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Design and Evaluation of a Smart Contract-Based Value-Added Tax (VAT) Collection System on the Open Network (TON) Blockchain.

Aminu Saleh[1], G.M Wajiga[2], Daniel Godwin[3] and Mustapha Ibrahim[4]

[1, 2, 3] Department of Computer Science, Faculty of Computing, Modibbo Adama University, Yola. Nigeria

[1, 4] Department of Computer Science, Federal Polytechnic Damaturu, Yobe State

aminusaleh@fedpodam.edu.ng[1], aminusaleh0444@gmail.com[1], gwajiga@mau.edu.ng[2], danspeakfuture@gmail.com[3], mustee2004@yahoo.com[4]

Abstract

Value-Added Tax (VAT) administration remains vulnerable to underreporting, invoice fraud, and delayed remittance where collection depends on centralised records and periodic self-reporting. This study designed, implemented, and evaluated a smart contract-based VAT collection prototype on The Open Network (TON) blockchain. Design Science Research guided the development of a Tact smart contract, a TypeScript and Express application programming interface, a PostgreSQL database, and a Next.js interface. The compiled contract was deployed on TON testnet and evaluated empirically against explicit correctness, timing, fee, and evidence-integrity benchmarks through a controlled 30-case experiment (VAT-EXP-20260721) comprising 20 valid payments and 10 deliberate invalid cases. Functional tests, VAT accuracy, response time, confirmation time, transaction fees, output routing, and evidence integrity were assessed and independently verified against the finalised on-chain trace. All 20 valid payments succeeded, all 10 invalid cases were rejected, and the VAT calculation error was 0 kobo. Mean wallet signing and broadcast response time was 2.542 seconds, mean testnet confirmation time was 5.988 seconds, and the mean full-trace fee was 0.001728416 TON. All 21 automated backend and smart contract tests passed. The prototype demonstrates deterministic VAT arithmetic, automated split payment, replay protection, and verifiable testnet records for the evaluated cases. The experiment did not measure production throughput, mainnet behaviour, statutory validity, or privacy compliance.

Keywords: Value-Added Tax; Blockchain; Smart Contracts; TON Blockchain; Tax Administration; Prototype Evaluation.

1. Introduction

Value Added Tax (VAT) is one of the most widely adopted forms of indirect taxation and constitutes a major source of government revenue in both developed and developing economies (Mazur, 2022; Pellegrino et al., 2024). By taxing the value added to goods and services at successive stages of production and distribution, VAT provides governments with a broad and relatively stable revenue base for financing public services, infrastructure development, and economic growth. Despite its significance, VAT administration continues to face persistent challenges that reduce its effectiveness and revenue-generating potential. Tax authorities worldwide encounter tax evasion, underreporting of transactions, false invoicing, delayed remittance, and fraudulent refund claims, all of which contribute to the VAT gap, the difference between expected and actual VAT revenues (European Commission, 2022). These challenges are particularly pronounced in developing economies, where weak institutional frameworks,

