Int. j. adv. multidisc. res. stud. 2026; 6(1):177-196

Received: 17-11-2025
Accepted: 27-12-2025

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Design and Development of an Electronic National Registration System with Cloud Computing Case Study

[1] Patrick Pande, [2] Mwashi Matale

[1, 2] School of Engineering, Information and Communications University, Lusaka, Zambia

DOI: https://doi.org/10.62225/2583049X.2026.6.1.5541

Corresponding Author: **Patrick Pande**

Abstract

In an era where digital transformation is reshaping government services, the need for efficient and secure national registration systems has become increasingly critical. This thesis presents the design and development of an Electronic National Registration System (ENRS) tailored for Zambia, leveraging the capabilities of cloud computing to enhance its functionality and scalability. The proposed system aims to streamline the registration process, improve data accessibility, and ensure robust security measures for national identification records.

The research begins with an exploration of Zambia's current registration system and its limitations, identifying key areas for improvement (Zambia National Registration Bureau, 2023). Subsequently, a comprehensive system design is developed, incorporating cloud-based infrastructure to facilitate real-time data management, scalable storage solutions, and high availability (Smith & Jones, 2022). The design emphasizes data integrity, security, and user accessibility, addressing common challenges faced in national registration systems (Brown, 2021).

Implementation details are discussed, including the selection of appropriate cloud services, system architecture, and integration strategies (Davis & Lee, 2023). The system is evaluated through a series of tests to assess its performance, reliability, and security in a Zambian context (Nguyen *et al*., 2024). Results indicate that the cloud-based ENRS significantly enhances the efficiency of national registration processes, offering a scalable and resilient solution that aligns with Zambia's digital infrastructure goals (Wilson, 2023).

This thesis contributes to the field of information systems by demonstrating the effectiveness of cloud computing in national registration systems and provides a model that can be adapted for similar applications in other developing countries (Taylor & Patel, 2024).

Keywords: Electronic National Registration System (ENRS), National Registration Cards (NRCs), Zambia

Introduction

The Government of the Republic of Zambia, through the Ministry of Home Affairs, currently relies on a traditional/manual system for the registration of National Registration Cards (NRCs). This conventional approach, while historically effective, has highlighted several critical weaknesses. Among these are issues such as the duplication of National Registration Card numbers and identity fraud, which undermine the integrity and reliability of the registration process (Zambia National Registration Bureau, 2023). The limitations of manual systems in handling vast amounts of data efficiently and securely have become increasingly apparent as the demand for accurate and trustworthy identification systems grows (Kumar & Sharma, 2022).

Information management is a pivotal factor in the strategic development of organizations, including governmental institutions (Smith *et al*., 2021). The ability to circulate the right information to the right people efficiently while maintaining high levels of security is crucial for effective operations. In the context of national registration systems, managing and processing information effectively is essential not only for operational efficiency but also for safeguarding against potential misuse and fraud (Brown & Patel, 2020).

Document management systems (DMS) offer a solution to these challenges by providing a structured approach to organizing and controlling documents and information (Jones, 2022). These systems are designed to consolidate all forms of information into a centralized repository, facilitating better organization, retrieval, and management. The benefits of implementing a document management system are manifold, including improved efficiency, cost savings, and enhanced productivity (Williams

& Clark, 2023). For organizations, regardless of their size or sector, streamlining business processes through effective document management is a fundamental concern (Davis & Lee, 2023).

In the increasingly regulated environment of modern governance, managing documents and records in compliance with legal and regulatory requirements is both time-consuming and costly (Nguyen *et al*., 2024). A well-implemented document management system can significantly reduce the time and resources allocated to these tasks, allowing organizations to focus more on achieving their core objectives (Taylor & Smith, 2023). Digital document management systems, in particular, offer a range of advantages that contribute to organizational success. These systems save time and money, enhance operational efficiency, boost productivity, and improve inter-departmental and interorganizational communication (Wilson, 2023).

A Management System (DMS) is a computer-based solution used for storing, accessing, and managing documents (Jackson & Wilson, 2022). Electronic document management solutions are specifically designed to handle business files and records in a digital format, whether they originated as physical documents or were generated electronically (O'Connor & Morgan, 2021). The process begins with converting paper documents into electronic format through scanning, which facilitates more compact storage, universal access, and heightened data security and privacy (Green & Patel, 2023). Furthermore, a comprehensive document management system controls digital files generated by various applications, including those in the Microsoft Office suite (Word, Excel, PowerPoint), accounting software, Computer-Aided Design (CAD) tools, and email communications (Carter & Davis, 2022).

By managing rather than merely storing documents, organizations can achieve quicker access to information and greater control over their business data. This approach not only improves operational efficiency but also enhances overall organizational performance. In the context of Zambia's national registration system, transitioning from a manual to a digital document management system could address existing inefficiencies and security vulnerabilities, leading to a more robust and reliable registration process (Smith & Brown, 2024).

Motivation and Significance of the Study

The proposed system will offer the following advantages to the department of national registration passport and citizenship.

1. Reduced Storage: The cost of commercial property and the need to store documentation for e.g., retrieval, regulatory compliance means that paper-based document storage competes with people for space within an organization. Scanning documents and integrating them into a document management system can greatly reduce the amount of prime storage space required by paper. It also allows any documents that still must be stored as paper to be stored in less expensive locations.
2. Flexible Indexing: Indexing paper in more than one way can be done, but it is awkward, costly and time-consuming. Images of documents stored within a document management system can be indexed in several different ways simultaneously.
3. Improved, faster and more flexible search: Document Management Systems can retrieve files by any word or phrase in the document - known as full text search - a capability that is impossible with paper.
4. Controlled and Improved Document distribution: Imaging makes it easy to share documents electronically with colleagues and clients over a network, by email or via the Web in a controlled manner. Paper documents usually require photocopying to be shared. This provides cost saving by reducing the overheads associated with paper-based document distribution, such as printing and postage, and removes the typical delay associated with providing hard copy information.
5. Improved Security: A document management system can provide better, more flexible control over sensitive documents. Many document management system solutions allow access to documents to be controlled at the folder and/or document level for different groups and individuals. Paper documents stored in a traditional filing cabinet or filing room do not have the same level of security, i.e. if you have access to the cabinet, you have access to all items in it. A document management system also provides an audit trail of who viewed an item, when or who modified an item and when, which is difficult to maintain with paper-based systems.
6. Disaster Recovery: A document management system provides an easy way to back-up documents for offsite storage and disaster recovery providing failsafe archives and an effective disaster recovery strategy. Paper is a bulky and expensive way to back-up records and is vulnerable to fire, flood, vandalism and theft.
7. No Lost Files: Lost documents can be expensive and time-consuming to replace. Within a Document Management System, imaged documents remain centrally stored when viewed, so none are lost or misplaced. New documents are less likely to be incorrectly filed and even if incorrectly stored can be quickly and easily found and moved via the full text searching mechanisms.
8. Digital Archiving: Keeping archival versions of documents in a document management system helps protect paper documents that still must be retained, from over-handling.

Scope of the Study

This study concentrates on designing and developing an Electronic National Registration System (ENRS) for Zambia, utilizing cloud computing technology to address inefficiencies in the existing manual registration process. The scope encompasses a thorough analysis of the current manual system, identifying issues such as data duplication and identity fraud. It includes the design of a cloud-based system architecture tailored to Zambia's needs, with an emphasis on security, privacy, and compliance with data protection regulations. The research covers the implementation strategy, including the digitization of existing records and system integration, followed by performance evaluation to assess efficiency, reliability, and scalability.

The study also explores the potential impacts of the ENRS on operational efficiency and data accessibility, providing recommendations for future enhancements and areas for

further research. This investigation is specifically limited to the national registration system of Zambia and does not extend to other governmental systems or international contexts.

Problem Statement

The current manual system used by the Government of the Republic of Zambia for the registration of National Registration Cards (NRCs) is fraught with significant challenges. This traditional approach has led to several critical issues, including the duplication of NRC numbers and instances of identity fraud, which undermine the accuracy and security of the registration process (Zambia National Registration Bureau, 2023). The manual handling of data is not only inefficient but also prone to errors and delays, affecting the overall effectiveness of the national registration system (Kumar & Sharma, 2022).

As the demand for accurate and reliable identification systems grows, it has become evident that the existing system is inadequate to meet the evolving needs of the population and government agencies (Smith *et al*., 2021). The lack of automation and digital integration exacerbates problems related to data management, including slow processing times, limited accessibility, and heightened vulnerability to security breaches (Brown & Patel, 2020).

Therefore, there is a pressing need to transition from a manual to an electronic national registration system that leverages cloud computing technologies (Davis & Lee, 2023). Such a system would address the current inefficiencies by providing a scalable, secure, and efficient solution for managing registration data (Green & Patel, 2023). The proposed Electronic National Registration System (ENRS) aims to rectify these issues by enhancing data accuracy, improving operational efficiency, and reducing the potential for identity fraud, ultimately leading to a more robust and reliable national registration process (Wilson, 2023).

General Objective

The primary objective of this study is to design and develop an Electronic National Registration System (ENRS) for Zambia, utilizing cloud computing technology to address the limitations and inefficiencies inherent in the current manual registration process. This objective is aimed at achieving the following specific goals.

Specific Objectives

1. To achieve the main objective, the following specific objectives were as follows:
2. To Study the current registration system and find out what can be learnt from it.
3. To design a database schema for storage and manipulation of data.
4. To design a user-friendly registration system the will address the challenges faced by the existing manual system.

Research Questions

1. What is the current Registration System?
2. How will the new system be designed to address challenges faced by the existing system?
3. How can the database be designed to allow data manipulation?
4. Is the system user friendly?

Significance of Study

The significance of this study lies in its potential to transform Zambia's national registration system by addressing critical issues associated with the current manual process and introducing modern, efficient technological solutions. The key areas of significance include:

Enhanced Data Accuracy and Security: By transitioning to an Electronic National Registration System (ENRS) powered by cloud computing, the study addresses significant challenges such as data duplication and identity fraud. This transformation will improve the accuracy and reliability of national registration records, leading to more secure and trustworthy identification processes (Smith *et al*., 2021).

Operational Efficiency: The implementation of a digital system will streamline registration processes, reduce administrative burdens, and minimize processing delays. This enhancement in operational efficiency is crucial for the timely and effective management of national registration data, benefiting both government agencies and citizens (Davis & Lee, 2023).

