Design and Development of a Secure Cloud-Based Land Verification System: A Case Study of Lusaka Province

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ABSTRACT

Lusaka Province is facing significant challenges in land administration due to outdated paper-based systems, which lead to inefficiencies, corruption, and disputes. Traditional land management methods lack transparency, accessibility, and the capacity to handle urbanization and informal settlements.

Cloud computing offers a viable solution by providing a scalable and secure platform for land verification. A cloud-based system can improve data accuracy, streamline workflows, and enhance transparency while mitigating fraud risks. However, successful implementation requires consideration of legal, institutional, and socio-economic factors.

This research proposes the design and development of a **secure cloud-based land verification system** for Lusaka Province, ensuring data security through encryption, authentication, and access controls. Through a case study approach, the study aims to provide recommendations for improving land governance and supporting sustainable development using technology.

governance, promoting investment, and fostering sustainable development in the region through technological innovation.

Lack of Transparency: Limited accessibility to land ownership information and opaque verification processes contribute to mistrust among stakeholders, fostering an environment conducive to fraud and corruption.

Limited Accessibility: The reliance on physical records stored in decentralized locations restricts access to land ownership information, particularly for marginalized communities and stakeholders outside urban centers.

Vulnerability to Fraud and Corruption: Paper-based systems are susceptible to tampering, forgery, and unauthorized alterations, undermining the integrity of land records and perpetuating disputes and conflicts.

Inadequate Security Measures: The absence of robust security mechanisms leaves land ownership data vulnerable to unauthorized access, manipulation, and loss, posing risks to the rights and interests of landowners and investors.

Addressing these challenges requires the adoption of modern, technology-driven solutions that streamline land administration processes,

I. PROBLEM STATEMENT

One Lusaka Province, the capital region of Zambia, faces significant challenges in land administration and verification, which hinder socio-economic development and perpetuate land-related disputes and conflicts. The existing paper-based land verification systems are inefficient, prone to errors, vulnerable to fraud, and lack transparency, leading to a multitude of issues such as disputed land ownership, informal settlements, and inhibited investment opportunities. These challenges are exacerbated by rapid urbanization, population growth, and the dynamic nature of land transactions in the region.

Key issues with the current land verification systems include:

Inefficiency and Inaccuracy: Manual record-keeping processes result in delays, data duplication, and inaccuracies, leading to prolonged verification procedures and increased likelihood of errors.

enhance transparency, and improve the security of land ownership data. Cloud computing offers a promising platform for transforming land verification systems by providing scalable, accessible, and secure infrastructure for storing, managing, and sharing land records.

However, the design and implementation of a cloud-based land verification system for Lusaka Province must overcome several key challenges, including:

Legal and Regulatory Frameworks: Aligning the system with existing land tenure laws, regulations, and institutional mandates while ensuring compliance with data protection and privacy requirements.

Technological Infrastructure: Integrating the cloud-based system with existing land administration infrastructure, including legacy systems and databases, to ensure interoperability and data consistency.

User Accessibility and Adoption: Designing user-friendly interfaces and providing training and capacity-building initiatives to facilitate the adoption of the new system by stakeholders, including government agencies, landowners, investors, and the general public.

Security and Privacy Concerns: Implementing robust security measures, such as encryption, access controls, and audit trails, to safeguard the confidentiality, integrity, and availability of land ownership data stored in the cloud.

Socio-economic Considerations: Addressing socio-economic disparities and ensuring equitable access to land ownership information and verification services, particularly for marginalized communities and vulnerable groups.

Therefore, the overarching problem addressed by this thesis is the design and development of a secure, scalable, and user-friendly cloud-based land verification system tailored to the specific needs and challenges of Lusaka Province, with the aim of enhancing land governance, promoting investment, and fostering sustainable development in the region.

II. OBJECTIVE OF THE STUDY
I. General Objective
The general objective is to design and develop a web-based Design and Development of a Secure Cloud-Based Land Verification System.
II. Specific Objectives
✓ Implement Security Measures: Deploy robust security protocols to safeguard land ownership data stored in the cloud.
✓ Conduct Testing and Validation: Assess system functionality, performance, and usability through rigorous testing and validation processes.
✓ Ensure Integration: Seamlessly integrate the new system with existing land administration infrastructure and databases.
✓ Provide User Training: Deliver training programs to stakeholders to ensure effective utilization of the system.
✓ Evaluate Socio-Economic Impact: Measure the system's impact on land governance, investment, and socio-economic development.

