MAKERERE UNIVERSITY

KCCA PUBLIC TOILETS MANAGEMENT SYSTEM

BY

GROUP 10

Department of Information Systems
School of Computing and Informatics Technology

Project report Submitted to the College of Computing and Information Sciences in Partial fulfillment of the Requirements for the Award of a Degree of Bachelors of Information Systems and Technology at Makerere University

Option: Systems Development/Information security/System management

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DECLARATION

We, undersigned members of group (10) declare that this project report entitled "**KCCA Public Toilets Management System**" is our original work and has not been submitted to any other institution of higher learning for any academic award. The report was prepared under the guidance of our supervisor and all sources of information used have been duly acknowledged.

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DEDICATION

This project is wholeheartedly dedicated to our beloved parents and guardians, lecturers, and colleagues whose unwavering support, guidance, and encouragement have been our pillar of strength that enabled us to successfully complete this project and throughout our academic journey at Makerere University.

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LIST OF ACRONYMS

DFD	Data Flow Diagram
ERD	Entity Relationship Diagram
HTML	HyperText Markup Language
CSS	Cascading Style Sheets
PHP	Hypertext Preprocessor (Personal Home Page)
SQL	Structured Query Language
MySQL	My Structured Query Language
WAMP	Windows, Apache, MySQL, PHP
KCCA	Kampala Capital City Authority
RBAC	Role-Based Access Control
SDLC	System Development Life Cycle
SRS	Software Requirements Specification
IoT	Internet of Things
RFID	Radio-Frequency Identification
CSV	Comma-Separated Values
JSON	JavaScript Object Notation
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure

ABSTRACT

The study focused on the design and development of a KCCA Public Toilets Management System aimed at improving the monitoring of consumables and maintenance activities in public toilet facilities managed by Kampala Capital City Authority (KCCA). The existing manual system relied on physical inspections and verbal reporting, which resulted in delayed maintenance responses, frequent stock-outs of consumables, poor hygiene conditions, and inadequate accountability.

The objectives of the study were to examine the current manual practices used in managing public toilets, design a web-based supervisor dashboard, and develop an attendant application for reporting consumable levels and maintenance issues. The study employed an agile system development methodology supported by interviews, questionnaires, and document review for requirements gathering (Sommerville, 2016). Data collected from supervisors and attendants was analyzed using qualitative and quantitative methods.

The findings revealed that most attendants relied on verbal reporting and paper-based records for tracking consumables and maintenance requests. Frequent stock-outs, delayed maintenance responses, and lack of accountability were identified as the major operational challenges. The developed system provided features such as consumable tracking, maintenance reporting, alerts, and a supervisor dashboard for monitoring multiple facilities.

The study concluded that the KCCA Public Toilets Management System improved accountability, enhanced communication between attendants and supervisors, and supported timely maintenance and restocking decisions. The study recommended the adoption of digital sanitation management systems by KCCA and other municipalities to improve public hygiene and operational efficiency.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The project focused on the development of a digital management system for KCCA public toilets. The study examined how information systems and digital technologies could improve accountability, maintenance monitoring, and consumable management within public sanitation facilities. Information systems had increasingly been adopted globally to automate operational activities, improve communication, and support real-time decision-making (Sommerville, 2016). However, many public toilet facilities in Kampala still relied on manual methods of supervision and reporting, which limited operational efficiency and service delivery.

1.2 Background of the Study

The Kampala Capital City Authority (KCCA) is responsible for managing public toilet facilities located in taxi parks, markets, and city centres across Kampala. These facilities serve thousands of people daily and are important in maintaining public hygiene and sanitation standards within the city (Richmond et al., 2018) Proper management of public sanitation facilities helps reduce the spread of diseases and improves the health and wellbeing of urban populations.

Despite their importance, the management of public toilets in Kampala remains largely manual and inefficient. Supervisors are required to physically inspect facilities to monitor consumables such as toilet paper, soap, detergents, and water availability, while attendants mainly rely on verbal communication and paper records to report maintenance issues. This process is slow, inconsistent, and unreliable, especially considering that some supervisors manage multiple facilities at the same time.

As a result, many public toilets experience frequent stock-outs of essential consumables, delayed maintenance responses, and poor hygiene conditions (Ssekamatte et al., 2018). Users often encounter facilities without soap, toilet paper, or water for handwashing, while maintenance issues such as blocked drainage systems, broken taps, faulty locks, and bad odors remain unresolved for long periods (Monitor, 2025). Some facilities have even remained closed for several days due to unresolved maintenance and utility challenges (Monitor, 2025). These conditions negatively affect user experience and increase public health risks within the city.

In addition, the absence of centralized monitoring and historical operational data makes it difficult for KCCA to effectively plan procurement, monitor facility performance, enforce accountability, and carry out preventive maintenance (Mguni, et al., 2018). The continued reliance on manual monitoring limits timely decision-making and makes sanitation management increasingly difficult as Kampala's population continues to grow.

There is therefore a need for a digital management system that can improve monitoring of facility operations, maintenance activities, and consumable usage in KCCA public toilets. This study therefore focused on developing a web-based management system that enables attendants and supervisors to report issues, track consumables, and improve the overall management of public toilet facilities more efficiently.

1.3 Problem Statement

KCCA manages consumables and maintenance activities in public toilets through physical inspections, verbal communication, and paper-based records (Monitor, 2025). These methods make it difficult to efficiently collect, store, and access operational information across different public toilet facilities. As a result, monitoring consumable usage, tracking maintenance issues, and maintaining accurate records become challenging.

The challenge is largely attributed to the absence of a centralized digital system that can integrate monitoring, reporting, and record management processes. Consequently, operational information is often fragmented, limiting effective supervision, accountability, and planning for procurement and maintenance activities (Ssekamatte et al., 2018). In addition, weak monitoring and reporting mechanisms contribute to delays in addressing maintenance issues within sanitation facilities (Richmond et al., 2018).

Therefore, there is a need for a centralized Public Toilets Management System that digitizes consumable and maintenance records, supports monitoring and reporting, and improves accountability in KCCA public toilets.

1.4 Objectives

The project objectives guided the study and system development process.

1.4.1 General Objective

The aim of the project was to develop a KCCA Public Toilets Management System that digitizes consumable tracking, maintenance reporting, and supervisory monitoring to improve accountability and service delivery.

1.4.2 Specific Objectives

i. To examine the current manual practices of consumable usage and maintenance reporting in KCCA public toilets
ii. To design KCCA public toilet management system for monitoring consumable usage, and maintenance requests.
iii. To implement, test and validate KCCA public toilet management system for logging consumable levels and maintenance issues.

1.5 Scope of the Study

The study focused on the management of consumables and maintenance activities in public toilets operated by KCCA. The scope covered the content addressed by the study, the selected public toilet facilities involved, and the period during which the study was conducted.

1.5.1 Conceptual Scope

The study concentrated on consumable tracking, maintenance reporting, supervisor monitoring, and dashboard reporting. The study covered consumables such as toilet paper, hand soap, detergents, sanitary pads, and water supply monitoring. It also covered maintenance issues including broken taps, blocked drainage systems, faulty locks, lighting problems, and broken toilet seats. The study involved KCCA supervisors and toilet attendants who participated in requirements gathering and system evaluation.

1.5.2 Geographical Scope

The study was conducted in Kampala City within selected KCCA public toilet facilities located in markets, taxi parks, and city centers. These included Old Taxi Park, New Taxi Park, Owino Market, Nakasero Market, Kamwokya, Centenary Park among others

1.5.3 Time Scope

The study covered the period from 2025 to 2026 during which requirements gathering, system analysis, design, implementation, testing, and documentation were conducted.

1.6 Significance of the Study

The study is important because it contributes to improving sanitation management through the use of information systems and digital technologies. The findings and the developed system are expected to improve monitoring of public toilet facilities, strengthen accountability, and enhance service delivery in KCCA public toilets. The study also contributes to academic knowledge in the field of information systems and public sanitation management.

KCCA Management (Supervisors and Administrators)

The system provides a daily-updated supervisor dashboard that gives instant visibility into every facility's status without physical inspections. Colour-coded health indicators immediately highlight facilities needing attention, enabling faster decision-making. Automated toast notifications alert supervisors the moment a consumable reaches Low or Empty, or when a high-priority maintenance issue is reported, effectively preventing stock-outs and unsanitary conditions.

The maintenance workflow management module tracks every reported issue ensuring no repair is forgotten. Comprehensive reporting on consumable usage, maintenance summaries, and alert history generates data-driven insights that support evidence-based procurement planning, budget allocation, and performance evaluation of attendants. Reports can be exported to CSV for further analysis.

Toilet Attendants

Attendants benefit from a mobile-optimised stock logging interface designed for simplicity. Attendants can log consumables levels daily depending on the current quantity available. This replaces error-prone paper or verbal reporting.

One-tap maintenance reporting uses pre-defined categories, so attendants can report a blocked drain, broken tap, or lighting issue instantly with minimal effort. An activity history view lets them see their past submissions, giving a sense of ownership and a personal record of their work. Each submission provides instant confirmation, reassuring attendants that their report has been received and will be acted upon.

Public Users

Although public users do not interact with the system directly, they gain significant indirect benefits. Consistent availability of consumables like soap, toilet paper, and detergent means cleaner, more hygienic facilities that meet user expectations. Faster maintenance repairs reduce facility downtime—broken taps, blocked drains, or faulty lights are fixed more quickly.

Improved overall sanitation contributes to a healthier environment, lowering the risk of disease transmission and providing a more dignified experience when using public toilets. Finally, data-driven service improvement enables KCCA to allocate resources where they are most needed, leading to better-maintained facilities city-wide.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature and related systems relevant to public toilet management systems. The review examines previous studies, existing sanitation management systems, their strengths, weaknesses, and the gaps addressed by the proposed KCCA Public Toilets Management System. The aim of the review is to identify contributions made by previous studies and systems and establish the added value of the proposed web-based public toilet management system.

2.2 Public toilet management

Kampala Capital City Authority (KCCA) is responsible for managing public sanitation facilities across Kampala City. Public toilets located in taxi parks, markets, and city centers serve thousands of users daily and play an important role in maintaining public hygiene and sanitation standards (Richmond, et al., 2018). Proper management of these facilities helps reduce disease outbreaks, improve environmental cleanliness, and support public health in urban areas.

2.2.1 How the current manual management works.

The existing management approach relies heavily on physical presence and paper-based records. Supervisors are expected to travel to each facility, often daily, to visually check the level of consumables such as toilet paper, soap, and detergent, and to assess the general condition of taps, doors, drainage systems, and lighting. When an attendant identifies a problem such as a broken lock or a blocked drain, they must either wait for the supervisor's next visit to report it verbally, or write the issue down on a paper log that may not be reviewed promptly. Maintenance requests are not systematically tracked; repairs are typically initiated only after a problem has become severe enough to attract attention, often through user complaints. The entire cycle from problem identification to resolution depends on the availability, memory, and diligence of individual staff members, and there is no central record of what was done, when, or by whom.

2.2.2 Challenges faced:

I. **Monitoring is inconsistent and unreliable**.

Supervisors cannot be present at all facilities simultaneously, and the frequency of inspections varies depending on staff availability, weather conditions, and other duties. As a result, consumables frequently run out before a refill is arranged, leaving users without basic hygiene supplies and exposing them to unhygienic conditions.