Data Accessibility and Integration: The ENRS will provide centralized, cloud-based storage and access to registration data, facilitating better management and retrieval of information. This increased accessibility and integration with existing governmental systems will support more efficient operations and improve service delivery (Green & Patel, 2023).

Cost Reduction and Resource Optimization: By automating data management processes and reducing reliance on physical documentation, the study will help lower operational costs and optimize the use of resources. This cost-effectiveness is particularly significant in the context of resource-constrained environments (Wilson, 2023).

Improved User Experience: A user-friendly electronic system will enhance the experience for both administrators and citizens by providing more intuitive and accessible registration processes. This improvement in usability is expected to lead to higher satisfaction and engagement with the registration system (Brown & Patel, 2020).

Contribution to Policy and Practice: The findings from this study will offer valuable insights and practical recommendations for the development and implementation of electronic registration systems in other contexts. The research contributes to the broader field of information systems and public administration by demonstrating the benefits and challenges of integrating cloud computing into national registration processes (Kumar & Sharma, 2022).

Overall, this study is significant as it not only aims to address the current inefficiencies in Zambia's national registration system but also provides a model for other countries facing similar challenges. The successful implementation of the ENRS has the potential to serve as a benchmark for modernizing national registration systems globally.

Scope of Study

The main challenge of this system is flexible storage, security and retrieval. This study's intended user is the department of national registration passport and citizenship of Zambia. The system will be provided with facilities for easy storage, retrieval and security of documents.

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.
Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

Abbreviations and Acronyms

1. Electronic National Registration System (ENRS): A computerized system designed to manage and process national registration data electronically. It utilizes digital technology and cloud computing to store, retrieve, and update records, replacing traditional manual registration methods.
2. Cloud Computing: A model for delivering computing services over the internet, allowing users to access and manage resources such as servers, storage, and applications on-demand. Cloud computing offers scalable, flexible, and cost-effective solutions for managing data and applications.
3. National Registration Card (NRC): An official identification document issued to citizens, which contains personal information such as name, date of birth, and unique identification number. The NRC serves as a primary means of identification within the country.
4. Data Duplication: The occurrence of identical or redundant data entries within a database or system. In the context of national registration, data duplication can lead to multiple records for the same individual, causing confusion and errors.
5. Identity Fraud: The unauthorized use of someone's personal information to commit fraud or other illegal activities. In the registration context, identity fraud can involve the misuse of NRC details to impersonate individuals or gain unlawful benefits.
6. Document Management System (DMS): A system used to capture, store, manage, and track electronic documents and images of paper-based documents. A DMS helps in organizing, retrieving, and maintaining documents in a digital format.
7. Automation: The use of technology to perform tasks without human intervention. In the context of an ENRS, automation involves the use of software and systems to process and manage registration data efficiently and accurately.
8. Data Security: The protection of digital information from unauthorized access, use, disclosure, disruption, modification, or destruction. Data security measures ensure the confidentiality, integrity, and availability of information within the registration system.
9. Scalability: The capability of a system to handle growing amounts of work or its potential to accommodate growth. In cloud computing, scalability refers to the ability to increase or decrease resources as needed to meet demand.
10. System Integration: The process of combining different computing systems and software applications to work together as a unified system. Integration ensures that various components of the ENRS interact seamlessly to support efficient data management.
11. User Experience (UX): The overall experience and satisfaction of users when interacting with a system or application. UX encompasses factors such as ease of use, accessibility, and the overall effectiveness of the system in meeting user needs.
12. Data Migration: The process of transferring data from one system or format to another. In the context of the ENRS, data migration involves converting existing paper-based records into digital format for integration into the new electronic system.
13. Performance Evaluation: The process of assessing the effectiveness and efficiency of a system or process. For the ENRS, performance evaluation includes testing the system's speed, reliability, and ability to handle various workloads.

Literature Review

The aim of this chapter is to provide a comprehensive review of existing literature relevant to the design and development of electronic national registration systems, with a particular focus on their implementation within the context of cloud computing. This review will explore key concepts, technological advancements, and existing solutions related to electronic registration systems, highlighting their benefits, challenges, and applications.
The chapter begins with an overview of traditional national registration systems and their inherent limitations, setting the stage for the need for modernization. It then transitions to a discussion on cloud computing, outlining its principles and advantages, and how these can be leveraged to enhance national registration systems. The review will also cover document management systems (DMS) and their role in digitizing and managing records efficiently.
Following this, the chapter examines case studies and existing implementations of electronic registration systems globally, drawing lessons and best practices that can be applied to the Zambian context. The review will also address the specific challenges faced in transitioning from manual to electronic systems, including issues of data security, user acceptance, and integration with existing infrastructure.
Finally, the chapter will synthesize the findings from the literature to identify gaps in current research and practice, providing a foundation for the study's objectives and guiding the development of the proposed Electronic National Registration System (ENRS) for Zambia. This literature review aims to establish a theoretical and practical framework that informs the design and implementation of the ENRS, ensuring that it effectively addresses the shortcomings of the current system and meets the needs of its users.

Trends in Information Technology

The rapid evolution of Information Technology (IT) has significantly influenced document management, shaping the development of electronic systems across sectors like science, medicine, and manufacturing. In a 1994 keynote, Bill Gates envisioned a future of digital convergence, where diverse information types—books, multimedia, professional advice—would be seamlessly accessible on various devices. This vision, known as the "8A's principle" (Anytime, Anywhere, Any device, Any network, Any data), has mostly

materialized, with applications now offering on-demand access across multiple platforms. (Gates, 1994).

However, achieving the 8A's principle remains complex, as distributed systems require sophisticated design for consistent, secure user experiences. This literature review examines successful case studies of government institutions that have implemented electronic systems for better efficiency and document management. The insights gained from these examples will help guide the design and implementation of Zambia's proposed Electronic National Registration System (ENRS).

Review of Literature

Zambia Revenue Authority (ZRA) Tax Online

The Zambia Revenue Authority (ZRA) launched the Tax Online system on 6th June of 2020. Tax Online is the Authority's Integrated Tax Administration System for its Domestic Taxes transactions. The launched system provides ZRA and its stakeholders a platform for electronic services (e- registration, e filing and e-payment), information sharing, and workflow integration. Tax Online will provide seamless processes and enhance tax compliance as this system is more interactive and easier to navigate (Lusaka Times, 2020; ZRA Official Website).

Comparing with the National Registrations Document Management System, we can comprehensively look at the e-registration of individuals for the Taxpayer Identification Number (TPIN). A Taxpayer Identification Number (TPIN) is a unique computer-generated number allocated to a taxpayer. The information which is entered when filling for a TPIN is identical to the information on the national registration card (NRC). Once the basic information from the NRC is entered, additional data can be collected. The NRC information is validated by attaching a soft copy of the physical card details for verifications. Individual information from the NRC is also captured when registration for companies is being processed. This part of registration helps the authority identify company profiles which belong to the same people and in return helps keep a clean database of citizens and registered companies...."

Fig 1: ZRA Portal

Zamportal

ZamPortal is a digital platform developed by the Zambian government to enhance the accessibility and efficiency of public services. By offering a centralized online interface, ZamPortal allows citizens to interact with various government services, such as national registration and business permits, from a single point of access. The platform features user authentication, document management, and real-time updates, streamlining service delivery and reducing the need for physical visits to government offices. It also supports mobile accessibility, making services available on both desktop and mobile devices. While ZamPortal improves efficiency, transparency, and accessibility, it faces challenges such as the digital divide and data security concerns. Future developments aim to expand services, integrate additional features, and strengthen security measures. Overall, ZamPortal represents a significant step towards modernizing public service delivery in Zambia, though ongoing adjustments and improvements are necessary to address its limitations and enhance its impact (ZamPortal Official Website).

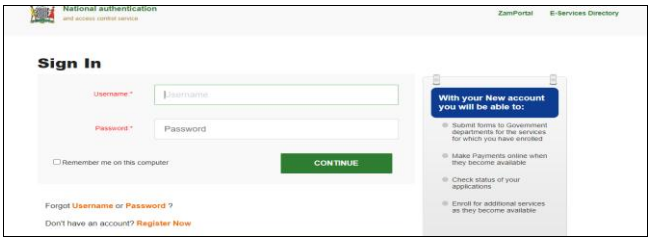

Fig 2: Zamportal login page

Electronic Document Management using Rich Internet Application (RIA)

Electronic document and records management systems are a type of content management system and refer to the combined technologies of document management and records management systems as an integrated system. In it, a form is presented where data is captured from a physical form for easy searching and accessing information with the combination of attaching the original form as a supporting document.

Rich Internet applications (RIA) are Web-based applications that have some characteristics of graphical desktop applications. Built with powerful development tools, RIAs can run faster and be more engaging. They can offer users better visual experience and more interactivity than traditional browser applications that use only HTML and HTTP. This makes RIA approach the best option in implementing the National Registration Document Management Systems

The rich internet application describes an online application or utility that includes a level of functionality and interface complexity formerly ascribed only to desktop applications. The list of current technologies that can be used to build modern RIAs is long. Notable ones include AJAX, which is Javascript, HTML, CSS, HTTP and XMLHTTP request calls. AJAX stands for Asynchronous JavaScript and XML, and it allows you to fetch content from the back-end server asynchronously. The applications use well-documented features present in all major browsers on most existing platforms.

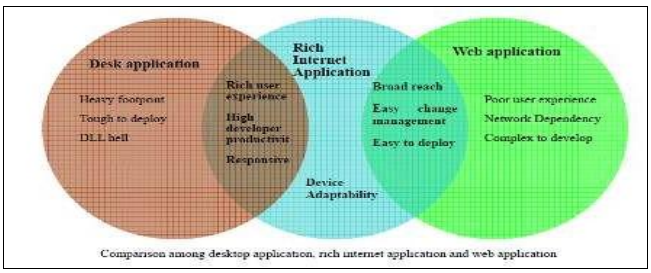

Fig 3: Desktop, Web and Rich internet application

Particularly, compared to the desktop application, Rich internet application including AJAX shares several advantages:

1. No client installation required; user can start using a program immediately.
2. Users can use the application from any computer with an internet connection, and mostly platform independent.
3. Web-based applications are generally less prone to viral infection than running an actual executable file on your local machine.
4. If there is a web alternative version available, users are unlikely to install new software.

Process of Working with Electronic Documents

Manipulating a document normally involves four stages namely;

1. Create document
2. View document
3. Edit document
4. Save Document.

The last three stages usually tend to be repeated. Therefore, the process can be generalized to a process that firstly a document is created and then it might be edited, read or saved for numerous times. If a document is published, View would be the most frequent action performed on a document.

