


**JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY**

# DESIGN AND DEVELOPMENT OF A PUBLIC ASSET LIFECYCLE MANAGEMENT AND AUDIT INFORMATION SYSTEM FOR GOVERNMENT INSTITUTIONS

BY

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This project has been submitted to the department of Commerce and Economic Studies in partial fulfilment of the Award of the Degree in Business Information Technology at Jomo Kenyatta University of Agriculture and Technology

**SEPTEMBER 2026**

## DECLARATION

This project proposal is my original work and has not been presented for a degree in any University nor educational institution.

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I confirm that the project presented by this student was carried out under my strict supervision.

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## DEDICATION

To **Dr. William Samoei Ruto C.G.H.** whose vision for accountable governance, efficient utilization of public resources, and responsible public asset management inspires the purpose of this project.

## ACKNOWLEDGEMENT

I am sincerely grateful to my supervisor, Ms. Faith Kivuva, for her guidance, constructive advice, and support throughout the undertaking of this project. Her valuable insights and encouragement contributed greatly to the successful completion of this study.

I also extend my appreciation to my Family and classmates for their moral support, encouragement, and assistance throughout my academic journey. I am equally grateful to everyone who contributed their time, knowledge, and support towards the completion of this project.

Finally, I give my earnest gratitude to Almighty God for granting me wisdom, strength, good health, care, and protection throughout my studies and the entire project process.

I remain forever grateful for His guidance and blessings.

**Glory be to God.**

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**KEYWORDS**

Public asset management; asset lifecycle management; asset tracking; audit readiness; QR Code; RFID; NFC; GPS; GIS; geo-fencing; digital asset register.

## DEFINITION OF KEY TERMS

**Public Asset:** A resource owned, controlled, or used by a public institution to support the delivery of public services.

**Asset Lifecycle Management:** The coordinated management of an asset from planning and acquisition through deployment, use, maintenance, renewal, and disposal.

**Asset Tracking:** The process of identifying, locating, monitoring, and maintaining records of assets and their movements throughout their lifecycle.

**Audit Readiness:** The state in which asset records, approvals, supporting evidence, and transaction histories are organized and sufficiently traceable for audit examination.

**QR Code:** A two-dimensional machine-readable code used in the proposed system to provide rapid access to an asset record through scanning.

**RFID:** Radio Frequency Identification, a technology that uses radio communication between a tag and a reader to identify or track an asset.

**NFC:** Near Field Communication, a short-range wireless technology that enables close-proximity communication between compatible devices or tags.

**GPS:** Global Positioning System, a satellite-based positioning technology used to determine the location of supported mobile assets.

**GIS:** Geographic Information System, a system for capturing, managing, analyzing, and presenting geographically referenced information.

**Geo-fencing:** A virtual geographic boundary used to trigger alerts or controls when a tracked asset enters or leaves an authorized area.

## ABSTRACT

Public institutions manage diverse assets that are essential to the delivery of public services, yet many asset records remain fragmented across manual registers and spreadsheets. This proposal presents the design and development of a Public Asset Lifecycle Management and Audit Information System for government institutions. The proposed system will support asset registration, identification, location tracking, maintenance scheduling, warranty management, custody control, digital approvals, audit workflows, and management reporting. A multi-technology approach incorporating QR codes, RFID, NFC, GPS, barcodes, and GIS will be used to support different categories and movement patterns of public assets. The study will adopt an applied research design and Prototyping methodology. Data will be collected through interviews, observation, and document analysis, while thematic analysis will be used to derive system requirements. The system will be implemented using Python and Django, with SQLite used during development and GeoDjango and OpenStreetMap supporting geospatial functions. Testing will include unit, integration, and User Acceptance Testing. The anticipated outcome is an affordable prototype that improves asset visibility, traceability, maintenance control, and audit readiness while providing a foundation for future integration with IoT and blockchain technologies.

# CHAPTER ONE

# INTRODUCTION

## 1.0 Introduction

This chapter introduces the proposed project by establishing the context in which public assets are managed, the problem that motivates the study, the objectives to be achieved, and the boundaries within which the project will be undertaken. It also explains the justification for developing an integrated information system for public asset lifecycle management and audit support.