II. **Maintenance is reactive rather than preventive**.

Repairs are only made after a breakdown occurs, leading to prolonged facility downtime and higher repair costs. In some cases, facilities have remained closed for extended periods due to unresolved maintenance issues, as documented by local media (Monitor, 2025).

III. **Accountability is weak**.

Without a digital trail, it is difficult to verify whether attendants have performed their duties, whether supervisors have responded to reported issues, or whether consumables have been used appropriately. This lack of transparency can lead to misreporting, misuse of resources, and low staff performance.

IV. **Procurement planning is inefficient**.

KCCA lacks reliable data on how quickly consumables are consumed at each facility. Ordering is based on rough estimates rather than actual usage patterns, causing either shortages or wasteful overstocking. The absence of historical records also makes it difficult to evaluate the performance of suppliers or justify budget allocations.

V. T**he approach is unsustainable**

The increasing number of public toilet users will only intensify the pressure on a system that relies on human memory and physical movement rather than on real-time data and automation. These challenges demonstrate the need for a more efficient, transparent, and data-driven management system for public sanitation facilities.

2.3 Review of Existing Systems

Several sanitation management systems and restroom monitoring solutions have been developed to improve maintenance coordination, hygiene management, consumable monitoring, and facility supervision. The following systems were reviewed to identify their contributions and limitations in relation to the proposed study.

2.3.1 Smart Toilet Monitoring System Using IoT

The Smart Toilet Monitoring System developed by Dhamale et al. (2020) used sensors and Arduino-based controllers to monitor toilet conditions such as odor, humidity, and occupancy levels. The system transmitted information to an online dashboard where administrators could monitor facility conditions remotely. The system improved environmental monitoring and reduced the need for continuous physical inspections. However, the system mainly focused on environmental conditions and lacked features for consumable tracking, maintenance reporting, and centralized management required in KCCA public toilets.

2.3.2 Intelligent Hygiene Monitoring System

The Intelligent Hygiene Monitoring System developed by Mahalsekar et al. (2022) integrated soap level monitoring, water level monitoring, odor detection, and RFID-based cleaner attendance tracking. The system used the ThingSpeak cloud platform to generate hygiene reports and maintenance notifications. The system improved cleaner accountability and hygiene monitoring. However, it provided limited support for centralized management of multiple public facilities and lacked scalable web-based reporting features suitable for KCCA operations.

2.3.3 Kimberly-Clark Professional's Onvation Platform

Kimberly-Clark Professional developed the Onvation Platform to support restroom management through centralized dashboards and digital monitoring tools (Kimberly-Clark Professional, 2024). The platform monitored restroom usage, consumable levels, and maintenance requirements across multiple facilities. The system supported centralized monitoring and improved maintenance coordination. However, the platform required expensive proprietary infrastructure and complex deployment requirements, making it less suitable for low-resource public sanitation environments such as KCCA public toilets.

2.3.4 eToilet System

The eToilet system developed by Eram Scientific Solutions automated sanitation services through electronic controls and digital monitoring features (Eram Scientific Solutions, 2021). The system included automated flushing, water management, occupancy monitoring, and selfcleaning functionality. The system improved sanitation operations and hygiene standards. However, the high installation costs, infrastructure requirements, and limited maintenance reporting features reduced its suitability for KCCA's operational environment.

2.4 Research Gap

Table 1. Showing comparative analysis of existing systems

Existing System	Key Features	Limitations
Smart Toilet Monitoring System Using IoT	Environmental monitoring, occupancy detection, dashboard monitoring	No consumable tracking or maintenance reporting
Intelligent Hygiene Monitoring System	Hygiene monitoring, cleaner attendance tracking, maintenance notifications	Limited scalability and centralized management
Kimberly-Clark Onvation Platform	Centralized dashboards, consumable monitoring, maintenance alerts	Expensive infrastructure and deployment costs
eToilet System	Automated flushing, water management, self-cleaning	High installation costs and limited reporting features

The literature review revealed that many existing sanitation management systems mainly focus on environmental monitoring, automation, and sensor-based operations. Most systems reviewed lack affordable and scalable web-based management features suitable for public sanitation facilities in developing urban environments such as Kampala.

Several systems also depend on expensive hardware infrastructure, stable internet connectivity, and advanced automation technologies that may not be practical for KCCA operations. In addition, many existing systems provide limited support for **centralized reporting, maintenance coordination, consumable tracking, and accountability management.**

Therefore, there is a need for a low-cost and web-based public toilet management system capable of improving consumable tracking, maintenance reporting, facility supervision, and operational record management in KCCA public toilets. The proposed system addresses these gaps by providing a centralized platform for attendants and supervisors to manage sanitation operations more efficiently.

CHAPTER THREE: RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

This chapter presents the methodology and techniques that were used during the development of the KCCA Public Toilets Management System. It describes the system development methodology, requirements gathering methods, sampling techniques, data collection methods, design techniques, programming tools, and testing methods used throughout the study and system development process.

3.2 System Development Methodology

The project followed the System Development Life Cycle (SDLC) using the Agile development methodology. Agile methodology was selected because it supports iterative development, continuous feedback, flexibility, and collaboration between developers and users (Sommerville, 2016). The methodology also allows system requirements and features to be improved gradually during development.

The study adopted a structured system design approach because it provided a clear and organized way of analyzing system processes, data flow, inputs, and outputs. The structured approach was suitable for designing the KCCA public toilet management system since it simplified process modeling and system documentation.

The SDLC phases followed during the project included planning, requirements gathering and analysis, system design, iterative development and implementation, testing and feedback, deployment, and maintenance.

3.3 Requirements Gathering

The study employed interviews, questionnaires, and document review to gather system requirements. These methods were selected because they enabled the researchers to collect both qualitative and quantitative information from users and stakeholders.

Interviews were used to collect detailed information from KCCA supervisors regarding maintenance procedures, procurement planning, and operational challenges. Questionnaires were distributed to toilet attendants because they allowed data to be collected from multiple respondents within a short period of time. Document review was used to examine maintenance records, operational reports, and related literature to better understand existing processes and system requirements.

The collected data was analyzed to identify functional requirements such as consumable reporting, maintenance reporting, dashboard monitoring, and report generation, as well as nonfunctional requirements including security, usability, and reliability.

3.4 Sampling Techniques

The study used purposive sampling and random sampling techniques. Purposive sampling was used when selecting KCCA supervisors and management staff because they possessed detailed knowledge about public toilet operations and management processes (Etikan, et al., 2016).

Random sampling was used to select toilet attendants from different public toilet facilities in order to ensure fairness and reduce selection bias. The use of both sampling techniques enabled the researchers to collect relevant and reliable information from respondents directly involved in public toilet operations.

3.5 Target Population and Sample Size

The target population consisted of KCCA supervisors, management staff, and toilet attendants working in public toilet facilities across Kampala City. These respondents were selected because they were directly involved in the management and operation of public toilets.

3.5.1 sample size

The determination of the sample size will be adopted from Daniel and Cochran formula. The formula to be used for unknown population size and the popular is given as:

Based on this calculation and considering the practical constraints of accessing all respondents within the project timeline, a target sample size of 10 respondents was adopted, comprising 2 supervisors and 8 toilet attendants from various facilities.

$n = Z^2P(1-P)/d^2$ Where:
n = sample size=10

N= population=45

Z = statistical value for 95% confidence level = 1.96 P = expected prevalence/proportion = 0.5 (50%) d = precision =?
Substituting the values

$N = 45$

$n = 10Z = 1.96$ (for 95% confidence)

$$P = 0.5$$

$$d = 1.96 \times \sqrt{\frac{0.5 \times 0.5 \times (45 - 10)}{10 \times (45 - 1)}}$$

$$d = 1.96 \times \sqrt{\frac{0.25 \times 35}{10 \times 44}}$$

$$d = 1.96 \times \sqrt{\frac{8.75}{440}}$$

$$d = 1.96 \times \sqrt{0.019886} \approx 1.96 \times 0.141 = 0.276$$

Thus, the precision (margin of error) is approximately 27.6%. This means that with a sample of 10 from a population of 45, at 95% confidence, the true population proportion is expected to be within ±27.6 percentage points of the sample estimate.

The confidence level used is 95% (Z = 1.96), and the expected prevalence is taken as 0.5 to maximize variability.

3.6 Data Collection Methods

3.6.1 Interviews

Interviews were conducted with 2 KCCA supervisors to gather detailed information about the current workflows, maintenance challenges, consumable monitoring practices, and procurement planning processes in public toilets. The interview technique enabled us to obtain in-depth information, seek clarification on responses, and gain a better understanding of the existing system and its limitations.

3.6.2 Questionnaires

A total of 15 questionnaires were distributed to public toilet attendants with a returned total of 10 questionnaires to collect information regarding daily operational challenges, consumable shortages, maintenance reporting procedures, and communication methods. The questionnaire technique was selected because it enabled the collection of standardized data from multiple respondents within a relatively short period, making it appropriate for quantitative data collection and analysis.

3.6.3 Document Review

A total of 5 documents were reviewed, including maintenance records, operational records, procurement reports, inventory records, and relevant KCCA policy documents. The document review provided secondary data that helped the researchers understand the existing management procedures, validate information obtained through interviews and questionnaires, and identify the functional and non-functional requirements for the proposed IoT-based public toilet management system.

3.6.4 Data collection results

Research Objective	Data Collection Tool	Key Results
To understand the current practices of monitoring consumables in KCCA public toilets.	Questionnaires, Interviews, Document Review	Consumable monitoring is predominantly manual, relying on verbal reporting and paper records. There is no automated mechanism for monitoring stock levels, resulting in delayed replenishment and frequent stock-outs.
To identify the challenges in the current public toilet management system.	Questionnaires, Interviews	Major challenges identified include inadequate consumable supplies, delayed maintenance response, inconsistent reporting, lack of communication between attendants and supervisors, poor facility conditions, and dependence on manual processes. Supervisors also highlighted the time-consuming nature of physical inspections and lack of real-time visibility.
To determine the current maintenance reporting process.	Questionnaires, Interviews, Document Review	Maintenance issues are mainly reported through phone calls, verbal communication, and logbooks. Fault resolution often takes between one week and more than one week due to delayed reporting and lack of centralized maintenance tracking.
To identify the most common maintenance problems experienced in public toilets.	Questionnaires, Maintenance Records	Broken taps, faulty locks, lighting failures, and blocked drainage were identified as the most common maintenance problems requiring frequent intervention.
To establish the methods used for planning consumable restocking.	Interviews, Procurement Records	Restocking decisions are reactive and are triggered by complete depletion of consumables, complaints from users, or scheduled procurement rather than actual stock levels or usage trends.
To assess the readiness of attendants to use a digital management system.	Questionnaires	All respondents owned mobile phones, with the majority using smartphones. Most attendants indicated willingness to use a digital system for reporting maintenance issues and monitoring consumables.
To identify opportunities for improving public toilet management.	Open-ended Questionnaires, Interviews	Respondents recommended timely replenishment of consumables, faster maintenance response, improved communication between attendants and supervisors, staff training on digital systems, and recognition of attendants' performance.

3.7 Design Techniques and Tools

The project used several design techniques and modeling tools to represent system processes, data flow, and database relationships.