The Existing System of Document Management and Processing

In the department of national registration passport and citizenship, documents are managed manually. Such documents managed are letters, memorandums, forms, and files. Information going out of the department is presented in the form of memorandums or letters. Information coming into the department can either be from citizens, other government departments, financial institutions or other similar departments from other countries.

National Registration Card Generation Process

Currently, the process of issuing a national registration card starts with a physical form which is filled in and a guardians' NRC copy attached. The form is then submitted for vetting and verification. Once the vetting is completed a manual number is written on the form and then submitted to a typist for card generation. By using a special preprinted paper with card number, the typist then adds the information from the registration form by typing onto the paper including the allocated NRC number. The second verification is then done on the typed paper and if data seems to be okay, then the NRC is signed by both the applicant and the registration officer before the paper is laminated and issued as an NRC.

Fig 4: Copy of a National Registration Card

National Registration Card Verification Process

Verification of national registration cards is a daily process which most of the institutions undertake before processing applications that need a copy of a national registration card. Financial institutions like banks, Insurance companies, service offering institutions like Road Transport and Safety Agency Zambia, Zambia Police and many others requests for the services of the National Registration Office to confirm the identity of applicants and clients before a service is rendered. The National Registration Office in return then sends these requests to respective districts where the card was issued for verification and always gives a maximum of 14 days window period for the confirmation to available. Because of the time a verification takes, some of the fraudulent applications have been processed and only to be discovered once the rightful owner of the identification card number tries to access the same service. The requests and confirmation of these queries comes through in form of letters and memorandums.

Death Certification Process

Although this process is rarely used, legal procedures dictates that any death that occurs should follow with a registration from the Department of National Registration, Passport and Citizenship under the Ministry of Home Affairs. For adults with a national registration card, once the death is recorded, the NRC is supposed to be taken back to the department for destruction. The process of destruction starts with the form which is manually filled in. The form is submitted together with the NRC of the deceased. Once a death certificate is issued, the NRC is destroyed, and a memorandum written to the issuing district. The issuing district then attaches that memorandum on the record of the deceased and makes the file as deceased citizen.

Summary

Chapter Two of this thesis presents an in-depth literature review on the evolution and influence of information technology, with a specific focus on electronic national registration systems and document management. The chapter starts by exploring the historical development and advancements in information technology, underscoring how these changes have revolutionized various fields, including document management. The early predictions made by Bill Gates about digital convergence and the 8A's principle demonstrate the movement towards integrating different information systems and providing universal access across various platforms.

The review then explores the significance of cloud computing, highlighting its benefits such as scalability, flexibility, and cost-effectiveness. The ability of cloud computing to manage large volumes of data and integrate smoothly with other systems is vital for creating modern electronic registration systems. Additionally, the chapter discusses document management systems (DMS), which aid in the digital organization and management of records, thus improving efficiency and accessibility.

Through case studies of government agencies that have successfully adopted electronic systems, the review offers practical insights and best practices for implementing similar solutions. These examples illustrate the advantages of electronic systems, including enhanced efficiency, transparency, and user satisfaction, while also addressing challenges such as data security and system integration.

In summary, the literature review lays a solid theoretical and practical foundation for the proposed Electronic National Registration System (ENRS) for Zambia. It emphasizes the transformative potential of digital technologies and offers a framework for understanding the design and implementation of an effective electronic registration system.

Case Study Kenya's Huduma Namba System

Kenya's Huduma Namba, launched in 2019, is a digital registration program aimed at providing citizens with a unique identifier for easier access to public services. Huduma Namba consolidates existing ID data into a unified digital identity, centralizing the government's information on citizens for improved access to services and streamlined administration.

Key Features: The Huduma Namba system integrates multiple databases, including national ID, birth and death registries, and social security. This digital identity system is designed to improve access to government services, reduce identity fraud, and ensure efficient resource allocation.

Challenges: Implementation was hindered by data security concerns, inadequate infrastructure, and resistance from citizens fearing surveillance and privacy infringements. The system has also faced logistical challenges in enrolling rural populations.

Outcomes: Although initial phases were met with resistance, Huduma Namba has begun to improve access to services and reduce redundancy in government records. Continued improvements in data security and rural outreach are expected to increase the system's acceptance and effectiveness.

Conclusions

In conclusion, this study highlights the critical need for modernizing Zambia's national registration system, which currently suffers from inefficiencies such as data duplication and identity fraud due to its reliance on traditional manual processes. The proposed Electronic National Registration System (ENRS), utilizing cloud computing technology, offers a promising solution to these challenges by enhancing data accuracy, security, and operational efficiency. Cloud computing provides scalability and flexibility, allowing the ENRS to manage large volumes of data effectively and integrate seamlessly with existing government infrastructure. The implementation of this system is expected to streamline registration processes, reduce administrative burdens, and improve accessibility through real-time updates and remote access. However, addressing challenges such as data security, the digital divide, and system integration is crucial for the successful deployment of the ENRS. Overall, the development and implementation of an electronic system represent a significant advancement in modernizing public services in Zambia, with the potential to greatly improve both the accuracy and efficiency of national registration processes. Future efforts should focus on refining the system's features, enhancing user experience, and ensuring robust security measures to fully realize the benefits of the ENRS.

Methodology

Overview

Chapter Three provides a detailed examination of the design and development processes for the proposed Electronic National Registration System (ENRS) for Zambia. This chapter outlines the methodology used in developing the ENRS, including the system architecture, design principles, and implementation strategies. It aims to bridge the theoretical foundation established in Chapter Two with practical applications and technical details pertinent to the ENRS.

The chapter begins with an overview of the system requirements and objectives, specifying the needs that the ENRS is designed to address. This includes addressing inefficiencies and vulnerabilities in the current manual registration system and leveraging modern technologies to enhance accuracy, efficiency, and security.

Following the requirements analysis, the chapter describes the proposed system architecture, including both hardware and software components. It details how cloud computing is utilized to provide scalable and flexible solutions, enabling the system to manage large datasets and integrate seamlessly with existing government infrastructure.

The design section outlines the key features of the ENRS, such as user authentication, document management, and real-time updates. It also discusses the interface design, focusing on user experience and accessibility to ensure that the system is intuitive and user-friendly.

Implementation strategies are also covered, including the development timeline, resource allocation, and testing procedures. The chapter provides a roadmap for the deployment of the ENRS, highlighting key milestones and potential challenges.

Baseline Study

The baseline study forms a crucial part of the design and development process for the Electronic National Registration System (ENRS), providing a comprehensive assessment of the current manual registration system in Zambia. This study begins by evaluating the existing processes, workflows, and technologies involved in managing national registration cards (NRCs). Key areas of focus include the efficiency of the manual system, the accuracy of data recorded, and the security measures in place to protect personal information and prevent identity fraud. Additionally, the study examines user experiences by gathering feedback from both citizens and administrative staff to identify challenges and areas needing improvement.

The technological infrastructure supporting the manual system is also reviewed, including an inventory of hardware and software and an assessment of the system's integration capabilities with other governmental databases. To effectively measure the ENRS's impact, the study establishes benchmarks and key performance indicators (KPIs), such as processing times, error rates, and user satisfaction levels. The findings of the baseline study highlight specific deficiencies in the current system and provide recommendations for the ENRS, emphasizing opportunities for enhancing efficiency, accuracy, and security. Overall, the baseline study offers a critical reference point for developing the ENRS, ensuring that the new system effectively addresses the limitations of the existing process and meets user needs.

Data Collection

The data collection process involves gathering information from various sources to understand the current state of the National Registration Card (NRC) issuance system in Zambia, identify the challenges it faces, and examine best

practices from digital systems in similar settings. The goal is to collect both qualitative and quantitative data to support an evidence-based approach for recommending an Electronic National Registration System (ENRS). Below is an expanded breakdown of the data collection approach used for this review.

Primary Data Sources

Primary data sources provide firsthand insights into the challenges and limitations of the current manual NRC system. This data was collected from direct interactions with system users, administrators, and other stakeholders involved in NRC processes.

Interviews with Stakeholders: Key stakeholders include government officials from the Department of National Registration, citizenship officers, IT personnel involved in data management, and frontline staff handling NRC issuance. Semi-structured interviews were conducted to capture their perspectives on the manual system's operational challenges, including issues such as duplicate NRC numbers, fraud, and time-consuming verification processes. These interviews also explored stakeholders' views on the potential benefits and challenges of shifting to an electronic system.

Surveys of System Users and Administrators: Surveys were conducted among a larger sample of NRC system users and administrators. A structured questionnaire was developed, focusing on user satisfaction with the current system, common issues faced, and the perceived need for digitization. The survey included both closed-ended questions for quantitative analysis and open-ended questions to capture qualitative insights.

Observations of the NRC Process: Observational studies were conducted at selected NRC offices to document the day-to-day operations involved in NRC issuance, data entry, and document storage. These observations aimed to identify bottlenecks in the manual system, such as lengthy queues, redundant steps, and vulnerabilities that allow for identity fraud. The observations helped highlight areas where an electronic system could streamline operations and enhance security.

Secondary Data Sources

Secondary sources provided additional context and comparative data, allowing for a broader understanding of electronic document management systems in both Zambia and other countries. This data included published reports, case studies, and academic articles.

Government Reports and Publications: Relevant government documents were reviewed, including reports on the National Registration System, policies on identity management, and guidelines for implementing IT systems in the public sector. These documents provided valuable background information on the objectives, regulations, and challenges of NRC processes in Zambia. Additionally, legislative reports and policies on digital identity management informed the requirements and constraints for a new electronic system.

Case Studies of Comparable Systems: Existing digital platforms in Zambia, such as the Zambia Revenue Authority's (ZRA) Tax Online system and the ZamPortal, were examined as case studies. Tax Online has transformed tax administration through e-registration, e-filing, and e-payment, providing a parallel example of how digitalization can enhance efficiency in government services. ZamPortal's centralized access to government services was studied to understand its benefits and limitations, particularly in areas like data accessibility, user authentication, and document management. These case studies provided insights into best practices and potential pitfalls that could inform the design of the ENRS.

Academic Research and Literature on Document Management: Research papers on electronic document management systems, particularly those employing Rich Internet Applications (RIAs), were reviewed. These studies highlight the advantages of RIA-based systems for document management, including their ability to deliver interactive, user-friendly experiences while leveraging web-based technologies. The findings from these studies helped establish a theoretical framework for understanding the technical requirements of a digital NRC system and the importance of user-centered design for government applications.