III. PROJECT RATIONALE
The design and development of a secure cloud-based land verification system for Lusaka Province are justified by the pressing need to enhance efficiency, transparency, and integrity in land administration processes while mitigating the risks of fraud and corruption prevalent in traditional paper-based systems. By streamlining workflows, improving accessibility to land ownership information, and promoting informed decision-making, the system will support economic development, attract investment, and facilitate sustainable urbanization in the region. Moreover, the project aligns with national development priorities outlined in Zambia's strategic plans, underscoring its significance in contributing to inclusive growth, poverty reduction, and the realization of sustainable development objectives. Through the adoption of modern technologies and best practices in land governance, the project seeks to address longstanding challenges in land verification, foster trust in governance institutions, and pave the way for equitable and resilient urban development in Lusaka Province.

IV. LITERATURE REVIEW
The literature on land administration, particularly in the context of developing countries like Zambia, highlights the critical role of efficient and transparent land verification systems in promoting economic development, reducing poverty, and ensuring social equity (Deininger & Feder, 2017). Traditional paper-based land administration systems have been widely criticized for their inefficiency, susceptibility to fraud, and limited accessibility, necessitating the adoption of modern technological solutions to address these challenges (Sarmento et al., 2019). Cloud computing has emerged as a promising approach to transforming land administration processes by providing scalable, cost-effective, and secure

infrastructure for storing, managing, and sharing land records (Rajabifard et al., 2013). The adoption of cloud-based land verification systems offers several potential benefits, including enhanced data accessibility, improved transparency, and reduced administrative burdens (Stoter et al., 2018). However, the successful implementation of such systems requires careful consideration of various factors, including legal frameworks, technological capabilities, institutional capacities, and stakeholder dynamics (van Oosterom et al., 2017).

In the Zambian context, land administration has been identified as a key priority area for governance reform, given its implications for property rights, investment, and socio-economic development (Habitat for Humanity International, 2019). Despite recent efforts to modernize land administration systems in Zambia, challenges persist, including fragmented land tenure arrangements, overlapping land claims, and inadequate institutional capacities (Musyoki et al., 2020). The transition to digital land verification systems presents both opportunities and challenges for improving land governance in Zambia. On one hand, digital technologies offer the potential to streamline administrative processes, reduce corruption, and enhance transparency in land transactions (Jacobsen & Øyen, 2015). On the other hand, the adoption of new technologies must be accompanied by robust legal frameworks, institutional reforms, and capacity-building initiatives to ensure their effective implementation and sustainability (Augustinus et al., 2016).

Moreover, the socio-economic impact of land administration reforms, including the adoption of cloud-based land verification systems, remains a topic of interest and debate among researchers and policymakers. Several studies have highlighted the potential benefits of improved land governance for poverty reduction, gender equality, and sustainable urban development (Kaufmann et al., 2016). However, empirical evidence on the actual impact of land administration reforms in developing countries like Zambia is limited and mixed, underscoring the need for further research and evaluation (Ali et al., 2018). In particular, there is a need for studies that assess the effectiveness, efficiency, and equity implications of cloud-based land verification systems in different socio-economic contexts and geographical settings (Enemark et al., 2020).

In conclusion, the literature review underscores the importance of modernizing land administration systems through the adoption of cloud-based technologies, particularly in the context of developing countries like Zambia. While cloud-based land verification systems offer significant potential to improve efficiency, transparency, and accountability in land governance, their successful implementation requires careful consideration of legal, institutional, technological, and socio-economic factors. Moreover, there is a need for empirical research to assess the actual impact of these systems on land tenure security, investment, and socio-economic development in diverse contexts.