3.7.1 Data Flow Diagrams (DFDs)

DFDs were used to illustrate how information moves within the system between attendants, supervisors, Administrators and the database.

3.7.2 Entity Relationship Diagrams (ERDs)

ERDs were used to model database entities, attributes, and relationships involved in consumable management and maintenance reporting and administration of the system.

3.7.3 Flowcharts

Flowcharts were used to describe system processes and workflow sequences within the application.

The system architecture followed a client-server model integrating an attendant reporting interface, supervisor dashboard and an administrator dashboard connected to a centralized database.

3.8 Implementation tools

The system was implemented using HTML, CSS, JavaScript, PHP, and MySQL. HTML and CSS were used for designing user interfaces, JavaScript supported interactive functionalities, while PHP handled server-side processing and system logic. MySQL was used for database management and storage of system records.

WAMP server was used as the development environment because it supports PHP and MySQL integration.

3.9 Testing Techniques and Methods

The system underwent different testing methods to ensure that it functioned correctly and met user requirements.

3.9.1 Unit Testing

Unit testing was carried out to test individual system modules such as login authentication, maintenance reporting, and consumable reporting.

3.9.2 Integration Testing

Integration testing was conducted to verify that different system modules worked together correctly without errors.

3.9.3 System Testing

System testing was performed on the complete system to evaluate whether all functional and non-functional requirements had been achieved.

CHAPTER FOUR: SYSTEMS ANALYSIS AND DESIGN

4.1 Introduction

This chapter presented the system analysis and design for the KCCA Public Toilets Management System. The chapter was based on the findings obtained during requirements gathering and data analysis in the Software Requirements Specification (SRS). The system was intended to address the challenges identified in the current manual management of public toilet facilities under Kampala Capital City Authority (KCCA), including frequent stock-outs of consumables, delayed maintenance response, poor communication, lack of real-time monitoring, and inadequate historical records.

The chapter describes the designed system, presents data analysis findings, identifies the system user requirements, and outlines the functional and non-functional requirements of the proposed system. The chapter provides the foundation for the implementation of a web-based system that improves accountability, communication, monitoring, and decision-making in the management of public toilet facilities.

4.2 Description of the Designed System

The KCCA Public Toilets Management System is a web-based information system developed to digitize the monitoring and management of public toilet facilities across Kampala. The system replaces the current paper-based and verbal reporting methods with a centralized digital platform.

The system is composed of three major users namely the Toilet Attendant, Supervisor, and System Administrator.

The Toilet Attendant uses a mobile-optimized interface to:

- ✓ Log consumable stock levels for items such as toilet paper, soap, detergents, and sanitary pads.
- ✓ Report maintenance issues using predefined categories.
- ✓ View the status of submitted maintenance requests.

The Supervisor uses a dashboard to:

- ✓ Monitor all supervised facilities in real-time.
- ✓ Receive alerts for low or empty stock levels.
- ✓ View and manage maintenance requests.
- ✓ Generate reports on consumable usage and maintenance trends.
- ✓ Register facilities and attendant accounts.

The System Administrator manages:

- ✓ User accounts and access control.
- ✓ Audit logs and system monitoring.

4.3 Data Analysis and Results

4.3.1 Qualitative Data Analysis:

Data from interviews and open-ended questionnaire responses was analysed using thematic analysis, following the approach described by Miles, et al., (2014). This involved transcribing interview recordings, reading through transcripts to gain familiarization, identifying patterns and themes, coding the data according to emerging themes, and interpreting the findings to draw meaningful insights. Key themes identified included operational challenges, communication gaps, accountability issues, and user expectations.

4.3.2 Quantitative Data Analysis:

Quantitative data from closed-ended questionnaire items was analyzed using descriptive statistics including frequencies, percentages, and means. Microsoft Excel was used to generate tables, charts, and graphs to summarize and present the findings. Cross-tabulation was performed to examine relationships between variables such as facility type and frequency of stock-outs, or mobile phone **ownership and willingness to use a digital system**

4.3.3 Data analysis tools and techniques

Data Type	Data Analysis Tool and techniques	Purpose
Quantitative Data	Microsoft Excel Google forms analytics	Used to clean, code, organize, and analyze questionnaire data. It was used to generate descriptive statistics such as frequencies and percentages and to present the results using tables, bar charts, and pie charts.
Qualitative Data	Google forms Thematic Analysis	Used to analyze interview and observation data by coding responses, identifying recurring patterns, and grouping them into themes that addressed the study objectives.

4.3.3 Presentation of Findings

Table 2. Age Distribution of Attendants

Age Group	Frequency	Percentage (%)
18-25 years	3	37.5
26-35 years	2	25
36-45 years	1	12.5
46 years and above	2	25
Total	8	100%

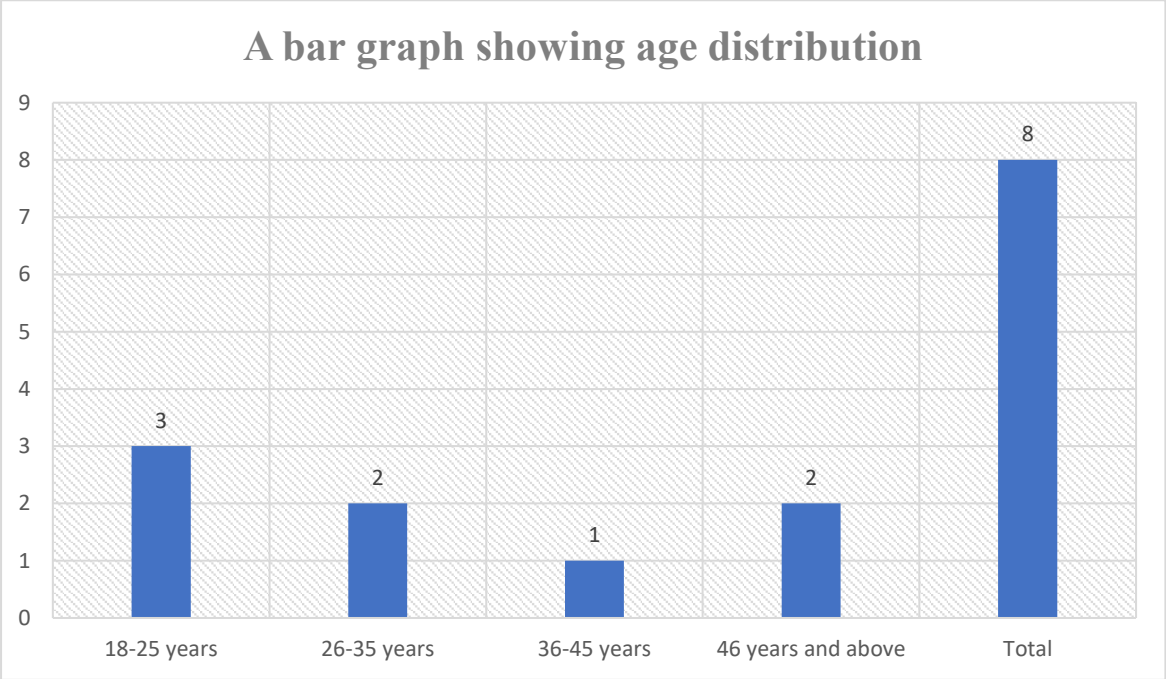


Figure 1: A bar graph showing the age distribution of attendants

In figure 1, the majority of attendants (37.5%) are in the 18-25 years age bracket, followed by those in the 26-35 years bracket (25%). This indicates a relatively young and potentially tech-savvy workforce that could adapt well to a digital system.

Table 3 Educational level of attendances

Education Level	Frequency	Percentage (%)
No formal education	2	25
Primary level	4	50
Secondary level	2	25
Tertiary level	0	0
Total	8	100%

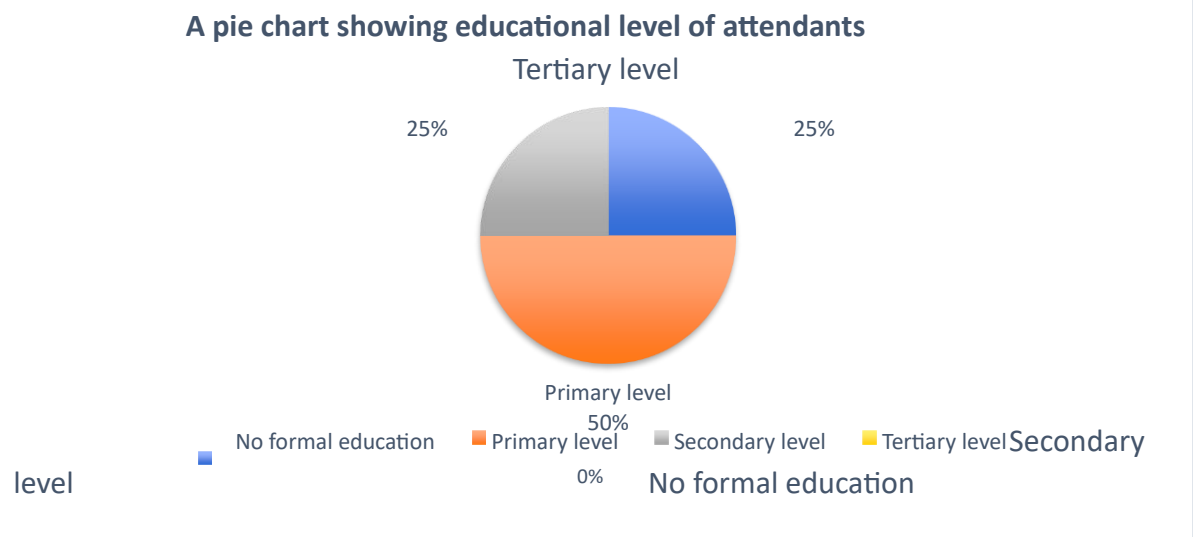


Figure 2 A pie chart showing the educational level of attendants

The majority of attendants have primary level education (50%) or secondary level education (25%), suggesting that a simple, intuitive interface with clear icons and minimal text would be most appropriate for the attendant application.