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inadequate digital infrastructure, and limited monitoring capacity hinder effective tax administration (Setyowati et al., 2020; IMF, 2023). To improve VAT administration, governments have increasingly adopted digital technologies, including electronic invoicing, digital reporting platforms, and automated tax management systems (Bellon et al., 2022). While these initiatives have enhanced operational efficiency and transaction visibility, many existing solutions remain dependent on centralized databases and self-reporting taxpayer, leaving them vulnerable to fraud, data manipulation, corruption, cybersecurity threats, and operational inefficiencies (Mazur, 2022; Lage Rodriguez, 2023). Consequently, there is growing interest in emerging technologies capable of providing greater transparency, security, and automation in tax collection. Blockchain technology has emerged as a promising solution for improving financial and administrative processes through its decentralized, transparent, and immutable ledger architecture (Han et al., 2023). A key advantage of blockchain is its support for smart contracts, which enable the automatic execution of predefined contractual conditions without the need for intermediaries (Pellegrino et al., 2024). In the context of VAT administration, smart contracts can automate tax calculation and remittance at the point of transaction, thereby reducing opportunities for tax evasion, delayed remittance, and fraudulent reporting while enhancing auditability and trust among taxpayers, businesses, and tax authorities (Sogaard, 2021; Louvieris et al., 2024). Among emerging blockchain platforms, The Open Network (TON) has attracted attention due to its high scalability, low transaction costs, and efficient smart contract capabilities. Designed to support high-volume decentralized applications, TON offers the capacity to process large numbers of transactions securely and efficiently, making it a suitable platform for digital payment and taxation systems (TON Documentation, 2024). These characteristics suggest that TON could provide an effective infrastructure for blockchain-enabled VAT collection by facilitating transparent, scalable, and automated tax remittance. Although blockchain has been widely proposed as a tool for improving tax administration, existing studies have primarily focused on general blockchain frameworks or other blockchain platforms, with limited attention given to the application of The Open Network (TON) in VAT collection systems (Lage Rodriguez, 2023; Pellegrino et al., 2024). Furthermore, the potential use of TON tokens as a medium for automating VAT collection and improving compliance remains largely unexplored. This gap limits the understanding of whether TON's technical capabilities can address persistent challenges in VAT administration more effectively than existing digital tax systems. This study addresses the identified gap by designing, implementing, deploying, and experimentally evaluating a TON-based VAT collection prototype. The contribution is not limited to a conceptual framework. It includes an executable split-payment smart contract, a full-stack web application, a verifiable testnet deployment (contract 0QCgAj-HS0wQmEAylsEJE6R4JquQ-QjrNecT20izMe4Us0cU, publicly inspectable at testnet.tonviewer.com; see Sections 3.4 and 6), automated software tests, and a controlled 30-case experiment (VAT-EXP-20260721; see Section 3.5 and Tables 3-6) that measures functional accuracy, invalid-case rejection, transaction timing, and full-trace fees.

Despite the fiscal importance of VAT and the introduction of digital tax systems, VAT collection still depends substantially on centralised records, taxpayer self-reporting, periodic reconciliation, and remittance after a sale. This arrangement leaves a time and control gap between collecting VAT from a customer and transferring it to government. The gap creates opportunities for transaction underreporting, false invoicing, alteration of records, delayed remittance, and weak auditability, particularly where institutional and digital monitoring capacity is limited (Setyowati et al., 2020; European Commission, 2022; IMF, 2023). Existing centralised platforms improve reporting efficiency but do not, by themselves, guarantee an immutable record or automatic separation of the tax component at the point of payment. The problem addressed by this study is therefore administrative: the absence of a transparent, tamper-resistant mechanism that separates and remits VAT automatically at the point of transaction. Although blockchain and smart contracts have been proposed for tax administration, much of the existing literature remains conceptual or focuses on platforms other than TON (Lage Rodriguez, 2023; Pellegrino et al., 2024). There is limited implementation-based evidence showing whether a TON smart contract can calculate Nigeria's 7.5 percent VAT accurately, split a customer's payment between merchant and government wallets, prevent invoice replay, reject malformed or unauthorised transactions, and do so with measurable transaction time and cost. This is the empirical gap addressed by the present study: the lack of evaluated evidence about the functional suitability and limitations of TON specifically, rather than blockchain in general, for automated VAT collection.

2. Related Works

Value Added Tax (VAT) is a consumption-based tax imposed on the value added to goods and services at various stages of production and distribution. Unlike direct taxes, VAT is collected incrementally throughout the supply chain, with the final burden borne by the end consumer (Ebrill et al., 2020). Due to its broad revenue base and relative administrative efficiency, VAT has become one of the most successful forms of taxation globally and contributes significantly to government revenue generation (OECD, 2021). Despite its theoretical advantages, VAT administration remains vulnerable to fraud, tax evasion, false invoicing, and underreporting of transactions (Keen & Slemrod, 2021). In developing economies, these challenges are further compounded by weak institutional frameworks, limited technological infrastructure, and inadequate compliance monitoring mechanisms (IMF, 2021). According to the Federal Inland Revenue Service (FIRS, 2021), improvements in digital tax administration have increased VAT revenue collection in Nigeria; however, challenges relating to compliance enforcement and delayed remittance continue to affect collection efficiency. Furthermore, traditional VAT systems depend heavily on taxpayer self-reporting and periodic remittance by businesses. This dependency creates opportunities for underreporting, invoice manipulation, delayed remittance, and other forms of non-compliance, resulting in significant revenue losses (World Bank, 2022). Haruna et al. (2021) demonstrated that technology-driven approaches to tax administration can substantially improve transparency and compliance in public sector financial management, a finding that underpins the motivation for this study. Blockchain technology is a decentralised digital ledger system that enables transactions and records to be stored securely across a distributed network of computers. Unlike traditional databases controlled by a central authority, blockchain operates through a consensus mechanism that allows multiple participants to validate and maintain shared transaction records (Crosby et al., 2016). One of the most important characteristics of blockchain technology is immutability. Once a transaction has been validated and recorded on the blockchain, it becomes extremely difficult to alter or delete. This feature provides a reliable and tamper-resistant audit trail, making blockchain particularly attractive for applications requiring transparency and accountability (Hughes et al., 2019). Another important feature of blockchain is decentralisation. In conventional systems, a