The discussion begins with the broader role of public assets in service delivery and narrows to the information and accountability requirements that arise when assets are acquired, assigned, moved, maintained, verified, and eventually disposed of.

## 1.1 Background of the Study

Government institutions handle massive amounts of public assets. These include ICT equipment, vehicles, medical devices, furniture, machinery, and infrastructure. Effective management of these resources dictates how well public services run. Asset lifecycle management tracks an item from procurement to disposal. Many public sector organizations still operate using manual asset registers and basic spreadsheets. These traditional methods create severe bottlenecks. Staff spend hours reconciling physical items with paper records. The lack of automated tracking leads to inaccurate data, missing items, and duplicate procurement. Digital transformation in the public sector requires modern tools to handle these complexities. Existing solutions don’t address the problem effectively and often target private enterprises and carry high licensing fees. Public institutions need systems tailored to their specific operational environments

and budget constraints. This study explores the design of a unified tracking platform to bridge this gap.

### 1.2 Problem Statement

Public institutions struggle with asset visibility and accountability due to outdated tracking methods. Manual registers and isolated spreadsheets fail to provide real-time data. This delay leads to the accumulation of ghost assets and unauthorized transfers. Maintenance schedules get missed because staff lack automated alerts. When auditors review these records, the process takes months because the data is fragmented. Existing digital solutions on the market usually rely on a single identification method like basic QR codes. This limitation makes them unsuitable for diverse government environments where different assets require different tracking technologies. A comprehensive platform combining multiple identification tools and lifecycle tracking is currently missing in many public institutions. This research addresses the need for an integrated, multi-technology system that ensures audit readiness and operational efficiency.

### 1.3 Objectives

#### 1.3 .1 General Objective

To investigate, design, and develop an Intelligent Public Asset Lifecycle Management, Tracking and Audit Information System that enhances transparency, accountability, operational efficiency and audit readiness in public institutions through intelligent tracking and digital asset management.

#### 1.3.2 Specific Objectives

i. To investigate the existing practices and challenges in the management of public assets.

ii. To develop a web-based system that supports QR Codes, RFID, NFC, GPS tracking, and barcode technologies.

iii. To develop features such as maintenance scheduling, warranty management, geo-fencing, photo verification, digital approvals, and audit workflows.

iv. To develop dashboards, GIS maps, heat maps, business intelligence reports, and asset utilization analytics to enable informed decision making.

v. To analyze the functionality, usability, security, and effectiveness of the proposed system and create a base for future integration of IoT and blockchain.

### 1.4 Scope and Limitation of the Study

The study focuses on designing and developing a web and mobile-compatible asset management platform. It covers the complete lifecycle of public assets from procurement to disposal. The system integrates QR codes, RFID, NFC, barcodes, GPS tracking, and GIS mapping. The scope includes testing these technologies in a simulated government environment. The research limits its focus to software development and prototype testing. Physical hardware deployment across a full government ministry falls outside the scope due to budget and time constraints. The system uses SQLite for development and Django for the backend. A production-level national rollout will require database migration to PostgreSQL. Mobile verification depends on standard smartphone sensors for GPS and camera functions.

### 1.5 Justification

Public funds are frequently lost through asset mismanagement and theft. Implementing a unified tracking system directly reduces these losses. Real-time visibility ensures that every item is accounted for at all times. Audit processes become faster and more accurate when data is

centralized and verified through multiple technologies like photo verification and geo-fencing. The proposed system provides a highly cost-effective alternative to expensive enterprise software. It gives government institutions the tools they need to comply with public finance management regulations. The modular design allows future integration with advanced technologies like IoT and blockchain. This protects the initial financial investment and supports long-term digital strategy.