Findings on Current System and Practices

Table 4 Methods Used to Track Consumables

Tracking Method	Frequency	Percentage (%)
Mental note	0	0
Paper records	3	37.5
Verbal reporting to supervisor	4	50
Not tracked	1	12.5
Total	8	100%

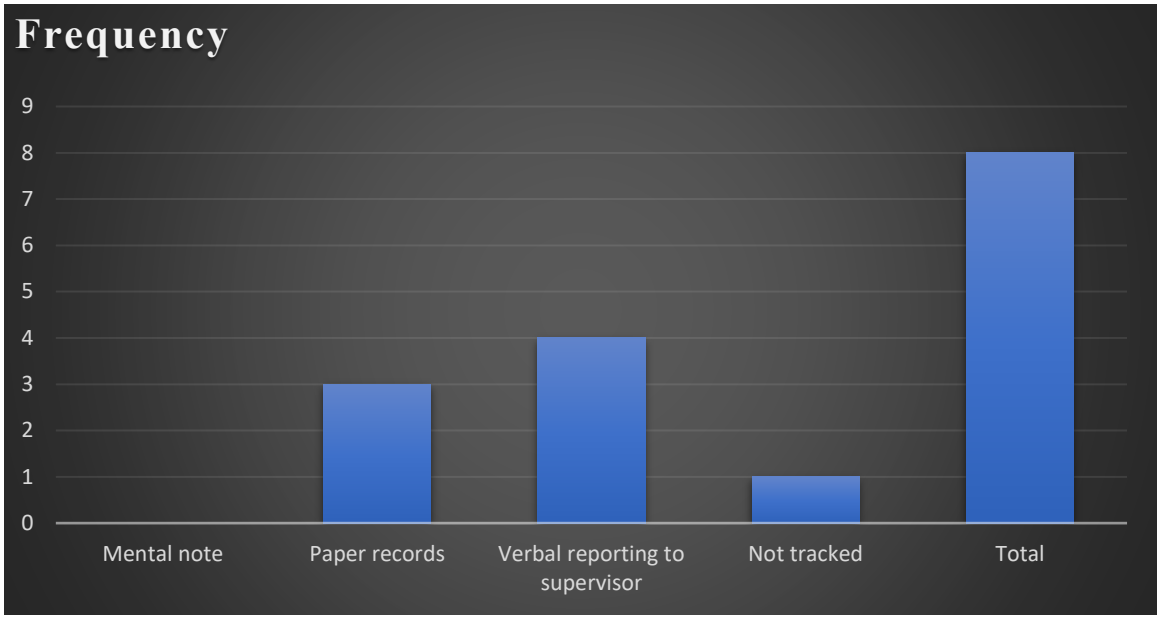


Figure 3 A bar graph showing methods used to track consumables

The findings reveal that the majority of attendants (50%) rely on verbal reporting to supervisors to track consumable levels, while only 37.5% maintain paper records. This indicates a highly informal and unreliable tracking system prone to human error and forgetfulness, explaining the frequent stock-outs reported.

Frequency of Checking Consumables

Table 5 Frequency of Checking Consumable Levels

Frequency	Frequency	Percentage (%)
Multiple times daily	5	62.5
Once daily	2	25
Every few days	0	0
Weekly	0	0
When I remember	1	12.5
Total	8	100%

62.5% of attendants check consumables multiple times daily, while 25% check once daily and 12.5% check whenever they remember. This inconsistent checking schedule contributes to stock-outs occurring before replenishment.

Current Maintenance Reporting Method.

Table 6 Methods of Reporting Maintenance Issues

Reporting Method	Frequency	Percentage (%)
Tell supervisor in person	1	12.5
Call supervisor	4	50
Write in a logbook	2	25
Wait for supervisor visit	1	12.5
Don't report	0	0
Total	8	100%

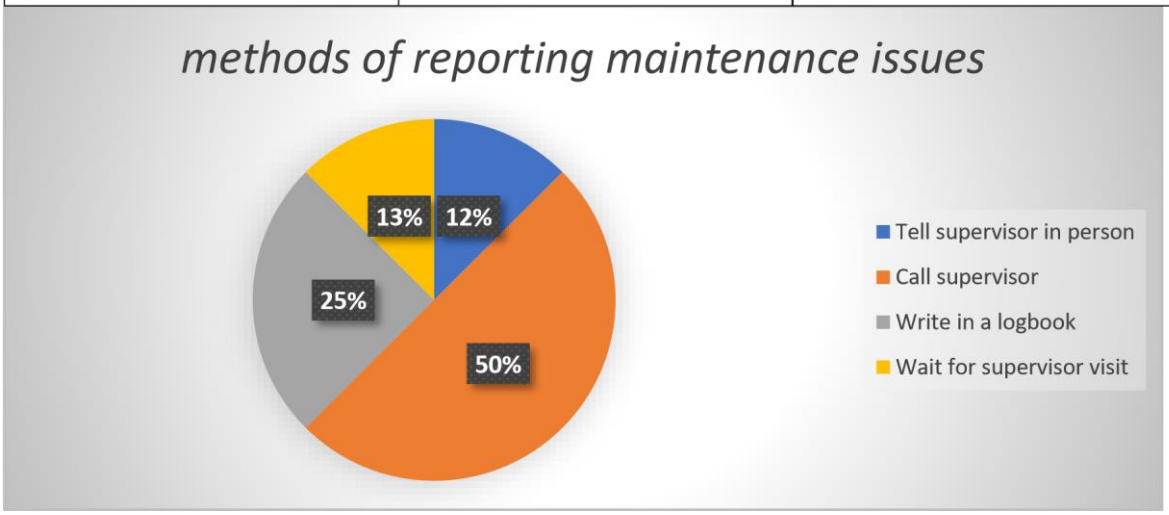


Figure 4 A pie chart representing the methods of reporting maintenance issues

The majority of attendants (50%) rely on calling the supervisor for reporting to communicate maintenance issues, while 50% use log books. Only 12.5% wait for supervisor visit, suggesting that written records are not consistently maintained, making it difficult to track maintenance history and response times.

Frequency of Stock-outs

Table 7 How Often Consumables Run Out Before Restocking

Frequency	Attendants (n=8)	Supervisors (n=2)
Very Often	3	2
Often	2	1
Sometimes	1	0
Rarely	1	1
Never	1	0

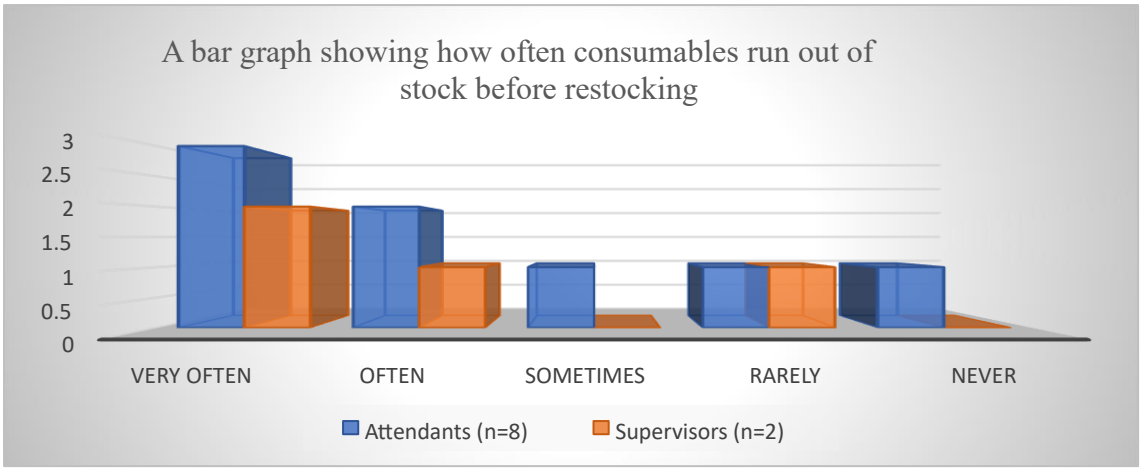


Figure 5 A bar graph showing how often consumables run out of stock before restocking

Both attendants and supervisors acknowledge that stock-outs are a frequent occurrence, with 37.5% of attendants and 100% of supervisors indicating that consumables run out "Very Often" or "Often" before restocking. This confirms the severity of the problem

Maintenance Response Times

Table 8 Time Taken to Fix Maintenance Issues

Response Time	Frequency	Percentage (%)
Same day	1	12.5
2-3 days	1	12.5
Within a week	3	37.5
More than a week	3	37.5
Never fixed	0	0
Total	8	100%

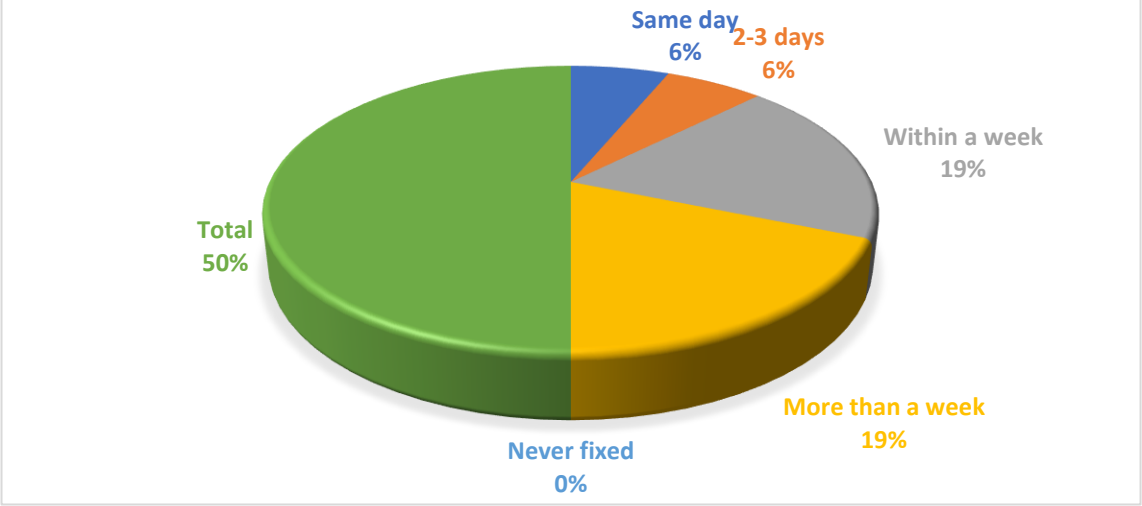


Figure 6 A pie chart showing time taken to fix maintenance issues

Only 12,5% of attendants report that maintenance issues are fixed the same day. The majority (37.5%) wait within a week, while 37.5% wait more than a week and 0% report that issues are never fixed. This confirms the reactive nature of maintenance and the prolonged downtimes highlighted in the problem statement.

Common Maintenance Problems

Table 9 Most Common Maintenance Problems (Ranked)

Problem Type	**Rank 1 (Most Common)**	**Rank 2**	**Rank 3**	**Overall Score***
Broken taps	3	4	3	10
Faulty locks	1	2	2	5
Lighting issues	2	1	2	5
Blocked drainage	2	0	1	3
Broken toilet seats	0	1	0	1
Cracked floors/walls	0	0	0	0

Broken taps emerged as the most common maintenance problem, followed by faulty locks and lighting issues. These findings inform the system design by identifying the key maintenance categories that should be included in the reporting interface.