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central authority maintains and controls records. Blockchain distributes this responsibility across multiple network participants, reducing the risk of a single point of failure and minimising opportunities for corruption or unauthorised modification of records (Risius & Spohrer, 2017). Because of these characteristics, blockchain technology has attracted increasing attention in public finance and taxation. Researchers have argued that blockchain can improve transparency, reduce fraud, enhance compliance monitoring, and automate tax administration processes (Deloitte, 2019; Gupta & Bose, 2022). Smart contracts are self-executing computer programs deployed on a blockchain network that automatically perform predefined actions when specified conditions are met. Unlike traditional agreements that require manual enforcement, smart contracts execute transactions automatically without human intervention (Cong & He, 2019). The primary objective of smart contracts is to automate processes that traditionally require verification, approval, or enforcement by third parties. Their execution improves operational efficiency, reduces administrative costs, and minimises opportunities for manipulation and disputes (Peters & Panayi, 2016). Within tax administration, smart contracts provide significant opportunities for improving compliance and reducing fraud. By embedding tax rules directly into smart contracts, tax obligations can be calculated, deducted, recorded, and remitted automatically at the point of transaction (Ainsworth & Alwohaibi, 2017). Such automation reduces dependence on taxpayer declarations and minimises opportunities for tax evasion and delayed remittance. Researchers have proposed smart contract-based split-payment mechanisms in which the VAT component of a transaction is automatically separated from the principal payment and transferred directly to the tax authority. Under this approach, businesses no longer hold collected VAT for extended periods before remittance, thereby improving government cash flow and reducing opportunities for misuse of tax proceeds (Deloitte, 2019). The Open Network (TON) is a decentralised blockchain platform designed to support fast, scalable, and secure digital transactions. TON was specifically developed to overcome limitations associated with earlier blockchain platforms, particularly those relating to scalability, transaction speed, and operational costs (TON Foundation, 2022). One of the distinguishing features of TON is its sharded architecture, which distributes transaction processing across multiple chains operating simultaneously. This mechanism significantly improves transaction throughput and enables the network to process large transaction volumes efficiently (TON Foundation, 2022). TON also provides relatively low transaction costs compared to many blockchain platforms. High transaction fees have been identified as a major barrier to blockchain adoption in financial and public-sector applications. By maintaining low operational costs, TON offers an environment that is more conducive to large-scale transaction systems such as VAT collection platforms (TON Foundation, 2022). The network's native cryptocurrency, Toncoin, facilitates transaction processing, network operations, decentralised application services, and smart contract execution. Its programmable nature enables developers to automate financial operations and create payment systems that can operate without direct human intervention, making TON particularly suitable for automated VAT administration systems.

3. Methodology

3.1 Research Design

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The study adopted Design Science Research because it required the construction and evaluation of an operational artefact rather than a conceptual proposal alone (Hevner et al., 2004; Peffers et al., 2007). The artefact comprised a VAT split-payment smart contract, a backend service, a relational database, and taxpayer and administrator web interfaces.The research activities were organised as follows: identification of VAT collection problems; definition of functional and security requirements; design and development of the artefact; local demonstration through automated tests; deployment to TON testnet; controlled experimental evaluation; and communication of results, limitations, and reproducibility evidence. The evaluation therefore combined software testing with direct measurement of finalised testnet transactions.