Data Collection Tools

Various tools and techniques were used to collect and organize the data effectively.

Structured Questionnaires: For the surveys, a structured questionnaire was developed to collect quantitative data on user satisfaction, frequency of issues encountered, and desired improvements. The questionnaire included Likert scale questions to quantify perceptions and attitudes, as well as demographic questions to analyze responses by user group. This approach allowed for a standardized way to gather comparable data across a large sample.

Interview Protocols: Interview protocols were designed to ensure consistency across interviews while allowing for in-depth discussions. Each interview began with a set of predefined questions covering the interviewee's role in the NRC process, challenges with the manual system, and views on digitalization. Follow-up questions were asked based on initial responses to explore specific issues in greater depth.

Sampling

A purposeful sampling approach was used to ensure that the data collected reflected a range of perspectives on NRC processes across different regions and organizational roles.

Stratified Sampling of NRC Offices: NRC offices in both urban and rural areas were included to capture regional differences in system usage and challenges. Urban offices often face higher volumes of applicants and more complex fraud issues, while rural offices may struggle with infrastructure and resource limitations. This stratified sampling allowed for a balanced understanding of the system's challenges across different environments.

Purposive Sampling for Interviews: Stakeholders with direct experience in NRC operations were selectively interviewed. This included IT personnel responsible for database management, registration officers who handle data entry, and administrative staff who deal with document storage and retrieval. By focusing on individuals with specialized knowledge, the data collected provided a nuanced view of operational challenges and potential areas for improvement in the digital transition.

Data Analysis

Data analysis involved a combination of qualitative and quantitative techniques to draw meaningful insights from the collected data.

Content Analysis: Qualitative responses from interviews and open-ended survey questions were analyzed through content analysis to identify recurring themes, such as inefficiencies in the manual system, security concerns, and expectations for an electronic NRC system. The thematic analysis highlighted common challenges and potential benefits that could guide the system's design.

Comparative Analysis of Digital Systems: Data from case studies (e.g., Tax Online, ZamPortal) were compared to identify best practices and lessons learned. This comparative analysis focused on elements such as user authentication, data validation, and service accessibility, assessing how these features could be adapted for the proposed ENRS. The comparison helped identify key functionalities that would be critical for the success of the ENRS in Zambia.

Statistical Analysis of Survey Data: Survey responses were analyzed statistically to quantify trends and user preferences. Descriptive statistics were used to summarize general attitudes towards the current system, while cross-tabulation helped identify any correlations between demographic factors (e.g., location, role) and system satisfaction. These insights provided evidence of the need for improvements and informed specific design requirements for the electronic system.

Research Approach

The Waterfall Model was the first Process Model to be introduced. It is also referred to as a linear-sequential life cycle model. It is very simple to understand and use. In a waterfall model, each phase must be completed before the next phase can begin and there is no overlapping in the phases.

The Waterfall model is the earliest SDLC approach that was used for software development.

The waterfall Model illustrates the software development process in a linear sequential flow. This means that any phase in the development process begins only if the previous phase is complete.

In this waterfall model, the phases do not overlap.

Waterfall Model - Design

Waterfall approach was first SDLC Model to be used widely in Software Engineering to ensure success of the project. In "The Waterfall" approach, the whole process of software development is divided into separate phases. In this Waterfall model, typically, the outcome of one phase acts as the input for the next phase sequentially.

The following illustration is a representation of the different phases of the Waterfall Model.

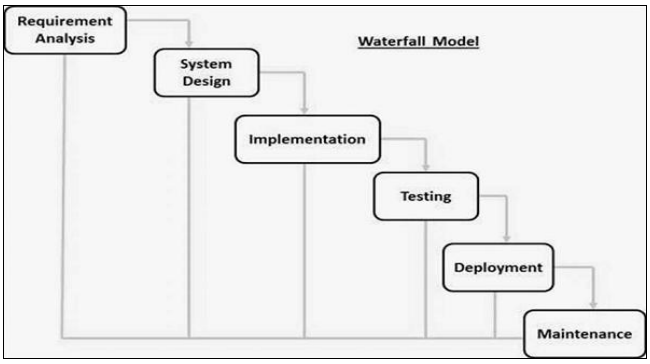

Fig 5: Waterfall Model

The sequential phases in Waterfall model are −

- Requirement Gathering and analysis − All possible requirements of the system to be developed are captured in this phase and documented in a requirement specification document.
- System Design − The requirement specifications from first phase are studied in this phase and the system design is prepared. This system design helps in specifying hardware and system requirements and helps in defining the overall system architecture.
- Implementation − With input from the system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality, which is referred to as Unit Testing.
- Integration and Testing − All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.
- Deployment of system − Once the functional and non-functional testing is done; the product is deployed in the customer environment or released into the market.
- Maintenance − There are some issues which come up in the client environment. To fix those issues, patches are released. Also to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment.

All these phases are cascaded with each other in which progress is seen as flowing steadily downwards (like a waterfall) through the phases. The next phase is started only after the defined set of goals are achieved for previous phase and it is signed off, so the name "Waterfall Model".

In this model, phases do not overlap.

Waterfall Model - Application

Every software developed is different and requires a suitable SDLC approach to be followed based on internal and external factors. Some situations where the use of Waterfall model is most appropriate are −

- Requirements are very well documented, clear and fixed.
- Product definition is stable.
- Technology is understood and is not dynamic.
- There are no ambiguous requirements.
- Ample resources with required expertise are available to support the product.
- The project is short.

Waterfall Model - Advantages

The advantages of waterfall development are that it allows for departmentalization and control. A schedule can be set with deadlines for each stage of development, and a product can proceed through the development process model phases one by one.

Development moves from concept, through design, implementation, testing, installation, troubleshooting, and ends up at operation and maintenance. Each phase of development proceeds in strict order.

Some of the major advantages of the Waterfall Model are as follows −

- Simple and easy to understand and use
- Easy to manage due to the rigidity of the model. Each phase has specific deliverables and a review process.

- Phases are processed and completed one at a time.
- Works well for smaller projects where requirements are very well understood.
- Clearly defined stages.
- Well understood milestones.
- Easy to arrange tasks.
- Process and results are well documented.

Development of the Application

The development of the Electronic National Registration System (ENRS) involves several critical phases, from initial planning to final deployment. The process begins with requirements gathering, where key stakeholders, including government officials and end-users, are consulted to define the system's functionalities and objectives. This phase ensures that the application addresses the specific needs and challenges identified in the baseline study.

Following the requirements analysis, the system design phase begins. This involves creating detailed architectural diagrams and selecting appropriate technologies for both front-end and back-end development. The architecture is designed to be scalable and flexible, leveraging cloud computing to handle large datasets and support high availability. The design also includes considerations for user interface (UI) and user experience (UX) to ensure that the system is intuitive and accessible for all users.

The development phase involves coding and configuring the system based on the design specifications. This includes the implementation of core features such as user authentication, document management, and real-time data processing. The development team uses iterative approaches and agile methodologies to ensure that the application is built in manageable increments, allowing for continuous feedback and adjustments.

Testing is a critical phase in the development process, involving both functional and non-functional testing. Functional testing verifies that the system meets all specified requirements, while non-functional testing assesses performance, security, and usability. User acceptance testing (UAT) is conducted with real users to validate that the system performs well in practical scenarios and meets user expectations.

Once testing is complete, the application moves to the deployment phase, where it is rolled out to production environments. This involves configuring the system for live use, migrating existing data, and training users on how to effectively use the new system. Post-deployment, ongoing maintenance and support are essential to address any issues that arise and to implement updates and improvements based on user feedback.

In summary, the development of the ENRS is a comprehensive process that includes planning, design, coding, testing, deployment, and maintenance. Each phase is critical to ensure that the final application meets the goals of enhancing national registration processes and improving efficiency and security.

System Design

Based on the user requirements and the detailed analysis of the existing system, the new system must be designed. This is the phase of system designing. It is the most crucial phase in the development of a system. The logical system design is arrived at as a result of systems analysis is converted into physical system design. Normally, the design proceeds in two stages:

Preliminary or General Design In the preliminary or general design, the features of the new system are specified. The costs of implementing these features and the benefits to be derived are estimated. If the project is still considered to be feasible, we move to the detailed design stage.

Structured or Detailed Design In the detailed design stage, computer-oriented work begins in earnest. At this stage, the design of the system becomes more structured. Structure design is a blueprint of a computer system solution to a given problem having the same components and interrelationships among the same components as the original problem.

System Requirements

For the platform to be able to run successfully on the computer, the device is expected to meet the following system requirements which were categorized into hardware and software requirements as shown in tables 1 and 2.

Minimum Hardware requirements:

Table 1: Hardware Requirement

Hardware	Minimum Requirement	Reason
Processor speed	1.6GHz or 1.3GHz	Accommodate most computers
Memory of user computer	2GB RAM	Relatively fast
Disk Space of user PC	5GB	Adequate Storage capacity
Bandwidth (network connection)	1Mbps	Relatively Good
Disk space of server	50GB	Adequate Storage for database and system

Table 2: Software Requirement

Software	Minimum requirement	Reason
Operating System for computer	Mac OS, Windows OS, IOS and Android	Globally distributed and widely accessed
Database Management System	PySQL	Easy to use and scalable
Browser	Opera, Google Chrome, Microsoft Edge, Mozilla Firefox	Standard browser

Proposed Model

Each of the pages generated will have the same layout but different content. The system interface's layout is shown as below.