Challenges Faced by Attendants

Table 10 Daily Challenges Reported by Attendants

Challenge	Frequency	Percentage (%)
Inadequate supplies	5	62.5
Slow maintenance response	6	75
Poor facility condition	3	37.5
Difficult users	7	87.5
Lack of communication with supervisors	5	62.5
Low pay	7	87.5
Lack of recognition	5	62.5

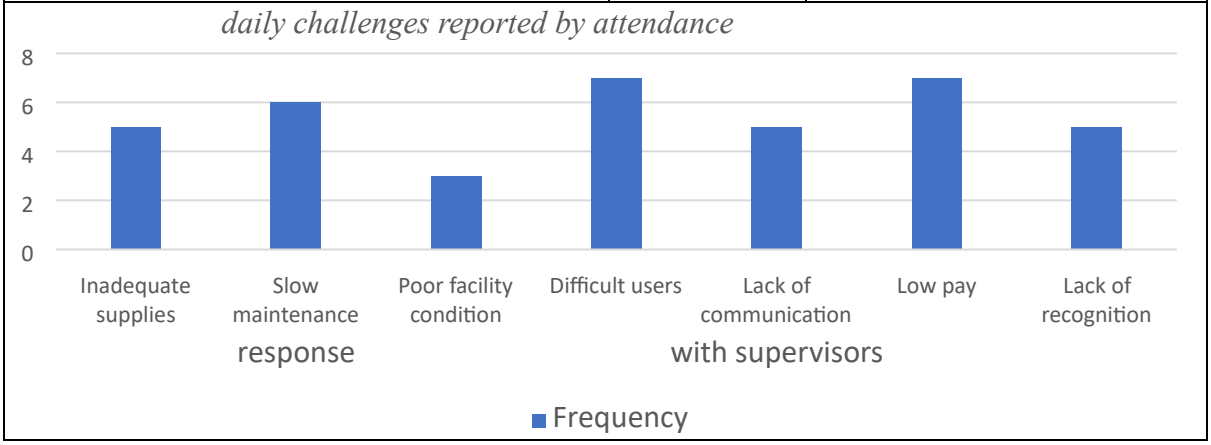


Figure 7: bar graph showing daily challenges reported by attendance

Difficult users (87.5%) and slow maintenance response (75%) are the most frequently cited challenges, directly supporting the need for a system that improves supply chain visibility and maintenance tracking.

Mobile Phone Ownership and Internet Access

Table 11 Mobile Phone Ownership

Phone Ownership	Frequency	Percentage (%)
Yes	10	100
No	0	0
Total	10	100%

Table 12 Type of Phone Owned

Phone Type	Frequency	Percentage (%)
Basic phone (calls/SMS only)	2	20
Smartphone (with internet)	8	80
Total	17	100%

Table 13 Internet Access on Phone

Internet Access	Frequency	Percentage (%)
Yes	4	50
No	2	25
Sometimes	2	25
Total	17	100%

The findings reveal high mobile phone ownership (100%) among attendants, with 80% owning smartphones and 50% having regular internet access. This indicates strong potential for a webbased application, while the 25% with basic phones suggests the need for SMS-based alerts as a complementary feature.

Supervisor Findings on Current Workflow

Table 14 Pain Points Identified by Supervisors:

Pain Point	Number of Supervisors	Percentage (%)
Time-consuming nature of physical inspections	2	100
Lack of real-time visibility between inspections	2	100
Inconsistent reporting from attendants	2	100
Difficulty verifying attendant reports	1	50
No historical data for planning	2	100
Delayed detection of maintenance issues	1	50

Restocking Planning: All 2 supervisors (100%) indicated that restocking decisions are based on reactive measures rather than data. Typical triggers for restocking include:

- ✓ Complete depletion of stock (reported by attendants verbally)
- ✓ User complaints
- ✓ Scheduled but infrequent bulk ordering

User Needs and Recommendations

When asked open-ended question about suggestions for improving toilet management, attendants provided the following recommendation

Table 15 Attendant Suggestions

Suggestion	Frequency	Percentage (%)
Ensure timely supply of consumables	7	87.5
Faster response to maintenance issues	6	75
Better communication with supervisors	7	87.5
Training on new systems	6	75
Recognition for good performance	5	62.5

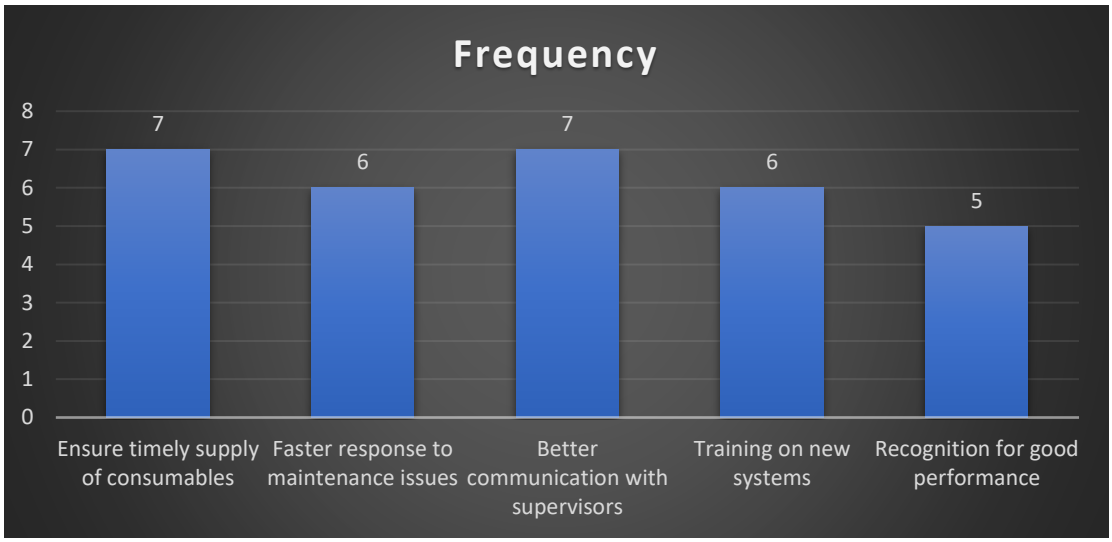


Figure 8 A combined bar graph showing attendant suggestions

The findings revealed several key issues in the current management system:

i. No supervisor reported having a formal restocking level system based on usage data
ii. The findings revealed several key issues in the current management system:
iii. 50% of attendants rely on verbal reporting for tracking consumables.
iv. 12.5% of attendants do not track consumables at all.
v. 100% of supervisors reported frequent stock-outs of essential consumables.
vi. 75% of attendants indicated that maintenance issues take within a week or more than a week to be resolved.
vii. 100% of supervisors reported lack of real-time visibility between inspections.
viii. 80% of attendants own smartphones, indicating suitability for a web-based mobile application.
ix. 50% of attendants have primary-level education, emphasizing the need for a simple and user-friendly interface.

The findings demonstrated the need for a digital system capable of providing:

i. Visible monitoring of consumables.
ii. Structured maintenance reporting.
iii. Faster communication between attendants and supervisors.
iv. Automated alerts and notifications.
v. Historical data for planning and decision-making.

The data analysis findings directly informed the design and requirements of the proposed KCCA Public Toilets Management System.

4.4 System user requirements

Based on the data analysis, the following user requirements were identified: a simple, mobile optimised interface for attendants to log stock levels and report issues with minimal text entry; a real-time dashboard for supervisors showing the status of all assigned facilities; the ability to track maintenance requests from submission to resolution; automated in-browser alerts when stock reaches low or empty levels; secure login and role-based access control; an audit trail of all system activities; and report generation for consumable usage and maintenance frequency.

4.5 Functional Requirements and non-functional requirement

4.5.1 Functional Requirement.

Functional requirements specify the expected behavior of the system, what the system must do. These requirements emerge directly from the challenges and needs identified during data collection.

Table 16 Functional Requirements for Attendant Application

ID	Functional Requirement	Source / Justification
FR-01	The system should provide a secure login interface for attendants using unique username and password credentials.	Need for accountability and preventing unauthorized access
FR-02	The system should allow attendants to log current stock levels for toilet paper, hand soap, detergents, sanitary pads and others using the assigned threshold (quantity)	62.5% of attendants cited inadequate supplies and therefore need for real-time visibility.
FR-03	The system should enable attendants to report maintenance issues by selecting from predefined categories: Broken taps, Faulty locks, Lighting issues, Blocked drainage, Broken toilet seats, Cracked floors/walls.	Based on ranked maintenance problems
FR-04	The system should allow attendants to add optional descriptive comments when reporting maintenance issues.	Captures details not covered by predefined categories.
FR-05	The system should display a confirmation message upon successful submission of consumable logs and maintenance reports.	User feedback and usability requirement.
FR-06	The system should allow attendants to view the status of their previously reported maintenance requests (Pending, In Progress, Resolved).	Transparency and user engagement
FR-07	The system should be optimized for mobile devices with simple, large buttons and minimal text input	80% smartphone ownership; educational levels

Table 17 Functional Requirements for Supervisor Dashboard

FR-08	The system should provide a dashboard displaying a summary of all supervised facilities with color-coded status indicators.	100% of supervisors oversee 7+ facilities; need for quick overview
FR-09	The system should generate real-time alerts for consumable levels marked as "Low" or "Empty" by attendants.	100% of supervisors requested realtime stock alerts (Table 2.16).
FR-10	The system should display all pending maintenance requests with facility name, issue type, date reported, and days pending.	100% of supervisors requested pending maintenance view
FR-11	The system should allow supervisors to update maintenance request status (In Progress, Resolved, Rejected).	Workflow management requirement.
FR-12	The system should automatically flag maintenance requests unresolved after 3 days for supervisor attention.	Response time data (Table 2.10); need to reduce delays.
FR-13	The system should enable supervisors to view detailed facility history including consumable logs and maintenance records.	90% reported lack of historical data for planning.
FR-14	The system should generate reports on consumable usage trends, maintenance frequency, and average response times over selectable periods.	75% requested usage trends for procurement and restocking planning need.
FR-15	The system should allow supervisors to register new facilities and attendant accounts.	System administration requirement.

Table 18 Functional Requirements for Alerting and Notifications

ID	**Functional Requirement**	**Source / Justification**
FR-16	The system should send alerts to supervisors when critical stock levels ("Empty") are reported, using toast notifications.	20% of attendants use basic phones; need for offline alerts
FR-17	The system should send notification to supervisors when high priority maintenance issues (e.g., blocked drainage) are reported.	Ensures rapid response to critical issues.
FR-18	The system should log all alerts sent for audit and tracking purposes.	Accountability and record-keeping.

4.5.2 Non-functional Requirements

Non-functional requirements specify the quality attributes and constraints of the system on how the system should perform.

Table 19 Non-functional Requirements

ID	Non-functional Requirement	Category	Source / Justification
NFR-01	The attendant application should load in under 3 seconds on 3G mobile network connections	Performance	50% have internet access, often on slow connections.
NFR-02	The supervisor dashboard should load in under 5 seconds on standard broadband connections.	Performance	Efficiency for daily use.
NFR-03	The system should achieve 99.5% uptime during peak operational hours (6:00 AM - 10:00 PM).	Availability	Facilities operate daily; system must be reliable.
NFR-04	All user passwords should be stored using secure hashing algorithms.	Security	Protect user accounts and data.
NFR-05	The system should enforce role-based access control: attendants' access only their facility; supervisors access multiple facilities.	Security	Data confidentiality and integrity.
NFR-06	The attendant interface should be usable by individuals with primary-level education, using icons and minimal text.	Usability	50% have primary or no formal education (Table 2.2).
NFR-07	The system should validate all user inputs to prevent SQL injection and data corruption	Security	Protect database integrity.
NFR-08	The system should be designed to support up to 50 facilities and 100 users without performance degradation.	Scalability	Future expansion capability.
NFR-09	The system should maintain an audit log of all data entries, modifications, and alerts for a minimum of 12 months.	Data Integrity	Accountability and audit requirements
NFR-10	The system should be compatible with Google Chrome, Mozilla Firefox, and Safari browsers	Compatibility	Standard browser support

4.5.2.1 System Requirements

Based on the functional and non-functional requirements, the following technical specifications are required for system implementation.