# CHAPTER TWO

# LITERATURE REVIEW AND CONCEPTUAL/THEORETICAL FRAMEWORK

## 2.0. Introduction

Public asset management involves planning, acquiring, operating, maintaining, renewing, and disposing of assets to ensure public organizations gain value throughout the lifecycle. Government entities must do more than account for physical items. They must ensure service continuity, maintain accountability, control risks, enforce budget discipline, and prove that public resources serve authorized purposes. Frameworks in developing countries link effective practices to improved efficiency and auditability. They also identify weak legal arrangements and poor data availability as recurring barriers (Hanis et al., 2010).

Contemporary asset management guidance similarly emphasizes managing assets systematically across their life cycles and aligning asset management activities with organizational objectives (International Organization for Standardization, 2024).

The Kenyan context provides a clear regulatory foundation. The Public Procurement and Asset Disposal Act of 2015 established procedures for public procurement and asset disposal (Public Procurement and Asset Disposal Act, 2015). A digital asset management system functions as an information infrastructure that supports statutory control and traceability.

This chapter reviews literature on public asset management, system adoption, identification technologies, and geospatial monitoring. It evaluates empirical evidence relevant to digitizing public asset registers in Kenya and identifies the research gap addressed by the proposed system

## 2.1 Concept and Scope of Public Asset Management

Public assets encompass land, buildings, vehicles, machinery, medical devices, and IT equipment controlled by public entities. Management spans the entire lifecycle, from needs assessment and procurement to deployment, maintenance, and eventual disposal. This perspective aligns with ISO 55000 research, which connects asset management to long-term public value and lifecycle costing (Salicath et al., 2016; Houessou et al., 2016).

Literature emphasizes connecting operational records to strategic financial decisions. Studies applying ISO 55000 show how these concepts adapt to specific environments, such as biomedical asset management in public hospitals (Houessou et al., 2016). The proposed system will record asset identifiers alongside acquisition details, location, responsible officers, condition, and maintenance history.

The statutory dimension carries particular weight in Kenya. The Public Procurement and Asset Disposal Act framework governs how entities procure and dispose of resources. Local studies report that disposal processes face financial risks and political interference. Procedural non-adherence also complicates these operations (Mbeba & Njoroge, 2022). Technology cannot eliminate these institutional risks entirely. It creates a stronger evidence trail showing who registered an asset and approved a transfer. The system also records who recommended an item for disposal.

## 2.2 Weaknesses of Manual Asset Tracking

Manual asset management relies heavily on paper registers and spreadsheets. Localized departmental records create further fragmentation. These tools fail when assets move across different sites or counties. Staff enter data inconsistently and transcribe serial numbers incorrectly. Updates frequently fail to reach the central register. This creates a loss of confidence in the relationship between the physical asset and the official record (Hanis et al., 2010).

Developing-country literature identifies data availability as a central challenge alongside fragmented organizational responsibilities (Hanis et al., 2010). Kenyan evidence adds a governance dimension where competing interests complicate disposal implementation (Mbeba & Njoroge, 2022). A system designed merely to digitize an existing spreadsheet would reproduce these exact weaknesses. The design objective must focus on controlled data capture and workflow accountability.

Manual processes also hinder preventive maintenance. A paper register confirms a vehicle exists but cannot reliably calculate the next service date or notify the responsible officer. Operations shift from planned maintenance to reactive repair. Hospital asset tracking literature illustrates this problem, showing how high-value equipment gets misplaced without automated checkpoint tracking (Patil et al., 2017). This underlying control problem applies directly to public vehicles and movable IT equipment.

## 2.3 Identification and Tracking Technologies

### 2.3.1 Barcodes and QR codes

Barcodes and QR codes provide a low-cost identification layer. A code encodes an asset number or a link to a digital record. Smartphones or handheld scanners capture the identifier during registration and verification. QR systems work well for institutions that already possess

smartphones and conduct indoor verifications. The main limitation involves visibility. Scanners cannot read damaged or obstructed labels. Reviewed applications show these codes function best as database-access mechanisms rather than complete governance solutions (Huzaeni et al., 2023).

Literature includes applications combining QR labeling with web-based inventory and geographical information systems. Studies describe fixed-asset systems for higher education institutions using these exact tools (Huzaeni et al., 2023). QR codes serve as a practical first layer for budget-constrained institutions. They do not independently solve custody or maintenance problems.