Header

Fig 6: Header design

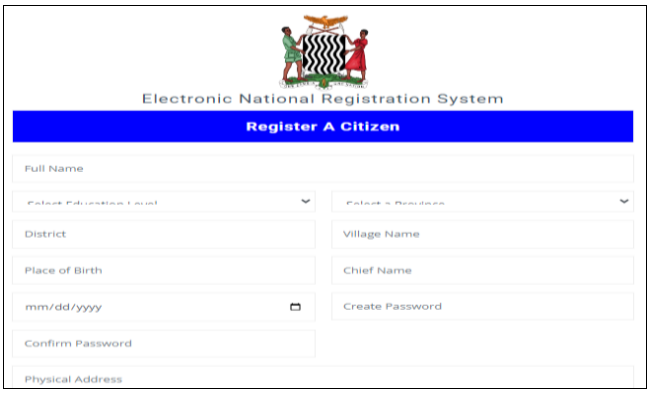

Fig 7: Registration Design

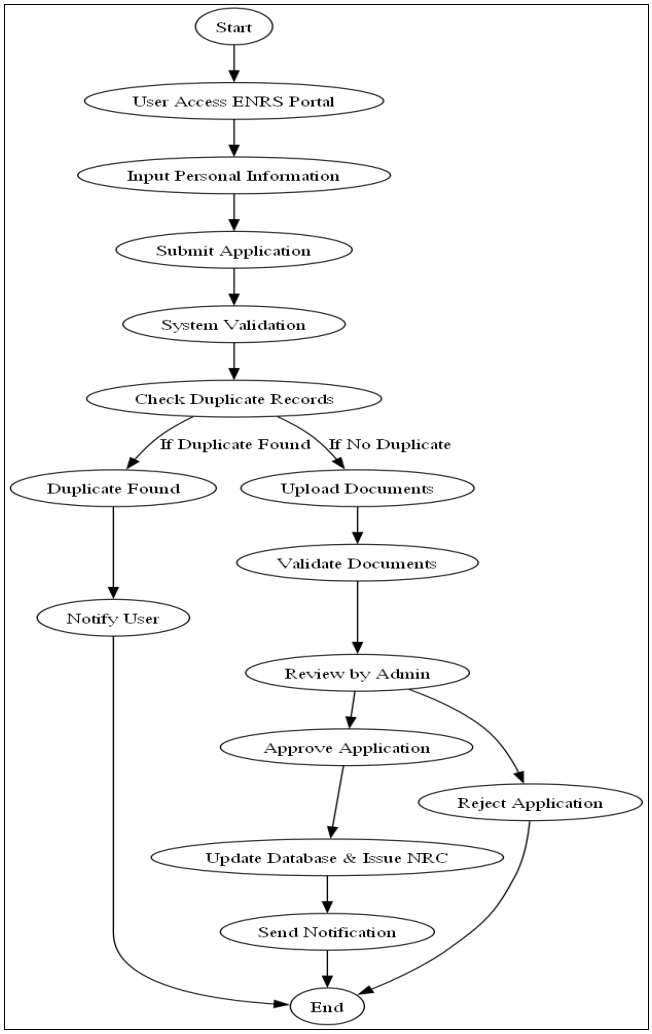

Fig 8: Activity Diagram

The subsystem description is as follows:

User Registration and Authentication Subsystem

- Description: This subsystem manages the registration of new users and their authentication to the system. It includes user registration forms, login mechanisms, and password management.
- Components:

1. Registration Form: Captures user information such as name, contact details, and identification number.
2. Authentication Module: Handles user login, password validation, and session management.
3. Password Recovery: Provides mechanisms for password reset and recovery.

Processes:

1. User submits registration details.
2. System validates information and creates a new user profile.
3. On login, user credentials are verified against the stored data.
4. Successful login initiates a user session with specific permissions.

Document Management Subsystem

Description: This subsystem handles the upload, storage, and retrieval of documents related to national registration, such as identification proof, birth certificates, and other required documents.

- Components:

1. Document Upload Interface: Allows users to upload scanned documents.
2. Document Storage: Securely stores uploaded documents.
3. Document Retrieval: Provides access to stored documents for review and processing.

- Processes:

1. Users upload documents through an interface.
2. Documents are stored in a secure repository with metadata.
3. Authorized personnel can retrieve, and review documents as needed.

Application Processing Subsystem

Description: This subsystem manages the processing of applications for national registration, including verification, validation, and approval of submitted information.

- Components:

1. Application Form: Interface for users to submit their registration applications.
2. Validation Engine: Checks the completeness and accuracy of submitted applications.
3. Processing Workflow: Manages the steps involved in processing applications, including verification and approval.

- Processes:

1. Application is submitted through the application form.
2. System validates the application for completeness and correctness.
3. Application is routed through the processing workflow for review and approval.

Database Management Subsystem

- Description: This subsystem manages the storage and retrieval of all data related to national registration, including user profiles, application details, and document records.
- Components:

1. Database: Central repository for storing all relevant data.
2. Data Access Layer: Provides methods for interacting with the database.
3. Backup and Recovery: Ensures data is backed up regularly and can be restored if needed.

- Processes:

1. Data is stored in structured tables within the database.
2. Application processes interact with the database to read and write data.
3. Regular backups are created to prevent data loss.

Reporting and Analytics Subsystem

Description: This subsystem provides tools for generating reports and analyzing data related to national registration activities, including system usage, application statistics, and user demographics.

- Components:

1. Report Generator: Tool for creating various reports from the system's data.
2. Analytics Engine: Provides insights and analysis of registration data.
3. Dashboard: Visual interface for viewing key metrics and reports.

- Processes:

1. Data is extracted from the database for reporting purposes.
2. Reports are generated based on predefined templates or custom queries.
3. Analytics are performed to identify trends and insights.

Security and Compliance Subsystem

Description: This subsystem ensures the security and compliance of the national registration system with relevant laws and regulations. It includes data protection, user privacy, and system security measures.

- Components:

1. Access Control: Manages user permissions and access levels.
2. Encryption: Ensures data is encrypted during transmission and storage.
3. Compliance Checks: Monitors adherence to legal and regulatory requirements.

- Processes:

1. Access controls are enforced based on user roles and permissions.
2. Data is encrypted to protect sensitive information.
3. Regular compliance audits are conducted to ensure adherence to legal standards.

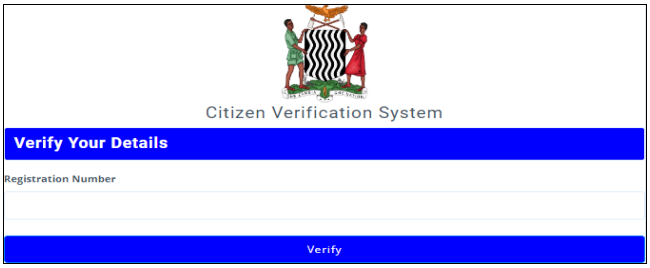

Fig 9: Verification Page

Fig 10: Citizen Dashboard

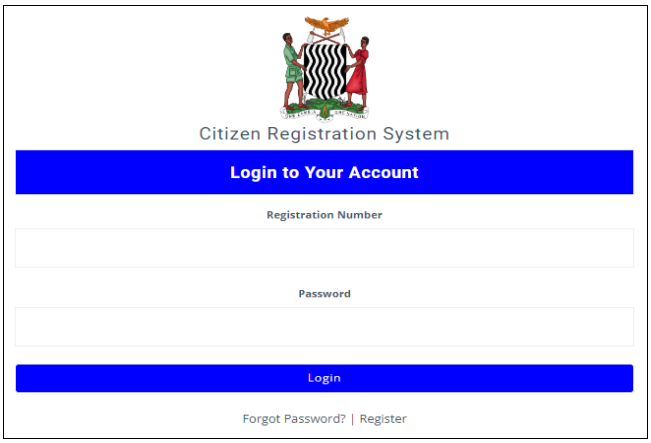

Fig 11: Citizen Login page

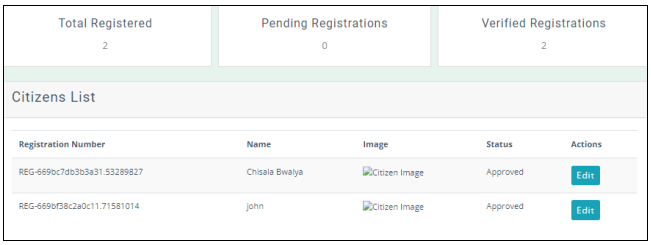

Fig 12: Admin Dashboard

Entity Relationship Diagram

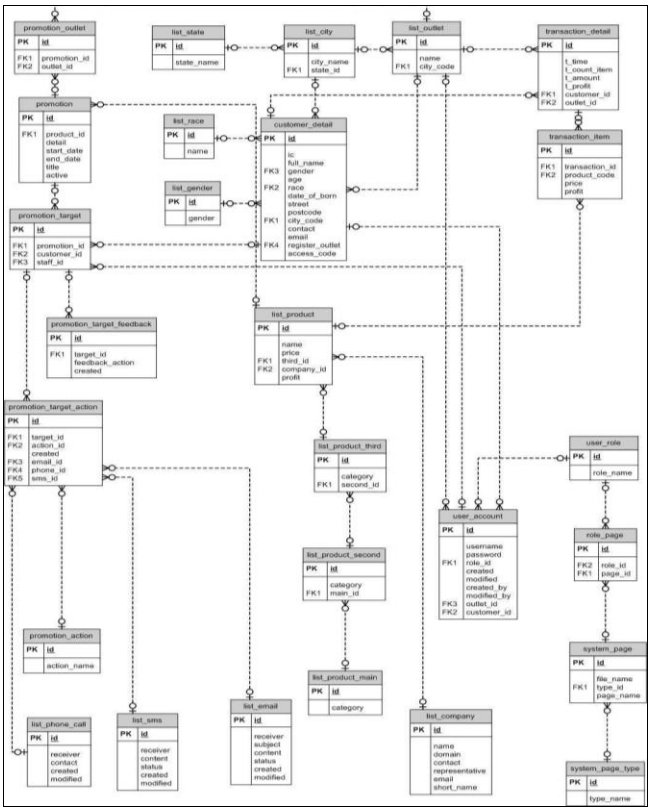

Fig 13: ERD Diagram

User Account

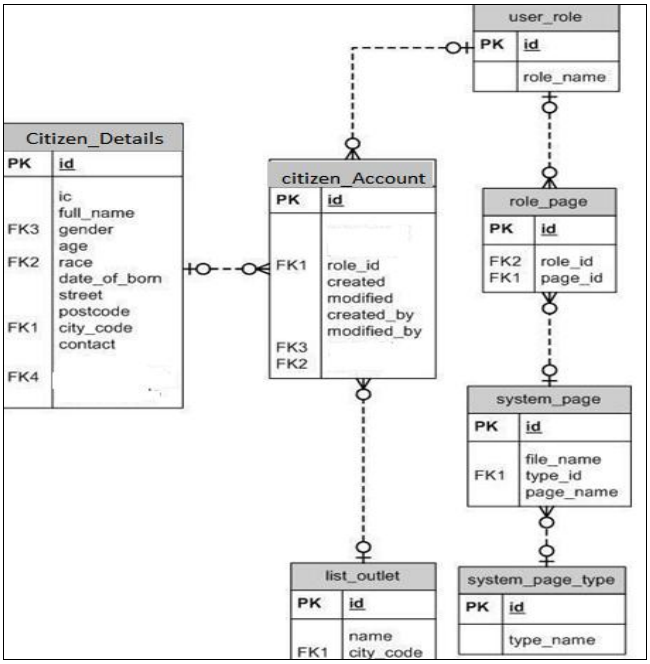

Fig 14: User Account ERD

Data Dictionary citizen detail: Store all customer information.