Table 20 Hardware Requirements

Component	Minimum Requirement	Recommended
Server (for deployment)	2.0 GHz dual-core processor, 4GB RAM, 100GB storage	3.0 GHz quad-core, 8GB RAM, 250GB SSD
Client Computer (for supervisors and administrator)	1.8 GHz processor, 2GB RAM, internet connection	2.5 GHz processor, 4GB RAM, broadband
Mobile Device (for attendants)	Basic smartphone with internet capability	Android/iOS smartphone with 3G/4G

Table 21 Software Requirements

Component	Technology	Justification
Frontend Development	HTML5, CSS3, JavaScript	Standard web technologies; mobile responsive
Backend Development	PHP	Open-source, widely supported, team expertise
Database	MySQL	Relational, open-source, integrates with PHP
Web Server	Apache(viaWAMP/XAMPP)	Development environment, free
Operating System	Window(development)Linux (production)	Compatibility and production stability

Table 22: Network Requirements

Requirement	Specification
Internet Bandwidth (Server)	Minimum 5 Mbps dedicated
Internet Bandwidth (Supervisor)	Minimum 2 Mbps
Mobile Network (Attendant)	3G or 4G connectivity preferred
Protocol	HTTP/HTTPS for web

4.6 High-Level Architecture the System

The KCCA Public Toilets Management System follows a three-tier client-server architecture comprising the Presentation Tier, Application Logic Tier, and Data Tier. This architecture ensures separation of concerns, maintainability, and scalability.

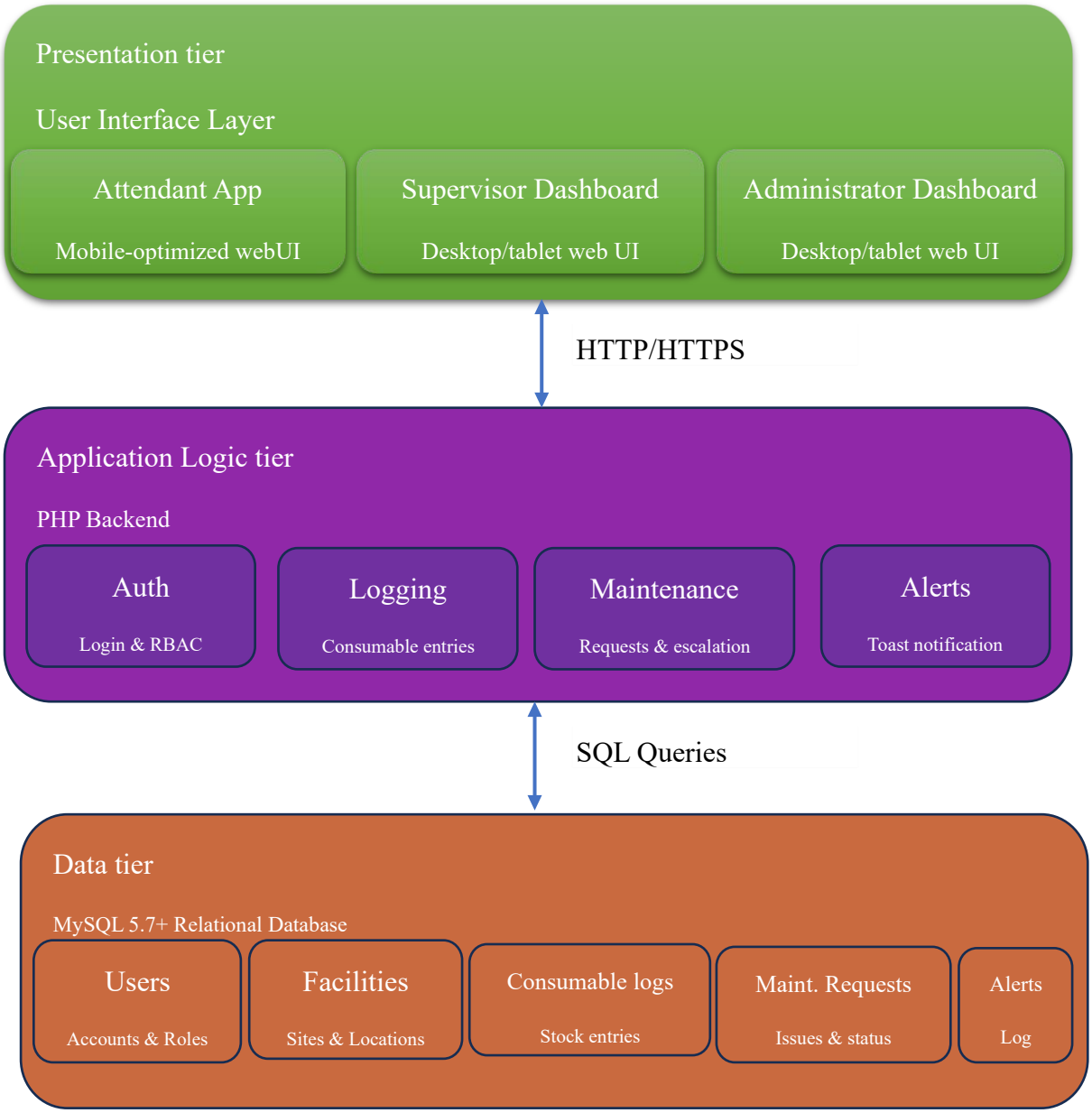


Figure 9: Three-Tier System Architecture Diagram

Presentation Tier (User Interface)

The front-end layer consists of two web interfaces:

- **Attendant Application**. a mobile-optimized web interface designed for low-literacy users, featuring large icons, color-coded inputs, and minimal text entry.
- **Supervisor Dashboard.** a desktop/tablet interface that aggregates daily-updated data from all supervised facilities with color-coded status indicators and management controls. Both interfaces communicate with the backend via HTTP/HTTPS protocols.
- **Administrator dashboard**. a desktop/tablet interface used to manage user accounts, facilities, and views audit logs.

Application Logic Tier (Backend)

The PHP backend handles all business logic including:

- User authentication and role-based access control.
- Consumable logging and threshold evaluation.
- Maintenance request management and auto-escalation after 3 days.
- Alert generation and toast notifications.
- Report compilation and audit trail maintenance.

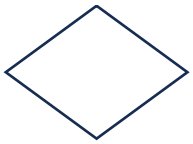
Data Tier (Database)

A MySQL relational database stores all system data including user accounts, facility records, consumable logs, maintenance requests, alert logs, consumable thresholds and audit trails.

4.7 System Flowchart

The flow chart models the procedural logic of the login and logout processes within the KCCA Public Toilets Management System. It explicitly shows decision points (e.g., username existence, password verification), error handling paths (e.g., invalid format, wrong password), and the final redirection based on user role (attendant or supervisor). Additionally, the diagram captures the session destruction and audit logging steps during logout. This diagram serves as a bridge between the functional requirements and the implementation, ensuring that all possible execution paths are considered and correctly coded (Dennis, Wixom, & Tegarden, 2020).

Key symbols

	Process
	Decision
	Flow
	Terminator

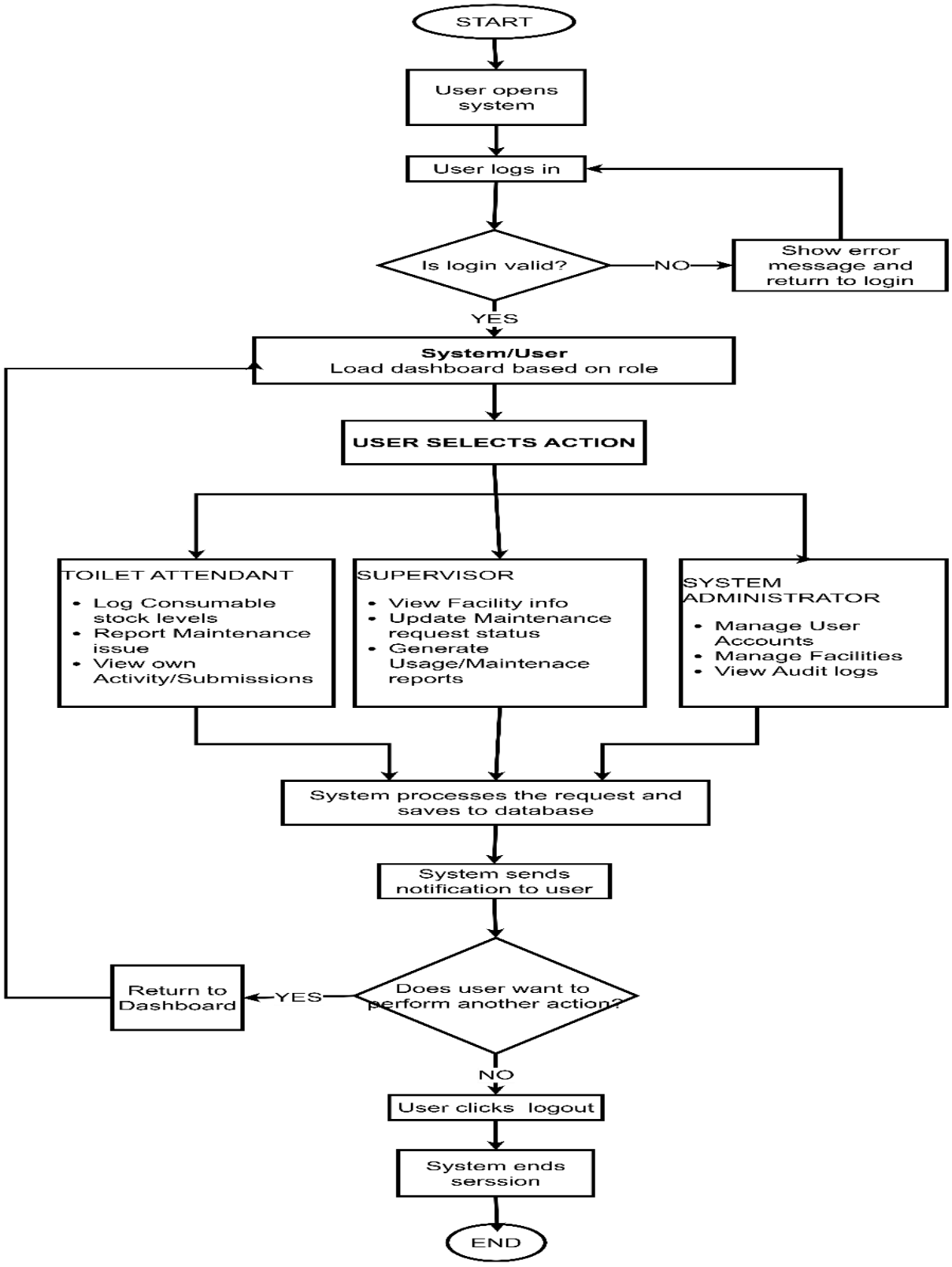


Figure 10: System Flowchart – KCCA Public Toilets Management System

The flowchart illustrates the end-to-end operational workflow of the KCCA Public Toilets Management System, detailing the user journey from initial access through authentication, role-based navigation, task execution, and session termination.

Process overview

The flow begins when a user opens the system and proceeds to the login interface. The system validates the entered credentials against the user data store. If authentication fails, an error message is displayed and the user is returned to the login screen. Upon successful validation, the system identifies the user's assigned role and loads the corresponding dashboard.