3.2 Prototype Implementation

The prototype was implemented as a full-stack TypeScript application. The frontend used Next.js and TON Connect to present taxpayer and administrator workflows and request wallet signatures. The backend used Node.js, Express, Prisma, and PostgreSQL for authentication, merchant records, invoices, idempotency, and payment status. The blockchain component was written in Tact and compiled for TON. Integer kobo and nanoton values were used throughout the payment path to avoid floating-point errors.

Table 1. Implemented prototype components (Source: Authors' design, 2026)

Layer	Technology	Implemented role
Frontend	Next.js, TypeScript, TON Connect	Taxpayer and administrator interfaces, wallet connection, and transaction initiation
Backend	Node.js and Express	Authentication, validation, invoice workflow, calculation, and receipt status
Database	PostgreSQL and Prisma	Users, merchants, invoices, idempotency records, and audit data
Smart contract	Tact on TON	VAT verification, replay prevention, atomic split payment, owner controls, and counters
Test environment	TON Sandbox and TON testnet	Deterministic contract tests and finalised public-network calls
Evidence	CSV, JSON, trace data, and SHA-256 manifest	Per-case results, aggregate metrics, deployment details, and integrity verification

3.3 System Architecture and Transaction Workflow

As shown in Figure 1, a customer initiates a merchant payment through the web interface. The backend calculates the net amount, VAT amount, and gross amount in integer units and returns an encoded contract payload. After the customer authorises the transaction in a TON wallet, the VATCollector contract validates the payload, records the invoice hash, sends the net share to the merchant wallet, and sends the VAT share to the designated government wallet. Finalised transactions remain inspectable on the TON ledger.

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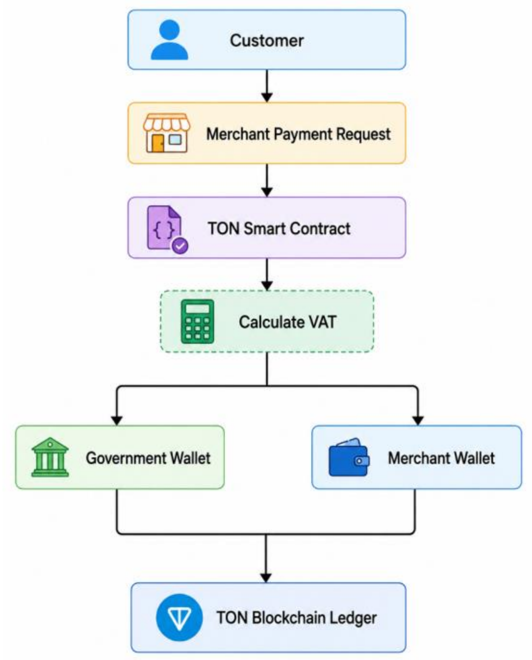

Figure 1. Implemented TON-based VAT collection workflow (Source: Authors' design, 2026)

The application workflow also performs off-chain checks for registered merchants, authenticated roles, unique invoice identifiers, and validated input. These application controls complement, but do not replace, the contract's on-chain validation.

3.4 Smart Contract Controls and Testnet Deployment

The VATCollector contract applies a fixed VAT rate of 750 basis points (7.5%). For each PayVAT message, it checks that the contract is not paused, the payload has not expired, the invoice hash has not been processed, the exchange rate matches the configured rate, the net amount meets the minimum, the submitted VAT equals the rounded expected VAT, the merchant is not the government wallet, and the attached value is sufficient. Only the owner may pause the contract or update the exchange rate, and a single rate update may not exceed 20 percent.

The compiled contract was deployed on TON testnet at 0QCgAj-HS0wQmEAylsEJE6R4JquQ-QjrNecT20izMe4Us0cU. The rebuilt source produced the same on-chain code hash as the deployed contract, 3668f2e3e86c062edcea31cf030e6a613710102f673897ed0a18b94522c2107d. The configured experimental exchange rate was 500,000 kobo per TON, equivalent to NGN 5,000 per TON. This fixed research rate was used to make the experiment reproducible and was not presented as a market exchange rate.