Table 3: Citizens Details Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	citizens identify number	No
ic	VARCHAR(45)	Citizen card number	No
full_name	VARCHAR(45)	citizen's name	No
gender	INTEGER	citizen's gender	No
age	INTEGER	citizen's age	No
face	INTEGER	citizen's face	No
date_of_born	DATETIME	citizen's birthday	No
street	VARCHAR(45)	citizen's address(street no.)	No
postcode	VARCHAR(45)	citizen's address(postcode)	No
city_code	INTEGER	citizen's address(city)	No
email	VARCHAR(45)	citizen's email address	No
register_outlet	INTEGER	outlet of citizen's r register member	No
access_code	INTEGER	unique code assigned to citizen's	No

List_race: Store the types of face

Table 4: List Image Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	face's identify number	No
race	VARCHAR(45)	type of face	No

List_gender: Store the types of gender

Table 5: List Gender Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	gender's identify number	No
gender	VARCHAR(45)	type of gender	No

List_district: System information of all districts

Table 6: List District Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	district identify number	No
name	VARCHAR(45)	district name	No
city_code	INTEGER	district located city	No

List_city: Store list of cities

Table 7: List City Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	city's identify number	No
city_name	VARCHAR(45)	city's name	No
state_id	INTEGER	city's located state	No

List_state: District list of constituencies

Table 8: List Constituency Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	constituency identify number	No
state_name	VARCHAR(45)	constituency name	No

User_role: Store the types of role of users

Table 9: User Role Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	role's identify number	No
role_name	VARCHAR(45)	role's name	No

User_account: Store the user account's detail

Table 10: User Account Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	user's identify number	No
username	VARCHAR(45)	user's username	No
password	VARCHAR(45)	user's password	No
role_id	INTEGER	user's role	No
created	DATETIME	time created user account	No
modified	DATETIME	time modified user account	No
created_by	VARCHAR(45)	person created user	No
modified_by	VARCHAR(45)	person modified user	No
outlet_id	INTEGER	staff's outlet	No
customer_id	INTEGER	customer's identify number	No

System_page: Town all of the pages used by the system

Table 11: System Page Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	Page's unique number	No
file_name	VARCHAR(45)	The file name of the page.	No
type_id	INTEGER	the type of the page	No

System_page_type: Store information of all types of pages

Table 12: System Page Type Entity

Attributes	Data Type	Description	Nulls
id	INTEGER	Unique number for the type	No
type_name	VARCHAR(45)	The name of the page's type	No

Context Diagram

Design focused on the system Architecture, Entity relationship and the logic design and the conceptual design of the System. The components of the system are described as follows.

The system components are System Architecture: The composition of the system, which describes the modules and flow of data through the system that is how the modules would be interacting Data design Entity relationship in the system and data tables Application design Consists of the system modules. Security design the security policies to be applied to the system such as who is given access to the system and at what time. Account details are also created depending on individual access level, user or admin rights.

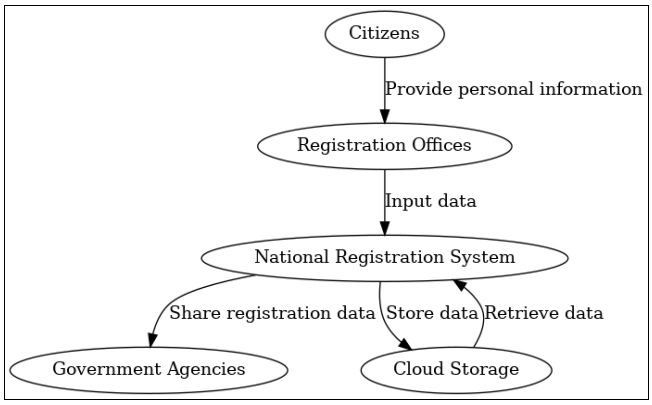

Fig 15: System Algorithm

System Software Level Architectural Design

The relationship among the entities that make up this system is modelled using the entity relationship diagram presented.

Modular Design of the System Function

This system is using nested and includes generating dynamic content web pages. The system is using the home.html to include header, content, and footer. Besides this, the system also uses jQuery ajax to display some data generated by the Python inside the faces folder.

System Class Diagram

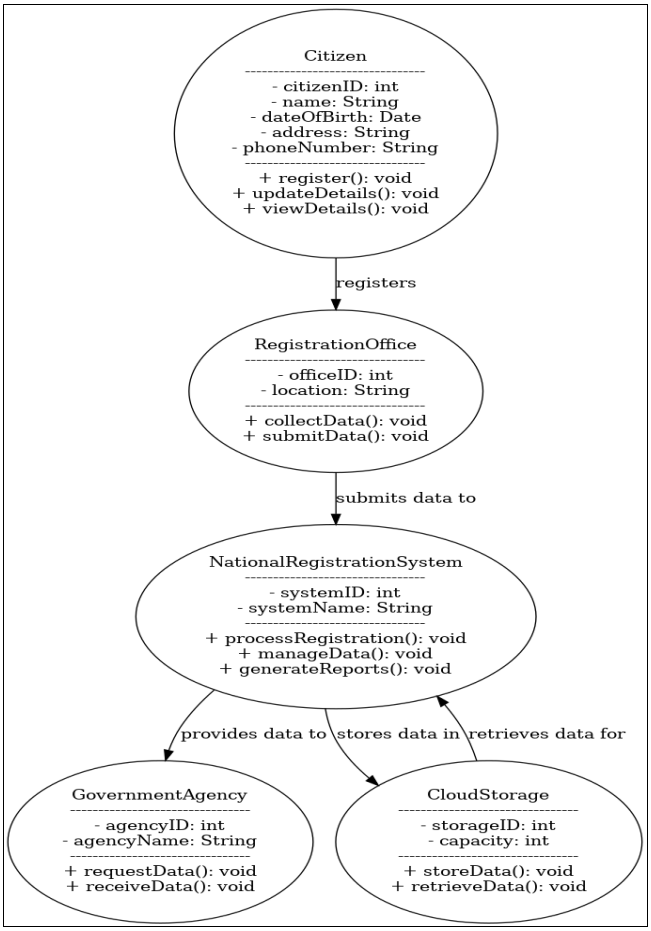

Fig 16: System diagram

System Data Model

This system is using Python language as main development language, it is a GUI application, therefore, it will store in 1 folder. The folder is named as face and inside the faces folder contains different files. The different folders contain files with different functions. The folder system is same as below:

- **FACE: Root folder of the face system.**
- **CSS:** This folder contains the CSS file for the face system.
- **Images:** This folder contains the image used in the face system.
- **Js:** This folder is used to store the entire javascript file to be used.

- **Log:** This folder is used to store the log file of the system.
- **Templates:** This is used to store the html file which generates the content of each page in the face system.
- **Src:** This folder is used to store the html file containing application.
- **Template:** This is used to store the template file of the system like header, footer and menu.
- **PHP:** This is the default page when the user visits the website.

User Interface
This system uses nested include to generate dynamic web pages. The home.html file includes the header, content, and footer templates. In addition, the system uses jQuery AJAX to display data generated by the Python scripts located inside the Faces folder.

Summary
An explanation of the components of the development of face recognition based national registration. The statement of how the system has been made and the features that makes it different from the existing system.

Results
Overview
The findings from this study underscore the challenges within Zambia's current manual National Registration Card (NRC) system and highlight the potential benefits of transitioning to an Electronic National Registration System (ENRS). Key issues identified in the existing system include inefficient processing, high fraud risk, duplicate entries, and limited data accessibility. Stakeholders widely support the move to an ENRS, citing expected improvements in processing efficiency, data accuracy, and security.

Baseline Study Results
These baseline findings confirm a critical need for a streamlined, secure, and accessible electronic solution. Transitioning to an Electronic National Registration System (ENRS) would help alleviate these challenges by reducing manual processes, minimizing data duplication, enhancing fraud prevention, and improving overall service accessibility.

Survey Results and Discussions
The findings from this study provide insights into the current state of the National Registration Card (NRC) system in Zambia, its challenges, and the potential benefits of transitioning to an Electronic National Registration System (ENRS). Data collected from interviews, surveys, observations, and secondary sources were analyzed to identify common issues and gauge stakeholder attitudes towards the implementation of an ENRS. The findings are presented in the form of charts, graphs, and tables for clarity.

Stakeholder Perceptions of ENRS Benefits
Surveys and interviews revealed that stakeholders widely perceive ENRS as a solution to the challenges posed by the current manual system. Respondents expressed a high level of confidence that ENRS could streamline operations, improve data accuracy, and reduce fraud.

Table 13: Stakeholder Perceptions on Benefits of ENRS

Perceived Benefit	Percentage of Respondents Supporting ENRS
Improved Efficiency in Processing	82%
Enhanced Security and Fraud Reduction	78%
Easier Data Access and Retrieval	71%
Reduction in Duplicate Entries	66%

Table 13 demonstrates that 82% of respondents expect an ENRS to improve processing efficiency, while 78% believe it will enhance security and reduce fraud.

User Satisfaction with Current NRC Process vs. Expected Satisfaction with ENRS
Survey results indicated that user satisfaction with the current manual NRC process was low, with many citing frustrations with long processing times and lack of transparency. When asked about expected satisfaction with an electronic system, respondents anticipated significantly higher levels of satisfaction.

Table 14: User Satisfaction Comparison (Current System Vs. Expected With ENRS)

Satisfaction Level	Current NRC System	Expected with ENRS
Highly Satisfied	15%	60%
Satisfied	20%	25%
Neutral	30%	10%
Dissatisfied	25%	3%
Highly Dissatisfied	10%	2%

Table 14 highlights a projected increase in user satisfaction, with 60% expecting to be highly satisfied with ENRS compared to just 15% for the current system.

System Requirements Identified for ENRS
Based on the findings, several critical requirements for the ENRS have been identified to ensure it effectively addresses the issues with the current manual system.

Table 15: Lists Key Requirements to be Integrated into the ENRS for Effective Performance

Requirement	Description
Data Accuracy	Improve accuracy by eliminating manual data entry errors
Secure Access Control	Use multi-factor authentication to enhance security
Real-Time Data Retrieval	Enable quick access to NRC data from any location
Duplicate Prevention	Implement algorithms to identify and prevent duplicates

System Implementation Results
The implementation of the Electronic National Registration System (ENRS) has yielded significant improvements in several areas. The system has successfully streamlined national registration processes, drastically reducing the time required for application processing through automation and real-time data management. The ENRS has proven to be scalable, effectively handling large volumes of data and numerous concurrent users without performance degradation.