### 2.3.2 RFID

Radio Frequency Identification tracks assets through radio communication and removes the need for direct visual scanning. Passive tags suit lower-cost indoor tracking. Active tags support longer-range monitoring but require more infrastructure. This technology proves valuable when staff must verify many assets quickly. Hospital implementations use readers at checkpoints to update movement records automatically (Patil et al., 2017).

These hospital studies clarify the operational logic. Readers detect tagged assets and record arrival times to help trace misplaced items (Patil et al., 2017). Implementation introduces specific design constraints like reader placement and signal interference. Tag durability also presents a challenge. Public institutions should treat this as a targeted option for high-value or high-mobility assets instead of a mandatory technology for every item.

### 2.3.3 NFC and GPS

Near Field Communication supports short-range interactions for controlled smartphone verification. The limited operating range confirms physical proximity but prevents rapid warehouse scanning. GPS suits mobile assets like vehicles by providing location histories and supporting geofencing. These devices increase power and communication requirements. The system requires a selection rule based on asset value and mobility. Total cost of ownership must also dictate the final choice (Patil et al., 2017; Huzaeni et al., 2023).

Literature supports a multi-technology architecture instead of a single universal identifier. The proposed system combines QR codes for general inventory with targeted RFID for indoor high-value assets. GPS handles vehicle tracking. All data feeds into one authoritative record within the Django application.

### 2.3.4 Geolocation, GIS and Geofencing

Geospatial functionality shifts the focus from simply knowing what exists to understanding where items are located and who controls them. A Geographic Information System layer displays assets by site and condition. Utilization status is also mapped. It supports spatial queries to identify equipment located outside assigned stations or map concentrations of underused resources (Huzaeni et al., 2023).

Geofencing acts as a control mechanism. A virtual boundary associates with a specific depot or authorized operating area. The system generates an alert when a GPS-enabled vehicle crosses this boundary. Staff must treat these alerts as exceptions requiring human verification since

signal errors or approved travel might produce false positives. Information availability enables accountable decisions but does not replace institutional judgment (Hanis et al., 2010).

Open mapping tools reduce licensing dependence. Using an open map does not automatically make the entire system low cost. Hosting, mobile data, security, and user training remain ongoing lifecycle expenses. Public asset value depends on service life and total lifecycle costs rather than a single acquisition decision (Salicath et al., 2016).

## 2.4 Theoretical Framework

### 2.4.1 Technology Acceptance Model

The Technology Acceptance Model explains adoption through perceived usefulness and perceived ease of use. Mandatory deployment of a new system does not guarantee meaningful use by public employees. Studies on mandatory e-government systems confirm that this model effectively assesses technology use in public institutions when combined with management and training support (Sebetci, 2015).

Perceived usefulness indicates whether employees believe the platform improves registration and verification. Audit preparation is another key factor. Perceived ease of use measures the effort required to scan an item or retrieve a record. Researchers must measure these constructs using survey indicators that ask if the system reduces search time and improves record confidence (Sebetci, 2015).

This model alone underrepresents organizational conditions. The Unified Theory of Acceptance and Use of Technology provides a stronger extension by introducing core determinants of

intention with moderating effects (Venkatesh et al., 2003). The study retains the original model as the principal theory while incorporating facilitating conditions and organizational support as contextual variables. Network reliability and institutional rules often determine actual use even when employees find a system useful.

### 2.4.2 Information Systems Success Model

The DeLone and McLean Information Systems Success Model provides a complementary evaluation lens. An asset management study must assess system quality and information quality alongside user acceptance. Net benefits require equal evaluation. This distinction prevents the common error of treating a simple system login as evidence of improved asset governance (DeLone & McLean, 2003).

The combined theoretical position uses the acceptance model to explain user resistance. The extended theory explains how organizational support shapes actual use. The success model evaluates whether the system produces quality information. ISO 55000 lifecycle thinking defines the specific management processes the software must support (Salicath et al., 2016).