3.5 Experimental Design and Dataset

The controlled run, VAT-EXP-20260721, was executed on TON testnet between 23:16:46 and 23:30:51 UTC on 21 July 2026. A designated customer W5 testnet wallet signed 30 sequential calls. The fixed dataset contained 10 small, 10 medium, and 10 large cases; 15 VAT-exclusive and 15 VAT-inclusive inputs; 20 valid payments; and 10 deliberate invalid cases.

The invalid cases tested duplicate invoices, incorrect VAT, a below-minimum amount, an expired payload, an incorrect exchange rate, underfunding, use of the government wallet as merchant, and an unauthorised pause attempt. The runner submitted each message, waited for the contract transaction, classified the TVM result, and recomputed the fee from the complete finalised trace.

Table 2. Experimental metrics and decision rules (Source: Authors' design, 2026)

Metric	**Computation**	**Decision rule**
Valid-payment success	Confirmed valid payments / intended valid payments	Successful contract execution and expected merchant and government outputs
Invalid-case rejection	Correctly rejected cases / deliberate invalid cases	Failed contract execution with no merchant or government transfer
VAT error	Actual VAT kobo minus expected VAT kobo	Zero kobo for every successful case
Wallet response	Time from local submission to signing and broadcast response	Reported in seconds
Confirmation	Time from submission to observed testnet contract transaction	Reported in seconds
Full-trace fee	Transaction total fees plus forwarding fees in the finalised trace	Reported in TON
Evidence integrity	Unique hashes and logical times plus SHA-256 checksum verification	All identifiers unique and all evidence checksums matched

3.6 Software Testing and Reproducibility

The contract test suite evaluated deployment state, correct split routing, invoice replay, incorrect VAT, incorrect exchange rate, below-minimum values, expired payloads, an invalid merchant route, underfunding, pause controls, owner-only configuration, and fee exposure. Backend tests evaluated health, authentication, role separation, money arithmetic, and API behaviour. Production builds and TypeScript checks were executed. The evidence package retained the deployment record, environment metadata, 30-row CSV and JSON datasets, aggregate summary, and a SHA-

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256 checksum manifest. The 30-case experiment called the smart contract directly. It did not use the browser, backend, database, or TON Connect interface to sign those experimental calls; those components were assessed separately through automated builds, tests, and HTTP smoke checks.

3.7 Evaluation Scope

The experiment used test wallets and synthetic values and did not involve real taxpayers, statutory records, or production funds. The evaluation was limited to functional correctness, negative controls, timing, fees, output routing, and evidence integrity for the stated dataset. No concurrent load test was conducted; therefore, throughput and maximum network scalability were outside the measured scope.

4. Results and Discussion

4.1 Automated Test, Build, and Smoke-Test Results

Table 3. Independently reproduced software verification results (Source: Authors' experimental data, 2026)

Verification item	Observed result	Interpretation
Backend automated tests	9/9 passed	Authentication, role, API, and money checks behaved as specified
Smart contract sandbox tests	12/12 passed	Positive routing and negative controls behaved as specified
TypeScript checks	Backend and frontend passed	No type-checking error prevented build
Production builds	Backend and frontend passed	Frontend generated 24 routes
Tact compilation	Passed	Contract source compiled successfully
HTTP smoke checks	Frontend and health HTTP 200; unauthorised admin HTTP 401	Basic availability and access control were confirmed

All 21 automated tests passed. The results establish that the implemented modules compiled and that the tested functional and access-control paths behaved as specified. They do not establish the absence of every security defect or the performance of the complete system under concurrent users.

4.2 Testnet Functional Outcomes

Table 4. Controlled TON testnet experiment outcomes (Source: Authors' experimental data, 2026)

Measure	Result	Finding
Total signed calls	30	10 small, 10 medium, and 10 large cases
Valid payments	20/20 successful	100% intended-payment success

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Invalid cases	10/10 rejected	100% rejection accuracy
Input modes	15 exclusive; 15 inclusive	Balanced coverage of the two amount-entry modes
VAT calculation error	0 kobo	Minimum, median, mean, and maximum were all zero
Successful output routing	20/20 matched	Recorded merchant and government values matched expected values
Rejected-case outputs	No unexpected transfer	Merchant and government outputs remained zero
Transaction identifiers	All unique	All 30 hashes and logical times were unique

The results show deterministic VAT arithmetic and expected outcome classification for the fixed dataset. Every valid case reached exit code zero and produced the expected split values. Every deliberate invalid case was rejected, including replay, incorrect arithmetic, stale data, underfunding, invalid routing, and unauthorised administration. These findings provide direct implementation evidence that was absent from the earlier conceptual evaluation.