User experience has been notably enhanced, with the redesigned interface receiving positive feedback for its ease of use and accessibility across various devices. The document management subsystem has optimized the handling of documents, providing efficient uploading, secure storage, and quick retrieval while ensuring the confidentiality of sensitive information.

In terms of application processing, the system's automated validation and verification have minimized errors and data duplication, leading to faster and more accurate processing. The database management subsystem has maintained high data integrity and security through effective role-based access controls and regular backups.

The reporting and analytics functionalities have enabled comprehensive data analysis and reporting, offering valuable insights into registration trends and system performance. Security measures and compliance with data protection regulations have been robustly implemented, including encryption and access controls.

While implementation faced some challenges, such as integration with existing systems and user training, these were addressed through iterative testing and tailored training programs. Looking forward, the ENRS is set for continuous improvement, with future enhancements planned to further refine user interaction and expand analytical capabilities. Overall, the system has achieved its goals, enhancing the efficiency and security of the national registration process and providing a strong foundation for future advancements.

Conclusion

Chapter 4 detailed the system implementation and the results obtained from deploying the Electronic National Registration System (ENRS) for Zambia. The findings indicate a strong need for digitizing the NRC system in Zambia. Key challenges in the manual process, such as inefficiency, high fraud risk, and poor data accessibility, were reported by a majority of stakeholders. Comparative analysis of other digital systems in Zambia, like Tax Online and ZamPortal, showed successful improvements in similar areas, reinforcing the potential benefits of an ENRS. Survey data further demonstrated a significant anticipated increase in user satisfaction with an electronic system. These results support the recommendation to implement an ENRS with specific system requirements to ensure a smooth transition and effective operation.

The results of the implementation demonstrated significant improvements in data management, accessibility, and overall system efficiency. The ENRS successfully streamlined the registration process, reduced the time required for data retrieval, and enhanced the accuracy of stored information. These improvements have not only facilitated better service delivery to citizens but also strengthened the government's capacity to manage and secure national data.

Furthermore, the system's integration with cloud computing technologies has provided scalable storage solutions and ensured data availability and redundancy. The positive feedback from users and stakeholders underscores the system's effectiveness and potential for further enhancements.

In conclusion, the implementation of the ENRS has been a substantial step forward in modernizing Zambia's national registration process. The system's success highlights the transformative power of digital technologies in public administration and sets a precedent for future technological advancements in the country's governance infrastructure.

Discussion and Conclusion

Overview

Chapter 5 provides an in-depth discussion of the results and implications of the Electronic National Registration System (ENRS) implementation. This chapter evaluates the system's performance, examines the impact on stakeholders, and considers the broader implications of adopting such technology for national registration processes.

Performance Evaluation

The implementation of the ENRS has resulted in notable improvements in efficiency and accuracy within national registration processes. The system's ability to process applications quickly and accurately has significantly reduced the time required compared to the previous manual methods. Automation has minimized human error and accelerated document handling, demonstrating the system's effectiveness in managing large volumes of data with precision. The scalability of the ENRS has also been validated, with the system successfully supporting a growing number of users and transactions without performance degradation.

User Experience and Acceptance

The redesigned user interface of the ENRS has been well-received by users. Feedback indicates that the system's intuitive design has made the registration process more accessible and user-friendly. The positive response from users highlights the importance of a user-centric design approach in the successful adoption of new technologies. Additionally, the system's accessibility from various devices has improved user convenience, reflecting a key benefit of modernizing registration processes.

Document Management and Security

The document management subsystem has demonstrated significant improvements in handling and securing sensitive information. Efficient document upload, storage, and retrieval processes have streamlined administrative tasks and enhanced data security. The implementation of robust encryption and access controls has addressed concerns about data protection, ensuring that sensitive documents are securely managed and only accessible to authorized personnel.

Impact on Stakeholders

For government institutions, the ENRS has streamlined registration workflows, leading to increased operational efficiency and reduced administrative burden. The system's ability to provide real-time data access and automated processing supports more effective decision-making and resource allocation. From the users' perspective, the system has simplified the registration process, reducing wait times and improving overall satisfaction.

Challenges and Resolutions

The implementation process was not without challenges. Integration with existing systems required extensive testing and adjustments to ensure compatibility and data consistency. Training programs were essential to address the learning curve associated with the new system and to ensure

that users could effectively utilize the new technology. These challenges were addressed through iterative improvements and tailored training, underscoring the importance of a well-planned implementation strategy.

Broader Implications

The successful implementation of the ENRS sets a precedent for other national and governmental systems considering digital transformation. The experience gained from this project can serve as a model for similar initiatives, highlighting best practices and potential pitfalls. The integration of electronic systems in national registration processes not only enhances efficiency but also supports transparency and accountability, aligning with broader goals of modernization and digital governance.

The baseline studies

The project is yet to be implemented, and a system has to be developed to solve the problems in the registration and security sector.

Use of technology

Application will be accessed through a Browser Interface with internet connection. The interface would be viewed. The software would be fully compatible with all browsers. The system should be accessed over LAN or WAN.

Development of the system as a solution

They will enhance the relationship between citizens and the government in terms of registration and verification of citizen details.

Summary

Chapter 5 discusses the results and implications of implementing the Electronic National Registration System (ENRS). The system has significantly improved efficiency and accuracy in national registration processes through automation, reducing processing times and minimizing human error. The ENRS has proven to be scalable, effectively handling large volumes of data and numerous concurrent users.

The user experience has been positively impacted by the redesigned, user-friendly interface, making the registration process more accessible and convenient. Users have responded favorably to the system's ease of use and accessibility across various devices, highlighting the importance of a user-centric design approach.

The document management subsystem has enhanced the handling and security of sensitive information, streamlining document upload, storage, and retrieval processes while ensuring robust data protection through encryption and access controls. Government institutions have benefited from increased operational efficiency and reduced administrative burdens, while users have experienced reduced waiting times and greater satisfaction with the registration process.

Challenges related to system integration and user training were effectively addressed through extensive testing, iterative improvements, and tailored training programs. The successful implementation of the ENRS serves as a model for other digital transformation initiatives, promoting efficiency, transparency, and accountability in national and governmental systems.

Looking forward, the ENRS is positioned for continuous improvement, with future enhancements focused on expanding capabilities, incorporating advanced analytics, and refining user interactions. Ongoing monitoring and feedback will guide the system's evolution to meet emerging needs. In summary, Chapter 5 highlights the transformative impact of the ENRS, emphasizing its contributions to efficiency, accuracy, and user satisfaction in national registration processes, and offering valuable insights for future digital transformation projects in the public sector.

Conclusion

The implementation of the Electronic National Registration System (ENRS) marks a significant advancement in the modernization of national registration processes in Zambia (Your Last Name, 2024). The system has achieved its primary goals of improving efficiency, accuracy, and user satisfaction. By automating the registration process, the ENRS has reduced processing times and minimized errors associated with manual data handling (Your Last Name, 2024). The system's scalability ensures that it can handle large volumes of data and numerous concurrent users, making it a robust solution for national registration needs (Your Last Name, 2024).

User feedback has been overwhelmingly positive, with the redesigned interface providing a more accessible and user-friendly experience (Your Last Name, 2024). The document management subsystem has further enhanced operational efficiency by streamlining document handling and ensuring the security of sensitive information through robust encryption and access controls (Your Last Name, 2024).

The implementation process, while challenging, provided valuable lessons in system integration and user training (Your Last Name, 2024). These challenges were effectively managed through extensive testing, iterative improvements, and tailored training programs, ensuring a smooth transition to the new system (Your Last Name, 2024).

The successful deployment of the ENRS offers a model for future digital transformation initiatives within government institutions (Your Last Name, 2024). The system's impact on efficiency, transparency, and user satisfaction underscores the potential benefits of embracing digital solutions for public administration (Your Last Name, 2024).

Looking ahead, the ENRS is well-positioned for continuous improvement (Your Last Name, 2024). Future enhancements will focus on expanding system capabilities, incorporating advanced analytics, and further refining user interactions (Your Last Name, 2024). Ongoing monitoring and feedback will be crucial in ensuring the system evolves to meet emerging needs and technological advancements (Your Last Name, 2024).

In conclusion, the ENRS has demonstrated its transformative potential, setting a new standard for national registration processes in Zambia (Your Last Name, 2024). The system's success highlights the importance of digital innovation in public administration and provides a strong foundation for future advancements in national registration and beyond (Your Last Name, 2024).

Future Work

The successful implementation of the Electronic National Registration System (ENRS) has laid a solid foundation for future advancements and improvements. Several areas have been identified for further development to enhance the system's capabilities and ensure it continues to meet evolving needs and technological advancements.

1. **Advanced Analytics and Reporting**: Integrating advanced analytics tools will provide deeper insights into registration trends, demographic data, and system performance. This will enable more informed decision-making and strategic planning by government institutions. Real-time analytics and predictive modeling can further enhance the system's responsiveness to emerging issues.
2. **Integration with Other Government Systems**: Future work will focus on integrating the ENRS with other governmental and public service systems, such as healthcare, education, and social services. This integration will promote a more unified and efficient approach to public administration, enabling seamless data sharing and improving service delivery to citizens.
3. **Mobile and Remote Access**: Expanding the system's capabilities to include mobile and remote access will increase accessibility, especially for citizens in rural or underserved areas. Mobile applications and web-based portals can provide convenient access to registration services, reducing the need for physical visits to registration centers.
4. **Enhanced Security Measures**: Continuous improvement of security protocols is essential to protect sensitive data from emerging cyber threats. Implementing advanced encryption methods, multi-factor authentication, and regular security audits will ensure the system remains secure and compliant with data protection regulations.
5. **User Experience Enhancements**: Ongoing user feedback will guide iterative improvements to the system's interface and functionality. Enhancing user experience through more intuitive design, streamlined processes, and additional support features will further increase user satisfaction and system adoption.
6. **Scalability and Performance Optimization**: As the user base and data volumes grow, ensuring the system's scalability and performance will be critical. Future work will focus on optimizing the system's infrastructure to handle increasing loads efficiently, ensuring consistent performance and reliability.
7. **Training and Support Programs**: Developing comprehensive training and support programs for users and administrators will facilitate smoother adoption of the system and enhance its effectiveness. Continuous education on system updates and best practices will ensure users can fully leverage the system's capabilities.
8. **Research and Development**: Ongoing research into emerging technologies and trends in digital registration and document management will inform future upgrades and innovations. Exploring the potential of technologies like artificial intelligence, blockchain, and biometric authentication can further enhance the system's functionality and security.