## 2.5 Empirical Review and Research Gap

Existing empirical work provides fragmented evidence. Public asset studies identify accountability and data availability as central concerns (Hanis et al., 2010). Kenyan research focuses heavily on procurement and compliance determinants like financial risk and political interference (Mbeba & Njoroge, 2022). Technology studies demonstrate how specific tools improve visibility in isolated environments (Patil et al., 2017; Huzaeni et al., 2023). Adoption research confirms that training and organizational support matter in public systems (Sebetci, 2015; Venkatesh et al., 2003).

The evidence base remains insufficient in several ways. Local literature emphasizes disposal practices over integrated digital lifecycle management (Mbeba & Njoroge, 2022). Technology studies usually examine a single identification method rather than a modular combination of multiple tracking tools. Researchers rarely integrate adoption metrics and system performance into the same evaluation model. The reviewed evidence also lacks direct evaluation of open-source architectures under local resource and connectivity constraints. The research gap involves the absence of a theoretically grounded framework linking system capabilities directly to organizational outcomes.

## 2.6 Conceptual Framework

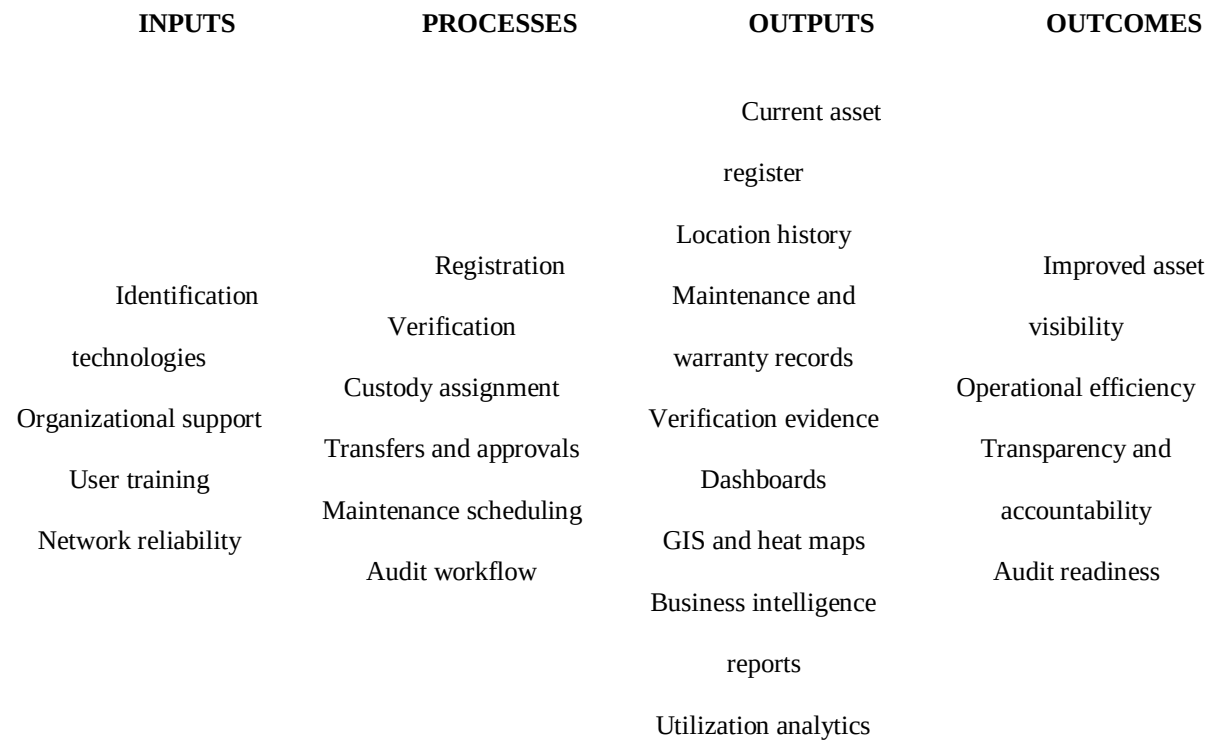



Figure 1: Conceptual framework for the proposed public asset lifecycle management and audit information system

The design perspective is also informed by established systems analysis and physical asset management literature, which emphasizes systematic requirements analysis, lifecycle planning, and asset management information systems (Dennis et al., 2015; Hastings, 2021).

