PulsePay – Fiscalization Mobile App

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***Abstract***

**This study describes a mobile based fiscalization system used by tax collectors in Zimbabwe to generate fiscal invoices to ensure tax compliance to ZIMRA. The technology attempts to improve the tax collection process by making it accurate and simpler for tax collectors to send their taxation records to the authority , making it clear for them to visualize the amounts collected and get an overview of their tax performance. The suggested system has these stages:**

* **Invoice generation**
* **Data Encryption and digital signature generation**
* **Payload submission and response pulling**
* **Fiscal QR Code generation**
* **Receipt Anomaly detection**

**The system transforms the users’ invoice data into the required JSON payload format. Creates receipt string with a summary of the receipts taxes and invoice data from which a digital signature and hash are generated using RSA keys. The signature and hash are sent along with the receipt JSON payload to Zimra. An md5 hash version of the generated signature is then used to come up with a URL used so invoice validation and invoice QR Code generated. Anomaly detection measures are put on the system to detected erroneous receipts and potential cases of fraud. This system has the potential to be widely adopted by many tax payers in various working environment because of its simple usability, diversity and its ability to do some useful tax reporting.**

**Keywords: FDMS (Fiscal Data Management System), Fiscalization, Digital Signature, Encryption, Anomaly.**

1. INTRODUCTION

In the digital age, fiscalization has become a fundamental part in ensuring compliance with tax regulations. Traditionally, businesses in Zimbabwe have relied heavily on Electronic Cash Registers (ECRs) and fiscalized printers for issuing fiscalized receipts and invoices. However, these are now face significant challenges with the introduction of ZIMRA’s FDMS (Fiscal Data Management System), particularly in remote

and low-network areas, where connectivity problems are disrupting the fiscalization processes.

With the growth of mobile technology, there is a unique opportunity to overcome these challenges. This project proposes a mobile-based fiscalization application that allows users to generate fiscalized receipts and invoices even in areas with poor network connectivity. Beyond receipt generation, the mobile app also offers detailed tax reporting, receipt anomaly detection, and advanced data analytics for sales and tax predictions — equipping businesses with intelligent tools for compliance and operational insights.

The objectives of this paper are threefold:

* To successfully connect to Zimra’s API gateway and handle all fiscalization processes and requests
* To encrypt invoice data ,putting digital signature on every generated invoice
* To detect anomalies in receipt to reduce erroneous invoices and invoice fraud
* To analyse invoices’ data to give users full insights on tax performance and returns

The suggested system has the potential to boost tax compliance among VAT registered companies in Zimbabwe, overall improving the countries year tax collections.

1. PROBLEM STATEMENT

As from January 2024, TARMS and FDMS from ZIMRA replaced the already existing ZIMRA tax collection systems with a new one that required the upgrading of already existing tax collection devices and systems to match up with the current implementation. Interaction with FDMS is heavily dependent on stable internet connection to perform the fiscalization tasks and these upgrades on devices that are almost obsolete are posing agonizing network challenges and unexpected device failures. These challenge are not only affecting the tax collection authorities but also inconveniences businesses and customers alike. Therefore, there is an unforeseen need for a mobile fiscalization solution that is not only cheap but can operate reliably given the nation’s current conditions while also offering intelligent reporting and anomaly detection features

1. RELATED WORK

The term fiscalization refers to the implementation of systems and processes that ensure accurate reporting and monitoring of financial transactions with the main goal set to ensure proper tax compliance. This tax compliance had been enforced through hardware based fiscal devices and has since evolved alongside technological advancements to include software based and hybrid based systems [1].

Combating tax evasion and enhancing revenue collection are the main objectives of fiscalization, especially in cash-heavy industries like retail and hospitality [2]. Fiscalization has been implemented in a variety of ways by different countries. For example, Sweden and Kenya have shifted to software-driven solutions that are integrated with their national tax systems, whereas others like Italy and Serbia have depended on fiscal cash registers (FCRs) [10].

**Fiscalization Technologies and Standards**

According to [5], fiscalization has historically necessitated the deployment of physical fiscal memory devices that safely held transaction data and made manipulation difficult. These device were ranging from electronic cash registers, electronic signature devices to fiscalized printers that were being distributed by some companies like Eltrade. With recent development in fiscal and tax regulatory systems, these device have since become obsolete and seen to be causing a lot of challenges when it comes to being compatible with these modern day tax systems. More scalability and flexibility are provided by more recent systems, which make use of cloud computing, encryption, and real-time data transfer [3]. To advance the digitization of fiscal data, the OECD created the framework Audit File for Tax (SAF-T), which establishes a framework for the electronic interchange of trustworthy accounting data [1]. In countries like Zimbabwe there has been a rise in the use of virtual fiscalization systems that are working alongside accounting packages to ensure that tax collectors are able to issue out fiscal invoices.