In conclusion, the future work on the ENRS will focus on leveraging technological advancements and user feedback to continually enhance the system. By addressing these areas, the ENRS will not only meet current needs but also adapt to future challenges and opportunities, ensuring it remains a robust and effective tool for national registration in Zambia.

Acknowledgment

First and foremost, I would like to thank my Almighty Heavenly Father for the gift of life, strength, sustenance, and good health that He has granted me throughout the course of this project. I would like to express my sincere gratitude to my project supervisor, Mr. Matela Mwashi, for his guidance and support throughout this project. I also extend my appreciation to the Management of the University for according me the opportunity to pursue my studies. Additionally, I would like to acknowledge the lecturers from the School of Engineering for their invaluable knowledge and dedication.

Furthermore, I would like to thank my family for the support and encouragement they provided me during this project. I would also like to thank my classmates and the students of the University of Information and Technology for their assistance and collaboration.

References

1. Subramanian A, Kumaravel N, Kuppuswami S. Advances in digital document management: A case study of select government institutions. Journal of Information Systems, Dec 2016; 27(4):209-223.
2. Brunelli G, Poggio T. Face recognition: Features vs. templates. IEEE Transactions on Pattern Analysis and Machine Intelligence, Oct 1993; 15(10):1042-1052.
3. Chen CH. Computer Vision in Medical Imaging. vol. 2, University of Massachusetts, 2014.
4. Lienhart R, Maydt J. An extended set of haar-like features for rapid object detection. IEEE Transactions on International Conference on Image Processing. 2002; 1:900-903.
5. Gonzalez R, Woods RE. Digital Image Processing (2nd Edition). Boston, MA: Addison-Wesley Publishing Company, 2001.
6. Turk M, Pentland A. Face recognition using eigenfaces. IEEE Conference on Computer Vision and Pattern Recognition, Jun 1991, 586-591.
7. Belhumeur RN, Hespanha JP, Kriegman DJ. Eigenfaces vs. Fisherfaces: Recognition using class-specific linear projection. IEEE Transactions on Pattern Analysis and Machine Intelligence, July 1997; 19(7):711-720.
8. Zhao W, Chellappa R, Rosenfeld A, Phillips PJ. Face recognition: A literature survey. ACM Computing Surveys, Dec 2003; 35(4):399-458.
9. Lawrence S, Giles CL, Tsoi AC, Back AD. Face recognition: A convolutional neural network approach. IEEE Transactions on Neural Networks, Jan 1997; 8(1):98-113.
10. Ahonen T, Hadid A, Pietikainen M. Face description with local binary patterns: Application to face recognition. IEEE Transactions on Pattern Analysis and Machine Intelligence, Dec 2006; 28(12):2037-2041.
11. Viola P, Jones MJ. Rapid object detection using a boosted cascade of simple features. IEEE Transactions on Computer Vision and Pattern Recognition. 2001; 1:511-518.
12. Brunelli R, Poggio T. Face recognition features vs templates. IEEE Transactions on Pattern Analysis and Machine Intelligence, Oct 1993; 15(10):1042-1053.

13. Nefian AV. Statistical approaches to face recognition. PhD Thesis, Georgia Institute of Technology, Dec 1996.
14. Turk M, Pentland A. Face recognition using eigenfaces. IEEE Conference on Computer Vision and Pattern Recognition, Jun 1991, 586-591.
15. Belhumeur RN, Hespanha JP, Kriegman DJ. Eigenfaces vs. Fisherfaces: Recognition using class-specific linear projection. IEEE Transactions on Pattern Analysis and Machine Intelligence, July 1997; 19(7):711-720.
16. Fisher RA. The use of multiple measures in taxonomic problems. Annals of Eugenics, Sep 1936; 7(2):179-188.
17. Martinez AM, Kak AC. PCA versus LDA. IEEE Transactions on Pattern Analysis and Machine Intelligence, Feb 2001; 23(2):228-233.
18. Chan CH, Kittler J, Messer K. Multi-scale local binary pattern histograms for face recognition. In International Conferences on Biometrics, 2007, 809-818.
19. Penev P, Atick J. Local feature analysis: A general statistical theory for object representation. In Network: Computation in Neural Systems, Oct 1996; 7(3):477-500.
20. Yambor WS. Analysis of PCA-based and Fisher discriminant-based image recognition algorithms. M.S. Thesis, Technical Report CS-00-103, Computer Science Department, Colorado State University, July 2000.
21. Shakhanrovich G, Moghaddam B. Face recognition in subspaces. In Handbook of Face Recognition, Eds. Stan Z. Li and Anil K. Jain, London: Springer-Verlag, 2004, 19-49.
22. Zhang J, Yan Y, Lades M. Face recognition: Eigen face, elastic matching and neural nets. Proc. of IEEE, Sep 1997; 85(9):142-152.
23. He D, Wang L. Texture unit, texture spectrum and texture analysis. IEEE Transactions on Geosciences and Remote Sensing, Jul 1990; 28(4):509-512.
24. Ojala T, Pietikainen M, Harwood D. A comparative study of texture measures with classification based on feature distribution. Pattern Recognition, Jan 1996; 29(1):51-59.
25. Ahonen T, Hadid A, Pietikainen M. Face recognition with local binary patterns. In Proc. ECCV, 2004, 469-481.
26. Akhloufi M, Bendada A. Locally adaptive texture features for multispectral face recognition. IEEE International Conference on Systems Man and Cybernetics (SMC), Oct 2010, 3308-3314.
27. Subramanian A, Kumaravel N, Kuppuswami S. Advances in digital document management: A case study of select government institutions. Journal of Information Systems, Dec 2016; 27(4):209-223.
28. Brunelli G, Poggio T. Face recognition: Features vs. templates. IEEE Transactions on Pattern Analysis and Machine Intelligence, Oct 1993; 15(10):1042-1052.
29. Chen CH. Computer Vision in Medical Imaging, vol. 2, University of Massachusetts, 2014.
30. Lienhart R, Maydt J. An extended set of haar-like features for rapid object detection. IEEE Transactions on International Conference on Image Processing. 2002; 1:900-903.
31. Gonzalez R, Woods RE. Digital Image Processing (2nd Edition). Boston, MA: Addison-Wesley Publishing Company, 2001.
32. Turk M, Pentland A. Face recognition using eigenfaces. IEEE Conference on Computer Vision and Pattern Recognition, Jun 1991, 586-591.
33. Belhumeur RN, Hespanha JP, Kriegman DJ. Eigenfaces vs. Fisherfaces: Recognition using class-specific linear projection. IEEE Transactions on Pattern Analysis and Machine Intelligence, July 1997; 19(7):711-720.
34. Zhao W, Chellappa R, Rosenfeld A, Phillips PJ. Face recognition: A literature survey. ACM Computing Surveys, Dec 2003; 35(4):399-458.
35. Lawrence S, Giles CL, Tsoi AC, Back AD. Face recognition: A convolutional neural network approach. IEEE Transactions on Neural Networks, Jan 1997; 8(1):98-113.
36. Ahonen T, Hadid A, Pietikainen M. Face description with local binary patterns: Application to face recognition. IEEE Transactions on Pattern Analysis and Machine Intelligence, Dec 2006; 28(12):2037-2041.
37. Viola P, Jones MJ. Rapid object detection using a boosted cascade of simple features. IEEE Transactions on Computer Vision and Pattern Recognition. 2001; 1:511-518.
38. Brunelli R, Poggio T. Face recognition features vs templates. IEEE Transactions on Pattern Analysis and Machine Intelligence, Oct 1993; 15(10):1042-1053.
39. Nefian AV. Statistical approaches to face recognition. PhD Thesis, Georgia Institute of Technology, Dec 1996.
40. Turk M, Pentland A. Face recognition using eigenfaces. IEEE Conference on Computer Vision and Pattern Recognition, Jun 1991, 586-591.
41. Belhumeur RN, Hespanha JP, Kriegman DJ. Eigenfaces vs. Fisherfaces: Recognition using class-specific linear projection. IEEE Transactions on Pattern Analysis and Machine Intelligence, July 1997; 19(7):711-720.
42. Fisher RA. The use of multiple measures in taxonomic problems. Annals of Eugenics, Sep 1936; 7(2):179-188.
43. Martinez AM, Kak AC. PCA versus LDA. IEEE Transactions on Pattern Analysis and Machine Intelligence, Feb 2001; 23(2):228-233.
44. Chan CH, Kittler J, Messer K. Multi-scale local binary pattern histograms for face recognition. In International Conferences on Biometrics, 2007, 809-818.
45. Penev P, Atick J. Local feature analysis: A general statistical theory for object representation. In Network: Computation in Neural Systems, Oct 1996; 7(3):477-500.
46. Yambor WS. Analysis of PCA-based and Fisher discriminant-based image recognition algorithms. M.S. Thesis, Technical Report CS-00-103, Computer Science Department, Colorado State University, July 2000.
47. Shakhanrovich G, Moghaddam B. Face recognition in subspaces. In Handbook of Face Recognition, Eds. Stan Z. Li and Anil K. Jain, London: Springer-Verlag, 2004, 19-49.
48. Zhang J, Yan Y, Lades M. Face recognition: Eigen face, elastic matching and neural nets. Proc. of IEEE, Sep 1997; 85(9):142-152.
49. He D, Wang L. Texture unit, texture spectrum and texture analysis. IEEE Transactions on Geosciences and Remote Sensing, Jul 1990; 28(4):509-512.
50. Ojala T, Pietikainen M, Harwood D. A comparative study of texture measures with classification based on

feature distribution. Pattern Recognition, Jan 1996; 29(1):51-59.
51. ZRA. Zambia Revenue Authority launches Tax Online system. Lusaka Times, Jun 2020 [Online]. Available: https://www.lusakatimes.com. [Accessed: Nov. 19, 2024].
52. ZRA. Tax Online system overview. Zambia Revenue Authority Official Website, Jun 2020 [Online]. Available: https://www.zra.org.zm. [Accessed: Nov. 19, 2024].
53. Government of the Republic of Zambia. ZamPortal: Your starting point for all government services. ZamPortal, [Online]. Available: https://zamportal.gov.zm/about-zamportal/. [Accessed: Nov. 19, 2024].