4.3 Timing and Transaction Cst

Table 5. Testnet timing and full-trace fee statistics (Source: Authors' experimental data, 2026)

Metric	Minimum	Median	Mean	Maximum
Wallet signing and broadcast response (s)	2.048	2.560	2.542	3.073
Testnet contract confirmation (s)	5.424	5.986	5.988	6.733
Full-trace fee (TON)	0.000780813	0.002056019	0.001728416	0.002200754

Across the 30 sequential calls, local signing and broadcast responses remained between 2.048 and 3.073 seconds, while observed contract confirmation remained between 5.424 and 6.733 seconds. The total full-trace fee was 0.051852491 TON. These values describe this testnet run and its trace definition; they should not be generalised as fixed fees or latencies for TON mainnet. Because calls were sequential, the experiment does not support a throughput claim. A mechanistic explanation for these timing and fee patterns, grounded in TON's sharded architecture, is provided in Section 4.6.

4.4 On-Chain State and Evidence Integrity

Table 6. Final contract state and evidence checks (Source: Authors' experimental data, 2026)

Evidence item	Verified value
Contract transaction counter	20
Total successful gross value	1.201630000 TON

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Total VAT recorded	41,919 kobo (NGN 419.19)
Ending contract balance	0.140927232 TON
Contract state	Active and not paused
Deployed code hash	3668f2e3e86c062edcea31cf030e6a613710102f673897ed0a18b94522c2107d
Evidence checksums	All SHA-256 values matched the manifest

The final on-chain counters agreed with the 20 successful cases. Customer balance reduction reconciled exactly with successful gross value, source-side fees, and the ending contract balance, leaving an unexplained difference of 0 nanoton. The non-zero contract balance resulted from residual per-payment gas allowances. It did not change the recorded split values, but it indicates that production contract logic should include an explicit residual-balance policy.

4.5 User Interface Demonstration

Figures 2 to 4 show the implemented taxpayer and administrator interfaces. They demonstrate that the research artefact includes operational screens for wallet connection, VAT calculation, transaction initiation, and administrative monitoring. The screenshots document interface implementation; they are not treated as evidence from the direct 30-case contract experiment.

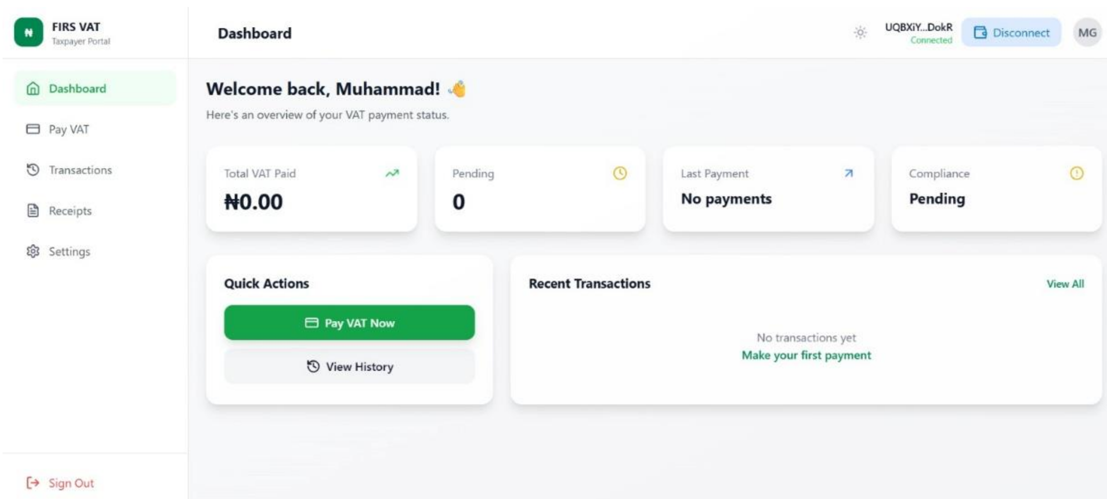

Figure 2. Taxpayer dashboard and connected TON wallet (Source: Authors' prototype interface, 2026)

The taxpayer dashboard presents payment status, compliance summary, recent transactions, and direct navigation to the VAT payment workflow.