V. METHODOLOGY

i. Introduction

In this chapter we will be looking at the research methods that will be employed in the study in order to achieve the objectives of the study. This chapter will cover system analysis, system modeling and methodology used in the system. Prototyping approach to be used will be to deliver the first model. In prototyping model, a system that mimics the real system is given to the users and the real system is developed by basing on the prototype or by improving on it. Thus: the users to use the system in part and see whether they find it a good system. To give users time to learn how to use and interact with the system. Oral and written interviews or questioners will be used to collect requirements information from the locals since the other possible means like observation requires an existing system to learn from it.

ii. System Analysis

What is system analysis? System analysis can be defined as ""the process of studying a procedure or business in order to identify its goals and purposes and create systems and procedures that will achieve them in an efficient way". Another view sees system analysis as a problem-solving technique that breaks down a system into its component pieces for the purpose of the studying how well those component parts work and interact to accomplish their purpose. (Lonnie D. Bentley p.160 7th edition.)This also describes the plan that the investigator will undertake to develop the ways of solving problems and provide guidance in various steps of undertaking the research. This study uses descriptive research design because it is interested in describing the satiation as it exists during the time of study without making manipulations. It provides the researcher with an opportunity to gain deeper insights into the subject matter under study. Robson (2002) points out that descriptive study portrays an accurate profile of persons, events or situation. Chandran (2004) also states descriptive study describes the existing conditions and attitudes through observation and

interpretation techniques. In the present study, this design is the most preferable because it helps to deepen understanding of the current situation as it exists. It enables obtaining of both quantitative and qualitative data for the study because of utilization of questionnaires and the interview guides.

iii.Feasibility Study

A feasibility study is a detailed report that discusses the project's frames of analysis in depth. It also considers the strategy, operations, people and control as well as risk and constraints. The goal is to get a solution towards the completeness and revamp of a project.
There six type of feasibility which shall discussed in the context of this project they include; economic schedule, technical, political, contractual organizational feasibility. (Will Kenton, 2018).

Schedule feasibility

Typically, this means estimating how long the system will take to develop, and if it can be completed in a given time period using some methods like payback period. Therefore, the time allocated for undertaking the project is three

iv.Research Approach

The software development methodology which will be used to implement the cloud based land verification system is the waterfall software development methodology The waterfall model is the first published model of software development process that was derived from more general system engineering process. It is an example of a plan driven process in principle, the waterfall model requires that you plan and schedule all process activities before you start working on them. Requirements analysis and Definition: System services, constraints and goals are established by consulting system users. (Sommerville, 2011).

1. System and Software Design: Allocates requirements either to hardware or software, software design involves identifying and describing the fundamental software system abstractions and their relationships. (Sommerville, 2011).
2. Implementation and Unit Testing: Software design is realized as a set of programs or program units; unit testing involves verifying that each unit meets its specification. (Sommerville, 2011).
3. Integration and System testing: Individual program units or programs are integrated and

months, which is ample time to finish the project and ensure that it is working.

Technical feasibility

Basically, this assessment is based on an outline design of system requirements, to determine whether the company has the technical expertise to handle completion of the project. Therefore, this study will be aimed at examining whether the organization has.

Economic Feasibility

This concerns itself with the financial assessment of benefits of the project that may be tangible or intangible and the capital one is going to use to establish the project.

Requirement elicitation

Requirements elicitation/discovery includes those techniques to be used by systems analysts to Identify or extract system problems and solution requirements from the user community and Other relevant. (Morrill, 2013). Techniques that can be used are Interviews, questionnaires, Journals Internet.

tested as a complete system. After testing, the software is taken to the customer. (Sommerville, 2011).

4. Operation and Maintenance: This is the longest life cycle phase, where the system is installed and put into practical use. Maintenance involves correcting errors which were not discovered in the life cycle.

Parallel Methodology

It refers to the act of promoting concurrent interactions between software development and testing in the whole lifecycle of the software. Four core values are emphasized in this methodology.

1. Individual and team interactions over processes and tools.
2. Working software over comprehensive documentation.
3. Customer collaboration over contract negotiation.
4. Responding to change over following a plan. This method calls for incremental as well as interactive software design approach which is divided into various models. It enables the customer to have a chance of viewing the product and proposing their preferences if any in the process of product development.

Additionally, in this method, once the iteration is done, the customer is given an

opportunity where the obtained product features are availed for review by the customer and make any adjustments. The testing and development work is done concurrently at each phase where the level of user acceptance is evaluated. Regular communication is done with the developers to determine the requirements and as well conduct planning needed.

The Discovery of Facts

In the context of this research on the design and development of a secure cloud-based land verification system for Lusaka Province, the discovery of facts involves a comprehensive review of literature encompassing land administration systems, cloud computing technologies, legal frameworks, socio-economic implications, and technological considerations. This process entails identifying relevant literature on existing land administration systems in Zambia, exploring the potential of cloud computing solutions for transforming land governance, assessing legal and regulatory frameworks governing land administration, analyzing the socio-economic implications of land administration reforms, and evaluating technological considerations pertinent to system design and development. Through systematic exploration and analysis of these key areas, researchers gain valuable insights into the complexities and nuances of land governance and technology innovation, enabling them to propose viable solutions and contribute to advancing knowledge in the field.