The conceptual framework contains four layers. System inputs comprise identification technologies and lifecycle functions. Organizational support forms the third input layer. System processes include registration, verification, custody assignment, and maintenance scheduling. Information outputs feature the current asset register and location history. Management dashboards provide the final output. Organizational outcomes result in audit readiness and operational efficiency. This structure follows the literature linking asset information to service performance (Hanis et al., 2010; Salicath et al., 2016).

The model includes moderators like user training and network reliability. Institutional compliance also acts as a moderator. These factors strengthen or weaken the relationship between system capabilities and final outcomes. A technically capable system fails to produce reliable data if staff do not use it consistently. This aligns with the extended acceptance theory emphasizing organizational intervention (Venkatesh et al., 2003).

Proposed relationships connect these layers. Identification capabilities improve data accuracy and traceability by reducing manual transcription (Patil et al., 2017). Lifecycle workflows increase operational efficiency through automated approvals and maintenance schedules (Mbeba & Njoroge, 2022; Salicath et al., 2016). Geospatial analytics provide managerial visibility for resource allocation (Huzaeni et al., 2023). Perceived usefulness drives the intention to actually

use the platform (Sebetci, 2015). Facilitating conditions determine final data quality alongside individual perceptions (Venkatesh et al., 2003). High data quality and consistent use ultimately produce audit readiness and transparency. Researchers must measure these outcomes empirically rather than assume them from initial deployment.

### 2.7 Conclusion

Literature supports developing a digital public asset management platform. Digitization does not automatically solve underlying governance problems. Public asset management involves legal requirements and institutional roles. Data quality remains a constant concern (Public Procurement and Asset Disposal Act, 2015; Hanis et al., 2010; Mbeba & Njoroge, 2022). Tracking technologies offer complementary capabilities. Their value depends on selecting the appropriate tool for each asset category and embedding it within controlled workflows (Patil et al., 2017; Huzaeni et al., 2023). The acceptance model provides a foundation for user adoption. Extended theories and success metrics account for organizational support and measurable benefits (Sebetci, 2015; Venkatesh et al., 2003; DeLone & McLean, 2003). This study addresses a specific gap by designing an affordable framework for public institutions. Outcomes will be defined strictly by data accuracy and audit readiness. Operational efficiency forms the final metric.

## CHAPTER THREE

## 3.0 METHODOLOGY

### 3.1 Introduction

This chapter outlines the methods and tools used to develop the Intelligent Public Asset Lifecycle Management system. It details the research design, data collection techniques, and the software development framework. The time schedule and project budget are also provided.

### 3.2 Research Design

The study adopts an applied research design utilizing the Prototyping methodology. Prototyping allows for iterative development and continuous feedback from potential end-users. The system is built in cycles. A basic functional model is developed first. Users test this model and provide feedback. The developers refine the features based on this input. This approach ensures the final product aligns closely with the actual operational needs of government procurement and audit officers.

### 3.3 Data Collection Techniques

Fact-finding is conducted using three primary techniques. Interviews are held with procurement officers, store clerks, and internal auditors to understand their daily workflows and pain points. Observation involves shadowing staff during physical asset verification exercises to identify bottlenecks in the current manual processes. Document analysis reviews existing audit reports, disposal forms, and procurement manuals to understand the regulatory requirements and standard operating procedures.

### 3.4 Data Analysis Tools

Qualitative data gathered from interviews and observations is analyzed using thematic analysis. The researchers group the responses into common themes such as verification delays, data entry errors, and reporting challenges. These themes directly inform the functional requirements of the

system. Process modeling tools like Draw.io are used to create Data Flow Diagrams and Entity Relationship Diagrams. These models visually analyze the data movement and storage requirements before coding begins.