Key technological components of modern fiscal systems include:

* Encryption and digital signatures: Ensuring data integrity and authenticity [4].
* QR codes: Common in countries like Zimbabwe and Hungary, these provide verifiable links to tax-registered invoices [9] [7].
* APIs for real-time reporting: As seen in Croatia’s fiscalization model, real-time APIs connect point-of-sale systems directly to tax authorities [8].

Fiscalization in mobile applications

Fiscalization has spread into the mobile application area as a result of the growing usage of smartphones and mobile point-of-sale (mPOS) systems. Businesses in the informal sector and small and medium-sized enterprises (SMEs) can join formal economies with lower overheads because to mobile fiscalization [7]. The field has rapidly advanced in recent years as we seen improvements and innovations ensuring that compliance can be ensured at ease with the use of mobile devices.

Mobile-compatible fiscalization, which has been adopted by nations like Zimbabwe, enables retailers to issue and fiscalize invoices through mobile applications that connect to national tax authority systems through secure API calls [9]. In some countries like Kenya and Nigeria, real-time mobile tax compliance has been in use for some years now. Kenya’s iTax and Nigeria’s eTax leverage mobile platforms to streamline VAT reporting and enhance compliance in the countries [10]. Many mobile fiscal apps in different countries now include an automated QR code generation feature, which contains fiscal data like tax identification , invoice totals and digital signatures , ensuring easy verification by customers and authorities.

Despite the promise in mobile fiscalization there are some challenges that remain and can be foreseen with the implementation of such systems. A main issue lies in device and network limitations. In regions with limited internet infrastructure, real time fiscalization be difficult to implement according to 6[]. Modern mobile applications also required mobile devices with better architecture meaning that acquiring a compatible mobile device could be unnecessarily expensive to some individuals or startups. In some regions it has been seen that ensuring mobile solutions comply with diverse fiscal regulations across jurisdictions requires an adaptive design [5].

Conversely, mobile fiscalization offers transformative opportunities for **financial inclusion** and **enhanced tax collection**, particularly in developing economies.

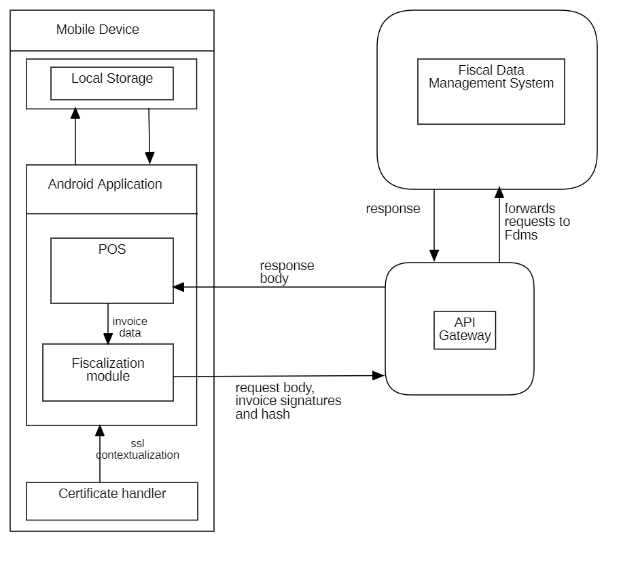
The development of fiscalization is indicative of more general patterns in tax compliance and digital governance. Modern fiscalization makes greater use of cloud services, APIs, and mobile technologies than did traditional systems, which were dependent on physical hardware. Particularly in developing nations, mobile fiscalization has a great deal of promise for expanding formal economic involvement to SMEs and unofficial enterprises. Future studies can concentrate on investigating machine learning techniques for automated tax fraud detection and improving security frameworks for mobile fiscal systems.

1. SOLUTION

The mobile fiscalized system is there to revolutionize and simplify the fiscalization process. It a more cheaper and convenient way to issues out fiscal invoices. The users will also benefit from the other inbuilt features of the system such as thorough reporting, fraud detection and inventory management.

However, careful assessment of the problems and prudent implementation are required to maximize its benefits while minimizing any negatives.

1. Features of the system
   * **SSL Contextualization**: This is core function as it is initialized first before interacting with the API gateway for any of the included functions. It ensures that all payment data is encrypted in transit, verifies that API calls between the application and the fiscal server are secured with SSL and makes sure that certificates are valid, current and trusted.
   * Fiscalization: this where transaction data is analyzed and tax calculations are done and Ids are identified. The invoice metadata is prepared and a signature is generated. In the process the metadata is also used in the generation of URL and a QR code that can be used for invoice verification.
   * Anomaly detection: the anomaly detection module goes through all submitted receipt and tries to pick up potential anomalies that can lead to invoice verification failure or tax fraud.
   * Reporting and analysis: this feature of the Pulse Pay provides users with comprehensive insights into their sales and tax data. It generates detailed reports on transactions, including total sales, tax breakdowns, and receipt summaries.
   * Inventory Management: enables businesses to track and manage their stock levels efficiently. It keeps real-time records of product quantities, sales, and restocking needs, ensuring that inventory is always up to date. The system automatically updates stock when sales are made and alerts users when items reach low stock thresholds.
   * Invoicing: this feature simplifies the creation and management of customer invoices. Users can generate fiscalized invoices directly from the mobile POS, complete with tax calculations and QR codes for verification. Each invoice is automatically recorded in the system, linking to sales transactions and customer data
2. Solution Architecture