Background Reading

Here, the analysis team shall be engaged in the organization with aim of fact mining exercise. They will be able to obtain clear details on the same through use of institutional reports, organizational charts and other relevant documents from the organization.

Interviewing

In interviewing method, the teams involved i.e. the development team and the organizational personnel will make an appointment and meet. This will be followed by asking of the interview questions from the interview guide in relation to the domain of the organization. The interviews will enrich the information available for the study.

Observation

Observation methods will be utilized by the analysis team where they will be observing the organizational personnel in their natural working environment and set up for a predetermined time. The method will involve observation of the routine tasks as they are being performed without any form of probing.

Sampling of Documents

In this case, the various documents and dairies maintained by the staff in their normal workings will be examined. The various findings will be drawn from the records marinated in those documents which have been sampled.

Questionnaires

Questionnaires will be developed containing both open and closed questions which will be then administered to the staff. They will be analyzed for completeness and analyzed through drawing conclusions from the responses provided by the staff.

Research Design

Research design describes the plan that the investigator will undertake to develop the ways of solving problems and provide guidance in various steps of undertaking the research. This study uses descriptive research design because it is interested in describing the satiation as it exists during the time of study without making manipulations. It provides the researcher with an opportunity to gain deeper insights into the subject matter under study. Robson (2002) points out that descriptive study portrays an accurate profile of persons, events or situation. Chandran (2004) also states descriptive study describes the existing conditions and attitudes through observation and interpretation techniques. In the present study, this design is the most preferable because it helps to deepen understanding of the current situation as it exists. It enables obtaining of both quantitative and qualitative data for the study because of utilization of questionnaires and the interview guides. Qualitative Research method is being used to gather complete and detailed description for the quality researching purposes. It can be either closed-ended or open-ended, indepth exploration of an aspect of life about which the interviewee a substantial experience, often combined with considerable insight which brings the best way for to get information for research purpose. In this research the author has used interview for as a fact finding technique. This will help to gather the information from the users and the service providers, in the same time helps to rectify the problem statement and the proposed ideal system that convenient for both ends.

Project Life Cycle
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 s

development is divided into separate phases. In Waterfall model, typically, the outcome of one phase acts as the input for the next phase sequentially.
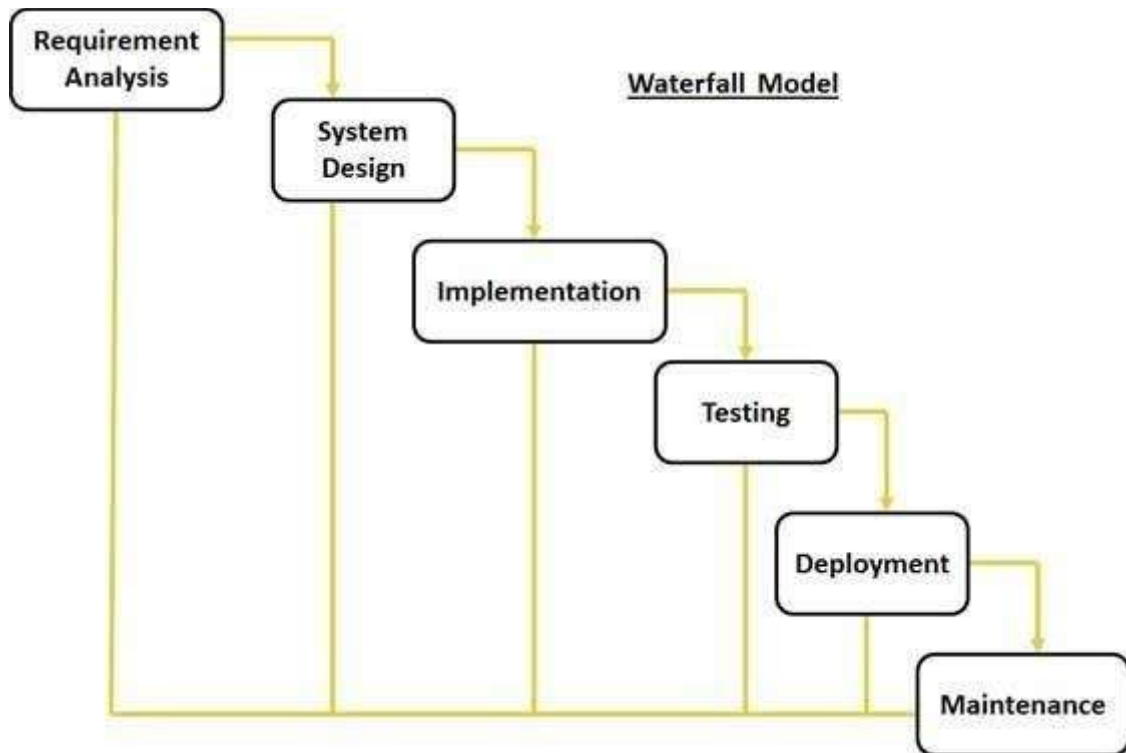Following is a diagrammatic representation of different phases of waterfall model.