### 3.5 System Implementation Tools

The system is developed using a robust stack of open-source technologies. Python serves as the primary programming language due to its readability and extensive library support. The backend logic is built using the Django framework, which provides built-in security features and an administrative interface. The frontend utilizes HTML5, CSS3, and Bootstrap 5 to ensure a responsive and mobile-friendly user interface. SQLite is used as the database during the development phase. GeoDjango integrates spatial data and OpenStreetMap for GIS mapping capabilities. The Python qrcode and python-barcode libraries handle the generation of identification tags. Matplotlib and Plotly generate the analytical charts and business intelligence reports. Visual Studio Code is the primary development environment, with Git and GitHub managing version control. Figma is used for UI/UX wireframing. Deployment is handled via PythonAnywhere.

### 3.6 Proposed Core Database Structure

| ENTITY / TABLE | KEY DATA FIELDS | PURPOSE |
|---|---|---|
| Asset | asset_id, asset_code, category, description, acquisition_date, cost, condition | Stores the master asset register and lifecycle attributes. |
| Location | location_id, site, department, latitude, longitude, | Stores authorized and |

| | | |
|---|---|---|
| | geo_fence | current asset locations. |
| Custody / Transfer | transfer_id, asset_id, from_user, to_user, date, approval_status | Records custody assignments and movement approvals. |
| Maintenance / Warranty | maintenance_id, asset_id, service_date, next_due, warranty_end, status | Tracks maintenance events, schedules, and warranty information. |
| Verification / Audit | verification_id, asset_id, verifier, date, photo, status, remarks | Maintains evidence of physical verification and audit actions. |
| User / Role | user_id, name, role, department, permissions | Controls authentication, authorization, and accountability. |

### 3.7 System Testing

Testing ensures the system functions correctly and meets security standards. Unit testing evaluates individual components like the QR code generator and the warranty alert module. Integration testing checks how these modules interact with the central database. User Acceptance Testing involves a small group of public officers who perform standard tasks like registering a new asset, conducting a mobile verification, and generating an audit report. Their feedback determines if the system is ready for deployment.

### 3.8 Time Schedule

The project spans four months. The schedule is broken down into specific phases to ensure timely completion.

| TIME | ACTIVITY | DURATION | MONTH |
|---|---|---|---|
| 1 | Proposal writing and approval | 2 Weeks | Month 1 |
| 2 | Literature review and data collection | 3 Weeks | Month 1 |
| 3 | System analysis and requirement gathering | 2 Weeks | Month 2 |
| 4 | UI/UX design and database modeling | 2 Weeks | Month 2 |
| 5 | Backend and frontend development | 4 Weeks | Month 3 |
| 6 | System integration and testing | 2 Weeks | Month 4 |
| 7 | Documentation and final report writing | 2 Weeks | Month 4 |
| 8 | Final presentation and submission | 1 Weeks | Month 4 |

### 3.8.1 Budget

The project budget covers all expenses related to research, software development, and documentation. The estimates are in Kenya Shillings (KES).

| ITEM | DESCRIPTION | ESTIMATED COST (KES) |
|---|---|---|
| Internet Data | downloads, and cloud backups | 5,000 |
| Printing and Binding | Proposal, draft reports, and final document | 4,000 |

| | | |
|---|---|---|
| Stationery | Notebooks, pens, and files | 1,500 |
| Domain and Hosting | PythonAnywhere deployment and domain registration | 6,000 |
| Miscellaneous | Transport and unforeseen expenses | 5,000 |
| | **TOTAL** | 21,500 |

### 3.9 Conclusion

This study aligns theoretical models of technology adoption with practical public sector needs. The literature review highlights the severe limitations of manual asset registries and single-technology tracking systems. The proposed methodology utilizes a multi-technology approach to solve these identified problems. Integrating QR codes, RFID, and GIS mapping directly addresses the operational inefficiencies documented in the empirical review. The system provides a practical application of the Technology Acceptance Model by offering an intuitive, accessible platform for government workers. This project establishes a foundation for modernizing public asset management. Future deployments can build on this framework to incorporate IoT sensors and blockchain ledgers, further securing public resources and enforcing strict financial accountability.

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