Role-Based Branching:

- **Toilet Attendants** are presented with options to log consumable stock quantities daily, report maintenance issues, or view their own activity history.
- **Supervisors** can view facility information, update maintenance request statuses, and generate usage or maintenance reports.
- **System Administrators** manage user accounts, facilities, and access audit logs.

Core processing

Regardless of the selected action, the system processes the request and persists the data to the appropriate database tables (e.g., consumable_log, maintenance_request). A confirmation notification is then sent to the user. A decision point follows, asking whether the user wishes to perform another action. If yes, the flow returns to the role-specific action selection; if no, the user may proceed to logout.

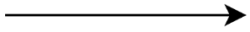
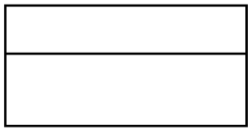
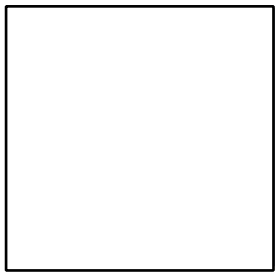
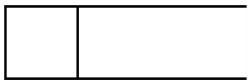
Termination

The user clicks the logout button, prompting the system to end the session securely, after which the process concludes. The diagram uses standard flowchart symbols: ovals for start/end, rectangles for processes, and diamonds for decision points, clearly mapping the logical sequence of system interactions.

4.8 Context Diagram (Level 0 DFD)

The Context Diagram presents the system as a single process and illustrates the data flows between the system and its external entities, (Dennis et al., 2020): Toilet Attendant, Supervisor, System Administrator

Table 4.1 key symbols used in the context diagram

Symbol	Name	Description
	Dataflow	Shows the direction in which information moves
	Process	Represents the specific function that transforms data inputs into outputs
	External entity	It provides inputs to the system and/or receives outputs from it.
	Data store	Represents where data is stored

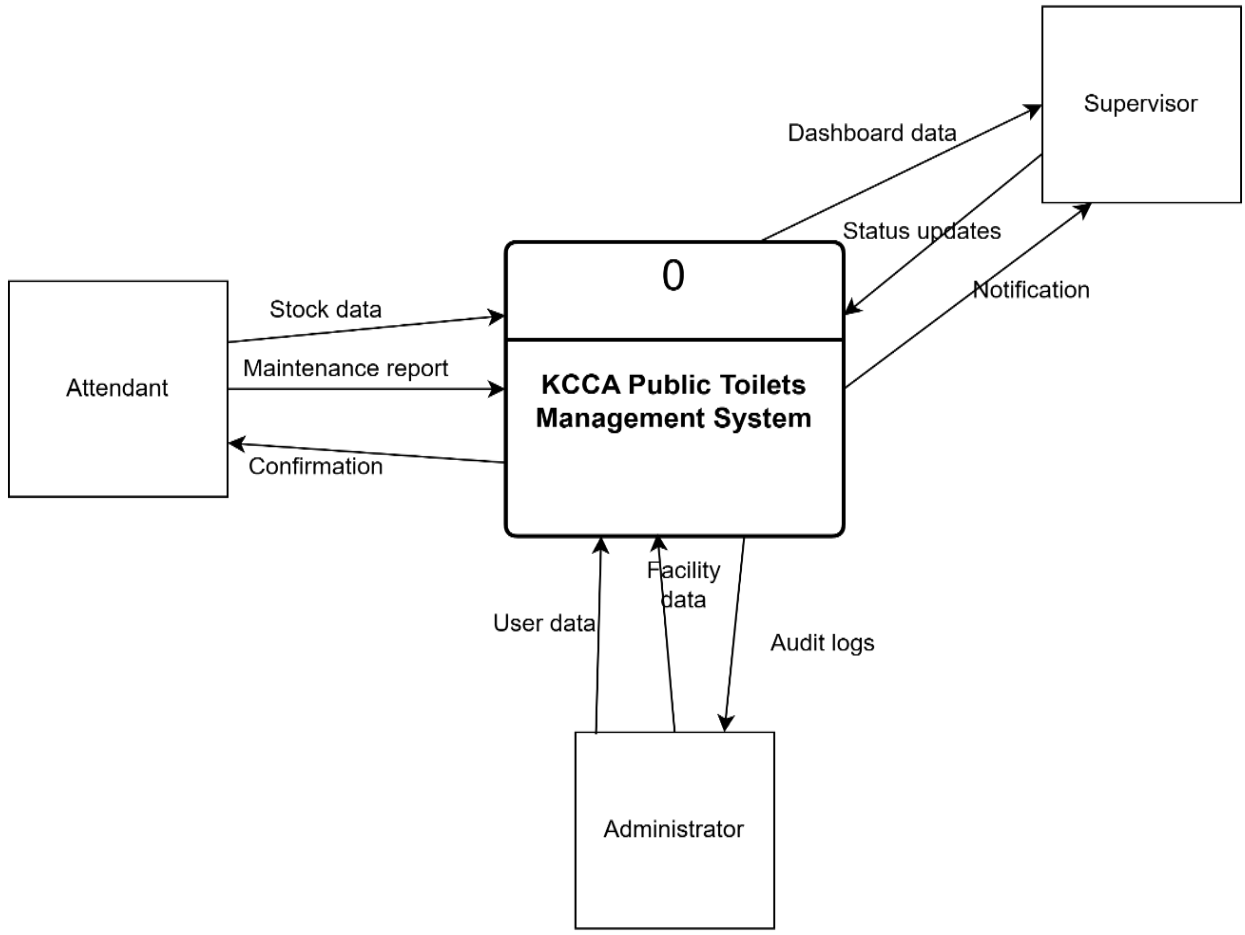


Figure 11: Context Diagram (Level-0 DFD)

The context diagram presents the KCCA Public Toilets Management System as a single centralised process (Process 0) surrounded by three external entities that interact with it.

The **Attendant** interacts with the system by submitting two categories of input data flows: stock data (consumable stock quantity logged per facility visit) and maintenance reports (issue category and optional description). In return, the system sends back a confirmation response to acknowledge successful submission.

The **Supervisor** engages in a bidirectional relationship with the system. The supervisor sends status update data flows into the system to change the state of maintenance requests (for example, from pending to in-progress or resolved). The system returns two outgoing flows to the supervisor: dashboard data, which includes real-time facility status information used to populate the colour-coded dashboard, and toast notifications.

The **Administrator** similarly has a bidirectional relationship. The admin sends user and facility data into the system to create, update, or delete user accounts and facility records. The system returns audit logs and reports to the administrator, providing a paged view of all system activity.

4.8.1 Level-1 Data Flow Diagram

The Level 1 DFD decomposes the central process into key sub-processes, showing how data flows between them and the system's data store

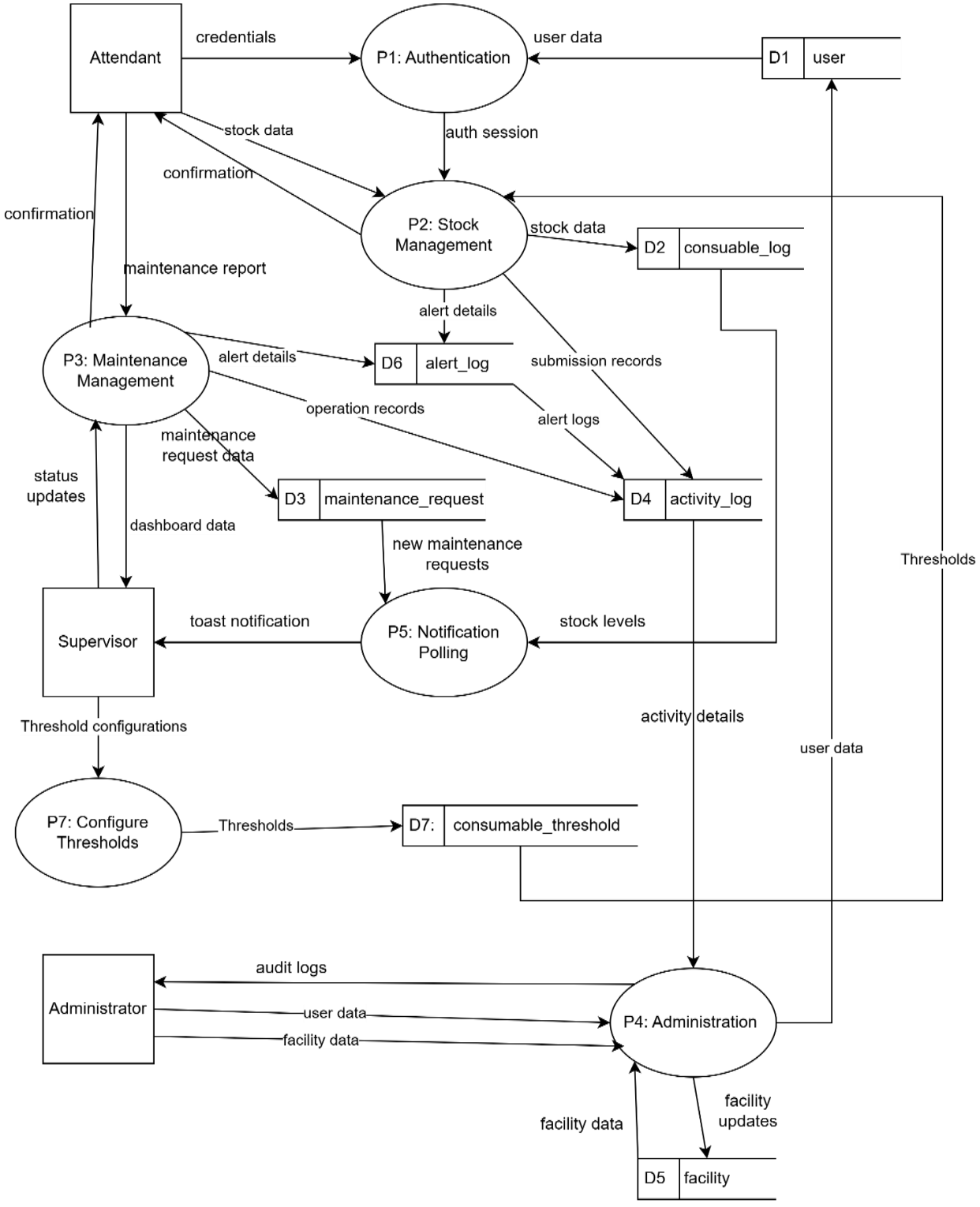


Figure 12 Level-1 Data Flow Diagram

P1: Authentication receives credentials (email and password) from all three external entities — Attendant, Supervisor, and Admin — and queries **D1: user** using a prepared statement to retrieve the matching user record. It verifies the bcrypt password hash and, on success, establishes a PHP session. It then passes an authenticated session context downstream to the role-specific processes.

P2: Stock Management receives stock level data from the Attendant following successful authentication. It writes new consumable log entries to **D2: consumable_log** via prepared statements, and records every submission in **D4: activity_log**. If any submitted stock level is Low or Empty, the process also writes an audit entry to the alert_log table.

P3: Maintenance Management receives maintenance reports from the Attendant (new issue submissions with category and description) and status update flows from the Supervisor (changing request states). New requests are written to **D3: maintenance_request** with an initial status of *pending*. Status changes update the same store. Both types of operation are recorded in **D4: activity_log**.

