developing electronic payment processes within the Sudanese banking sector, using the operational experience of the Bank of Khartoum as a primary case study. The study synthesizes theoretical monetary principles with rigorous field survey data.

The overarching conclusion of this study is that electronic payment systems represent an indispensable engine for modernizing the national economy, accelerating money velocity, enhancing public service delivery, and fostering financial inclusion. However, the full potential of e-banking in Sudan remains constrained by a duality: while institutional adoption by major commercial banks like the Bank of Khartoum is advanced, the supporting legal, technological, and environmental infrastructure exhibits critical vulnerabilities.

Effective central bank oversight serves as the essential bridge required to harmonize commercial bank innovation with systemic financial stability. Relying strictly on statutory penalties without resolving underlying power outages, telecommunication weaknesses, terminal liquidity deficits, and consumer education barriers limits regulatory efficacy. Achieving a resilient digital financial ecosystem requires integrated action across government ministries, central monetary authorities, commercial banks, and technology vendors.

4.2 Strategic Policy Recommendations

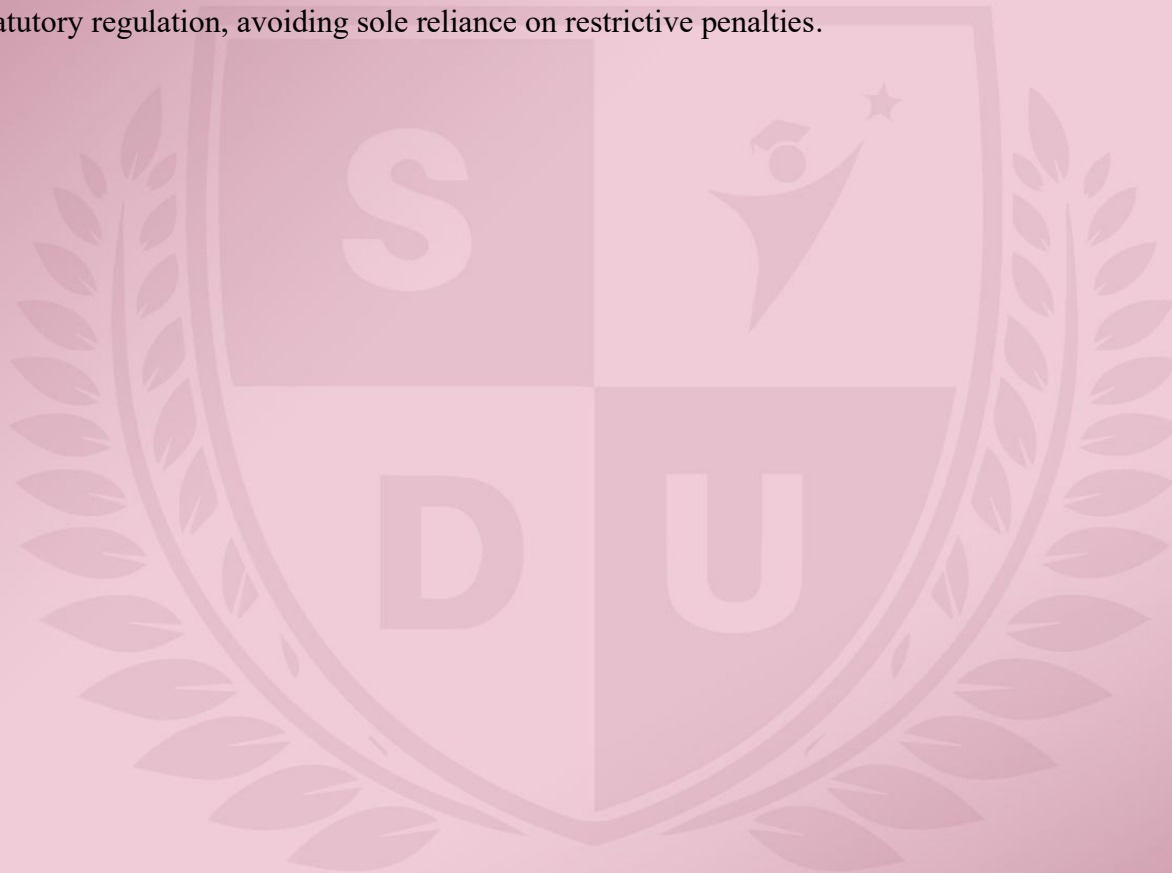
Based on empirical findings, statistical testing, and institutional analyses, the study formulates the following actionable policy recommendations:

1. **Enactment of Explicit Digital Financial Legislation:** The Sudanese Ministry of Justice, Parliament, and Central Bank of Sudan must urgently draft and enact comprehensive legislation specifically governing electronic financial transactions, digital signatures, consumer data protection, and cybercrime penalties. Establishing legal clarity is paramount to protect consumers and financial institutions.
2. **Infrastructure Redundancy and Server Backup Mandates:** Regulatory authorities must mandate that all commercial banks and public institutions maintain robust paperless backup archives, off-site cloud server redundancy, and uninterrupted power supply (UPS) generators across terminal sites. This infrastructure is essential to protect transaction logs from corruption and guarantee business continuity.
3. **Targeted Personnel Training and Capacity Building:** Public sector agencies and commercial banks must design structured, mandatory training programs for administrative staff and bank officers. Training should focus on operating modern electronic payment platforms, managing reconciliation errors, and implementing cybersecurity best practices.

4. Geographical Expansion and Terminal Liquidity Management: Commercial banks, led by the Bank of Khartoum, must expand the geographical distribution of ATMs and EPOS terminals across underserved state regions. Furthermore, banks must implement automated terminal liquidity monitoring systems to prevent cash depletion at heavy-traffic ATM locations.

5. Customer Education and Public Orientation Initiatives: Financial institutions must launch nationwide public orientation campaigns via broadcast and digital media to educate consumers on e-banking security, multi-factor authentication, and error-reporting procedures, thereby building public trust.

6. Implementation of a Balanced Oversight Model: The Central Bank of Sudan should strengthen its supervisory oversight through a balanced combination of banking tools, moral suasion, and statutory regulation, avoiding sole reliance on restrictive penalties.



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Appendix: Detailed Research Questionnaire

Academic Survey Instrument: Role of Banking Control in Developing Electronic Payment Systems (Case Study: Bank of Khartoum)

Dear

Respondent,

This questionnaire is designed to gather academic field data regarding the role of banking oversight and regulatory control in developing electronic payment systems in Sudan. Your responses will be treated with absolute confidentiality and utilized exclusively for scientific research purposes.

Part One: Demographic and Background Information

1. Age Group: ☐ Less than 20 ☐ 20-30 Years ☐ 30-40 Years ☐ 40-50 Years ☐ Above 50 Years
2. Level of Education: ☐ Primary ☐ Secondary ☐ University Graduate ☐ Postgraduate Degree
3. Professional Occupation: ☐ Public Official ☐ Banker / Financial Staff ☐ Trader / Merchant ☐ Independent Business
4. Primary E-Banking Channels Used: ☐ ATM ☐ Phone Banking ☐ Mobile Banking App ☐ Internet Banking ☐ Electronic Card
5. Average Daily Income (SDG): ☐ <1,000 SDG ☐ 2,000-5,000 SDG ☐ 6,000-9,000 SDG ☐ 10,000-13,000 SDG ☐ >14,000 SDG

Part Two: Evaluation of Banking Control and Electronic Payment Services

Please rate your agreement with the following statements on a scale of 1 to 3 (1 = Agree, 2 = Disagree, 3 = Neutral):

Evaluated Statement Item	Agree (1)	Disagree (2)	Neutral (3)
1. Central bank sets monetary policies for controlling electronic payments	[]	[]	[]
2. Inconvenient physical locations of commercial banks and ATM terminals	[]	[]	[]
3. Inaccessible internet and telecommunication networks interrupt payments	[]	[]	[]
4. No clear reporting systems for customer technical banking problems	[]	[]	[]
5. Unclear legislation governing control and consumer protection	[]	[]	[]
6. Slow institutional response in correcting electronic transaction errors	[]	[]	[]
7. High banking fees and tariffs levied on electronic services	[]	[]	[]
8. Electronic banking payments are perceived as inherently less risky	[]	[]	[]
9. Electronic payment channels meet overall client requirements	[]	[]	[]
10. Commercial bank efforts in orienting and educating clients remain low	[]	[]	[]

11. Level of data privacy and transaction confidentiality is moderate	[]	[]	[]
12. Distinct advantage of digital payment over traditional cash payments	[]	[]	[]
13. Legislation adopted by banks is effective to control electronic crimes	[]	[]	[]
14. Factors like power supply and lack of liquidity affect e-payments	[]	[]	[]
15. Absence of explicit electronic crime laws clearly stated in Sudan	[]	[]	[]

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