1. **Sales and Invoicing Module**: Responsible for ensuring that users are presented with the best layout to carry out the sale. Captures various sale and invoice data to be used in various sections of the system.
2. **Fiscalization Module**: This module is responsible for transforming the invoice/sale data into required formats of the Json Payloads. It ensures that receipts are submitted to the Zimra servers, invoice data recorded and ensures the generation of the verification QR codes.
3. **Security Module**: This component manages user authentication, access control, SSL contextualization and Key encryption to generate the required digital signatures and hashes.
4. **Reporting Module**: focuses on generating numerous system reports to be used by the users for analysis and summarizing purposes. It ensures that users get insights on their sales and tax totals
5. **Database Interface**: the system has a single database storing all the system data in a number of structured tables.
6. **Technology Stack**

* Mobile : Android, Flutter , Kotlin
* Backend : Python
* Database : SQFlite

1. **Methodology**

The system was developed using the agile development method to ensure rapid development and integration of modules. This also allowed for incremental delivery of features and iterative refinement of the system based on feedback. Development was mainly centered on these areas:

* User Interface and User Experience
* Fiscal data handling and encryption
* Receipt anomaly detection
* Secure storage and retrieval of invoice information

1. **Workflow**

* Transaction Initiation
* **Data Capture and fiscalization process:** upon completion , transaction data is encrypted using the merchant’s PKCS 12 private key , it is packaged into a fiscal receipt format compliant with national tax standards and transmitted to the authority’s API endpoint
* **QR Code generation:** A QR code containing fiscal metadata (signature, receipt number, timestamp) is generated and attached to the receipt.
* **Anomaly Detection:** an anomaly detection algorithm runs in the background going through the submitted receipt checking for receipts with potential errors and abnormalities.
* **Error handling and feedback:** In case of errors (e.g., network failure or fiscal API rejection), the system queues the transaction for retry while notifying the user with actionable error messages.

1. RESULTS AND FUTURE WORKS
2. Results

The system worked so well in allowing the users to complete a sale and issue out a fiscalized invoice that was successfully validated by the revenue authorities on the test server.

* 1. **Accuracy**: 99% of the invoices generated were calculated correctly.
  2. **Precision**: 99% of the invoice were validated with the correct tax amounts and tax data
  3. **Verification Rate**: 95% of invoices generated could be verified by the Zimra servers.
  4. **Encryption Accuracy**: 97% of the invoices generated had a valid signature and hash
  5. **System Response Time**: 3 seconds (average time for the system to process and send invoice tax data)

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| Objectives | Fully Achieved | Partially Achieved |
| To successfully connect to Zimra’s API gateway and handle all fiscalization processes and requests |  |  |
| To encrypt invoice data ,putting digital signature on every generated invoice |  |  |
| To detect anomalies in receipt to reduce erroneous invoices and invoice fraud |  |  |
| To analyze invoices’ data to give users full insights on tax performance and returns |  |  |

Future Works

1. Enhanced Functionality:
   * Payment Gateway Integration: Integrating the POS with payment gateways to easily cater for online and card payments. This introduces a wide range of seamless payment methods
   * Accounting package integration: Linking up the system with other accounting packages like Pastel and QuickBooks for further accounting functionalities and financial reporting.
2. Advanced Analysis:
   * AI based sales trend analysis: Incorporate some artificial intelligence algorithm to forecast some sales trends and potentials. This would also help users in future planning.
3. Advanced Security Features:

- Introduce biometrics authentication when accessing the system to reduce the chances of unauthorized access to the system.

4. Cloud Sync and Backup – Cloud storage of some system data would help in introducing functionalities like multi-location access to the same data, ensuring consistency when the same system is used in different locations.

If the future works are looked into and implemented the system becomes a more powerful and complete fiscalization and accounting tool. It’ll include features that most of the tax collectors would love to be incorporated with their operations improving overall tax compliance in the country.

Conclusion

In conclusion, the proposed Pulse Pay, fiscalization system presents a promising solution for improving fiscal devices used by tax collectors. By overcoming challenges and focusing on future advancements, this has the potential to revolutionize the way fiscal invoices are issues out, ultimately contributing to better tax collection which means achieving of national tax targets

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