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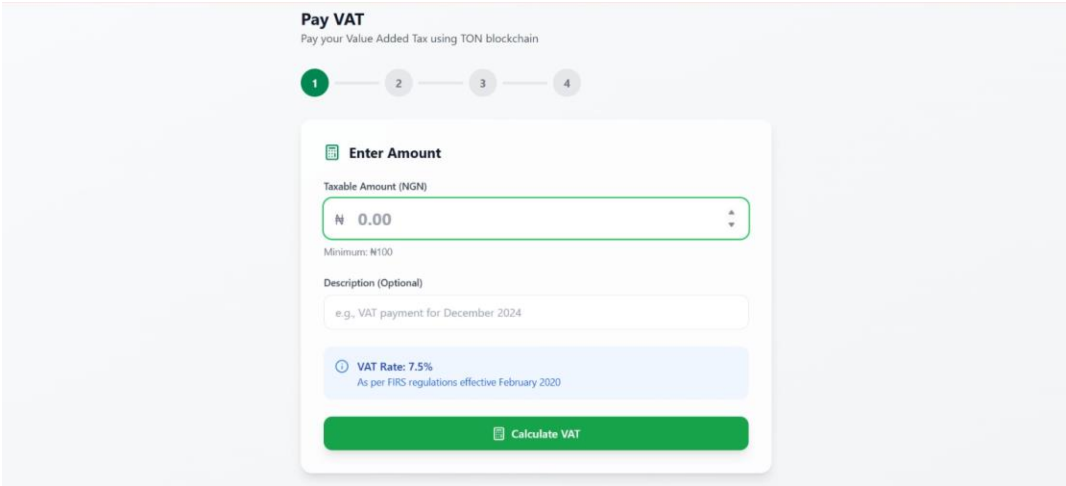

Figure 3. VAT payment and calculation interface (Source: Authors' prototype interface, 2026)

The payment interface accepts the taxable amount, displays the configured 7.5 percent rate, calculates the VAT in integer units, and guides the user towards wallet authorisation and blockchain confirmation.

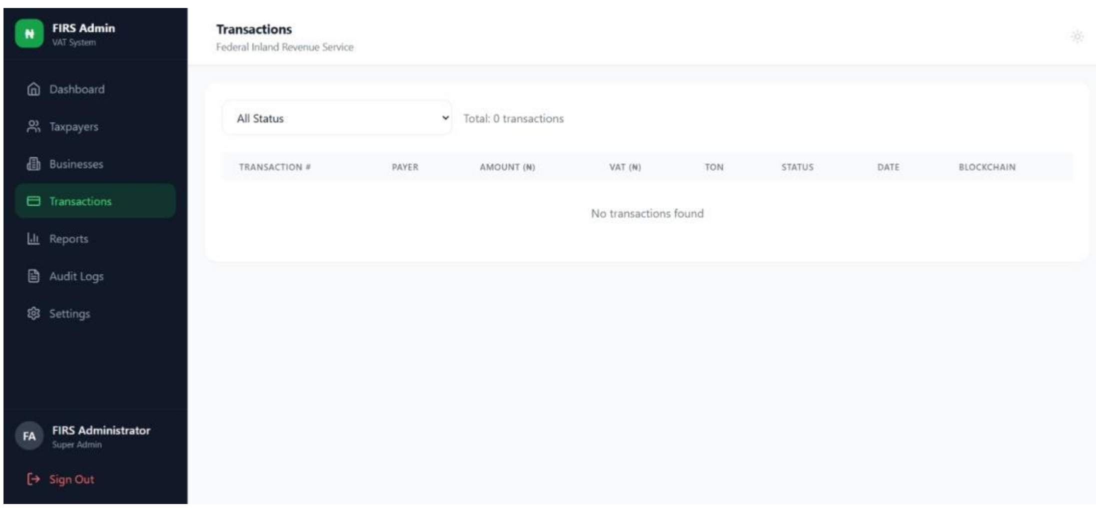

Figure 4. Administrator transaction-monitoring interface (Source: Authors' prototype interface, 2026)

The administrator interface provides transaction filtering and fields for payer, amount, VAT, TON reference, status, date, and blockchain confirmation. Production deployment would require formal institutional approval and privacy controls before tax officers could use these records.