Figure 1. Waterfall model

Source: Author

System Description
The system comprises of 3 major modules with their sub-modules as follows:

User:
SPLASH
☐Logo and short animation
1. REGISTER
✓ User to register with personal details (either seller or buyer)
2. LOGIN SYSTEM
✓ User can login using Username and Password (either seller or buyer)
3.LAND VERIFIER
✓ Fill the form with the required land owner information

✓ Display old properties and select one of them land to display
Or
✓ Start new orders and select required product and quantity
✓ Fill payment detail and send order (Payments to be made via mobile money)
4.ADMINISTRATOR
✓ Display land details and add new plots
✓ Display category list and can add/modify them
✓ Display customer orders

v.   **Gant Chat**

Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Research	■	■	■	■																
Drafting				■	■															
Prototype						■	■	■	■	■	■	■								
Data Collection													■	■						
Report													■	■						
Coding													■	■	■	■	■			
Evaluation																	■	■		
Final Report																			■	■

Figure 2. Project Schedule

Source: author

VI.   ESTIMATED OUTCOMES

The estimated outcome of the research on the design and development of a secure cloud-based land verification system for Lusaka Province entails the successful implementation of a functional system that digitizes land records, streamlines verification processes, and enhances accessibility to land ownership information. This system is expected to improve efficiency and transparency in land administration, mitigate the risks of fraud and corruption through robust security measures, empower stakeholders with user-friendly interfaces and capacity-building initiatives, and have a positive socio-economic impact by promoting investment and fostering sustainable development. Moreover, the demonstrated success of the system in Lusaka Province is anticipated to serve as a model for best practices in land governance and technology innovation, with potential implications for replication and adoption in other regions worldwide.

VII.   CONCLUSION

In conclusion, the design and development of a secure cloud-based land verification system for Lusaka Province represent a significant step towards modernizing land administration processes, enhancing transparency, and fostering socio-economic development in the region. Through a comprehensive review of literature and diligent research efforts, this study has proposed a viable solution to address the inefficiencies and challenges inherent in traditional paper-based land verification systems. The anticipated outcome of the research, including the implementation of a functional system, improved efficiency and transparency, enhanced security measures, and positive socio-economic impact, underscores the potential of technology-driven solutions to contribute to inclusive growth and sustainable development. By leveraging cloud computing technologies and best practices in land governance, the proposed system has the capacity to empower stakeholders, promote investment, and inspire innovation in land administration beyond Lusaka Province, ultimately contributing to the advancement of knowledge and the realization of development objectives on a broader scale.

VIII.   FUTURE WORKS

Future works in this area could focus on several avenues to further enhance the effectiveness and sustainability of the cloud-based land verification system. Firstly, ongoing research is needed to continuously evaluate and refine the system's performance, usability, and security features in response to evolving technological advancements and stakeholder needs. Additionally, efforts should be directed towards expanding the system's coverage to encompass other regions within Zambia and potentially

scaling it up for national implementation. Furthermore, future research could explore the integration of emerging technologies such as blockchain and artificial intelligence to enhance the system's capabilities in data management, authentication, and decision support. Moreover, there is a need for longitudinal studies to assess the long-term impact of the system on land governance, investment, and socio-economic development, providing valuable insights for policy-makers and practitioners in the field. Lastly, collaborative efforts with international partners and stakeholders could facilitate knowledge sharing, capacity building, and the adoption of best practices in land administration reform beyond national borders.

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