4.6 Discussion against the Evaluation Objectives

The on-chain transaction hashes, unique invoice records, and matching outputs support the transparency and accountability objectives for the evaluated dataset. Accuracy and compliance automation are supported by zero VAT error, successful split routing, and correct rejection of all invalid cases. The observed confirmation and fee distributions provide measured efficiency

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evidence rather than an architectural assumption. Security evidence is limited to the implemented controls and test cases. Replay protection, owner-only administration, pause control, amount validation, expiration, and underfunding checks operated as expected. However, the contract itself does not enforce a registry of approved merchants, and the current backend lookup confirms a matching customer message without fully validating the contract exit result and both output messages before issuing a receipt. These issues prevent a claim of complete end-to-end security. TON's sharded architecture may support future scale, but scalability was not demonstrated in this study. No concurrent API, database, or blockchain load test was performed. Consequently, the earlier claim that the framework had met a high-load scalability benchmark has been withdrawn. TON partitions the network into workchains and, within them, dynamically splitting and merging shardchains, each validated independently and coordinated through asynchronous message passing rather than a single sequential ledger (TON Foundation, 2022). A PayVAT call therefore does not resolve in one atomic step: the customer's external message must first be included in a block, the contract's compute phase validates the request, and the split payment is not returned as a function value but dispatched as two further internal messages, one crediting the merchant wallet and one crediting the government wallet, each a separate on-chain transaction with its own inclusion, gas, and forwarding cost. The 5.424-6.733 second confirmation window in Table 5 is consistent with this multi-transaction settlement path: the reported time spans block inclusion of the external call plus propagation of the two dependent internal messages, not the computational cost of the VAT arithmetic itself, which completes in milliseconds. Because calls were issued sequentially to a single VATCollector instance, all messages resolved within the same shard, so the measured spread reflects validator queuing and block-production timing rather than cross-shard hypercube routing. The full-trace fee (0.000780813-0.002200754 TON) likewise aggregates the compute gas of the contract call with the forwarding and storage fees of the two dependent output messages; larger transaction tiers, carrying larger integer payloads and marginally higher gas for the split-payment logic, produced correspondingly higher fees. These observations indicate that TON's asynchronous, message-passing settlement model, not implementation inefficiency, accounts for the multi-second confirmation and sub-cent fee profile reported.

4.7 Limitations

The evaluation used 30 sequential synthetic calls on TON testnet and cannot establish mainnet availability, statutory validity, real-world adoption, privacy compliance, or maximum throughput. The fixed exchange rate was an experimental parameter. The web, backend, database, and TON Connect workflow was not used to sign the 30 experimental calls, and the interface screenshots show demonstration states rather than a populated production tax system. Before production use, the backend must verify contract success and both split outputs before confirming a receipt; merchant authorisation should be enforced on-chain or through a cryptographically verifiable registry; residual gas balances require an explicit policy; dependencies require continuing security maintenance; and Nigerian tax, data-protection, accounting, identity, dispute, and wallet-custody requirements must be validated with the responsible institutions.

5. Conclusion

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This study designed, implemented, deployed, and evaluated a smart contract-based VAT collection prototype on TON. The artefact combined a Tact split-payment contract with a TypeScript backend, PostgreSQL data storage, and Next.js taxpayer and administrator interfaces. All 21 automated tests passed. In the controlled TON testnet experiment, all 20 valid payments succeeded, all 10 invalid cases were rejected, VAT error was zero kobo, mean confirmation time was 5.988 seconds, and mean full-trace fee was 0.001728416 TON. The findings show that deterministic VAT calculation, replay prevention, atomic payment splitting, and independently verifiable transaction records are technically feasible for the evaluated cases. They do not prove production scalability or complete end-to-end security. Future work should strengthen receipt verification and merchant authorisation, conduct concurrent performance and usability studies, assess privacy-preserving designs, and evaluate regulatory integration with Nigeria's existing tax administration infrastructure.

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