P4: Administration receives user and facility management data from the Administrator entity. It performs create, read, update, and delete operations on **D1: user** and **D5: facility**. All administrative actions are written to **D4: activity_log**, which is returned to the Admin as a paged audit log view.

P5: Notification Polling is a process invoked by the Supervisor's browser every 30 seconds via a GET request to *dashboard_poll.php*. The process reads new rows from **D2: consumable_log** and **D3: maintenance_request** that were inserted after the Supervisor's last poll timestamp. It returns a JSON response containing any new notifications to the Supervisor's browser, which then calls *showToast()* to display the in-browser alert.

P6: Configure Thresholds receives per-facility, per-consumable threshold values (restock quantity, peak, adequate, low, and critical percentages) from the Supervisor. It validates the input to ensure that the percentage hierarchy (Peak > Adequate > Low > Critical) is respected and then writes or updates the corresponding records in D6: consumable_threshold using prepared statements. These thresholds are subsequently used by P2: Stock Management to determine the status of a consumable whenever a new quantity is logged

4.9 Database design

The design is described by the conceptual design, which captures the high-level entities and their relationships in an implementation-independent form, and the logical design, which refines those entities into relations with defined attributes, domains, and constraints (Elmasri & Navathe, 2016).

4.9.1 Conceptual Database Design

The conceptual design identifies the real-world entities that the system must track, the attributes that describe each entity, and the relationships between them, Elmasri & Navathe, 2016). The primary output of this stage is the Entity Relationship Diagram (ERD) together with a formal description of each relationship and its multiplicity.

Entities

- **USER** – represents every person with a system account. The role attribute distinguishes attendants, supervisors, and administrators.
- **FACILITY** – represents a physical public toilet location operated by KCCA.
- **CONSUMABLE_LOG** – records a single stock level observation for one consumable item at one facility at a point in time.
- **MAINTENANCE_REQUEST** – records a maintenance issue reported by an attendant and tracks its resolution lifecycle.
- **ACTIVITY_LOG** – an append-only audit record of every significant action performed by any user.
- **ALERT_LOG** – records threshold-triggered events (critical or empty stock, high-priority maintenance) for audit purposes.
- **CONSUMABLE_THRESHOLD -** Defines the stock control limits for consumable items within each facility.

Relationships and Multiplicities

The following table formally describes each relationship identified in the ERD, its type, its multiplicity, and the business rule it enforces.

Table 23 Showing relationships and multiplicities

Relationship	Entities Involved	Multiplicity	Business Rule
Supervises	USER → FACILITY	One-to-Many	One supervisor user may be responsible for one or more facilities. Each facility must have exactly one assigned supervisor.
Assigned to	USER → FACILITY	Many-to-One	Many attendant users may be assigned to the same facility. An attendant belongs to at most one facility at a time. Admin users have no facility assignment.
Logs	USER → CONSUMABLE_LOG	One-to-Many	One attendant user may submit zero or many consumable log entries over time. Each log entry is attributed to exactly one attendant.
Has (stock)	FACILITY → CONSUMABLE_LOG	One-to-Many	One facility accumulates many consumable log records over its operational lifetime. Each log record belongs to exactly one facility.
Reports	USER → MAINTENANCE_REQUEST	One-to-Many	One attendant user may submit zero or many maintenance requests. Each request is attributed to exactly one attendant.
Has (maintenance)	FACILITY → MAINTENANCE_REQUEST	One-to-Many	One facility may have many maintenance requests raised against it. Each request is linked to exactly one facility.
Generates	USER → ACTIVITY_LOG	One-to-Many	Every system action by a user produces one activity log entry. One user may generate many activity log records. If a user is deleted, the UserID on their log entries is set to NULL to preserve audit history.
Triggers	FACILITY → ALERT_LOG	One-toMany	A facility may accumulate many alert records whenever a stock level crosses the low or empty threshold. Each alert record is associated with exactly one facility.

4.10 Entity Relationship Diagram (ERD)

The ERD below shows the six entities, their key attributes, and the relationships connecting them. Crow's-foot notation is used to indicate cardinality.

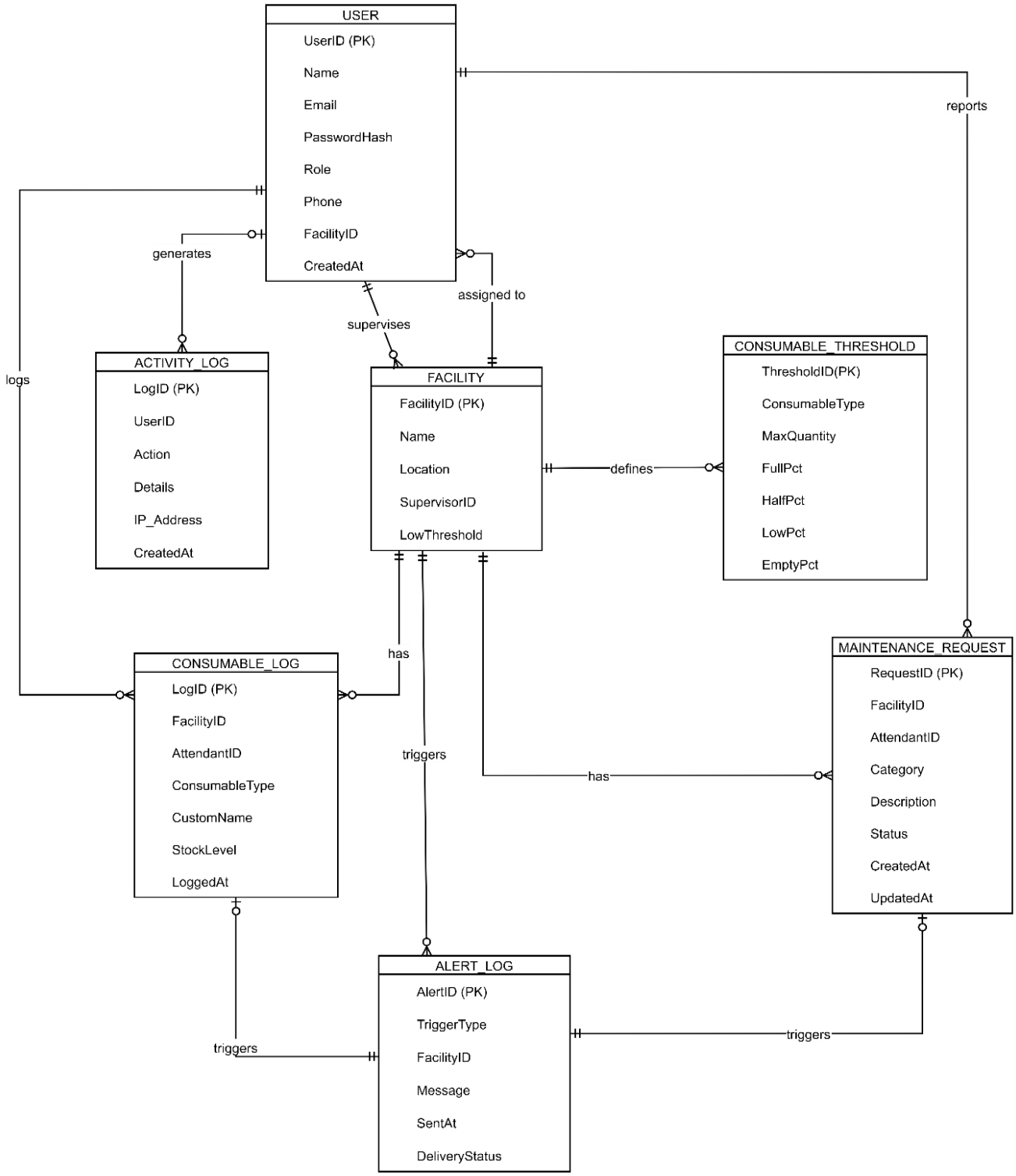


Figure 13 showing the entity relationship diagram

4.10.1 Logical Database Design

The logical design describes the structure of the data in a technology-independent manner. It defines the entities, attributes, primary keys (PK), foreign keys (FK), and the relationships between them.

Relation Schemas

The six relations and their schemas are defined below. Primary keys are **bold and underlined**; foreign keys are shown in *italics*.

USER (**UserID**, Name, Email, PasswordHash, Role, Phone, *FacilityID*, CreatedAt)

FACILITY (**FacilityID**, Name, Location, *SupervisorID*, LowThreshold)

CONSUMABLE_LOG (**LogID**, *FacilityID*, *AttendantID*, ConsumableType, CustomName, StockLevel, LoggedAt)

MAINTENANCE_REQUEST (**RequestID**, *FacilityID*, *AttendantID*, Category, Description, Status, CreatedAt, UpdatedAt)

ACTIVITY_LOG (**LogID**, *UserID*, Action, Details, IP_Address, CreatedAt)

ALERT_LOG (**AlertID**, TriggerType, *FacilityID*, Message, SentAt, DeliveryStatus)

CONSUMABLE_THRESHOLD (**ThresholdID,** FacilityID, ConsumableType, MaxQuantity FullPct, HalfPct, LowPct, EmptyPct, CreatedAt)

4.10.2 Physical database design

The physical database design below provides a complete, attribute-level description of every field in the database. It defines the name, description, data type, domain of allowed values, nullability, default value, and any additional constraints for each attribute (Coronel & Morris, 2019).

Table: USER

Stores all system accounts. The Role attribute determines which parts of the application the user can access and what operations they can perform.

Attribute	Description	Type	Domain / Allowed Values	Null	Default	Constraints
UserID	Unique identifier for each user account	Integer	Positive integers	NOT NULL	Autoincrement	PRIMARY KEY
Name	Full name of the user	String	Text, max 100 chars	NOT NULL	—	—
Email	Email address used for login	String	Valid email, Max 150 chars	NOT NULL	—	UNIQUE
Password Hash	bcrypt hash of the user's password	String	bcrypt output, max 255 chars	NOT NULL	—	—
Role	Determines the user's access level and capabilities	Enumeration	{attendant, supervisor, admin}	NOT NULL	—	—
Phone	Optional contact phone number	String	Text, max 20 chars	NULL	NULL	—
FacilityID	The facility the user is assigned to (attendants and supervisors only)	Integer	Must exist in FACILITY	NULL	NULL	FOREIGN KEY → FACILITY (facilityID), SET NULL on delete
CreatedAt	Timestamp when the account was created	Date/time	Valid datetime	NOT NULL	Current timestamp	—

Table 24 Users table

Table: FACILITY

Stores records for each public toilet facility operated by KCCA. Each facility must be assigned to a supervisor user account.

Table 25 Table for facility

Attribute	Description	Type	Domain / Allowed Values	Null	Default	Constraints
FacilityID	Unique identifier for each facility	Integer	Positive integers	NOT NULL	Autoincrement	PRIMARY KEY
Name	Descriptive name of the facility	String	Any text, max 150 chars	NOT NULL	—	
Location	Physical address or area description of the facility	String	Any text, max 255 chars	NOT NULL	—	
SupervisorID	The user responsible for overseeing this facility	Integer	Must exist in USER where Role = supervisor	NOT NULL	—	FOREIGN KEY → USER(UserID)
LowThreshold	Stock quantity below which a low-stock alert is triggered	Integer	Positive integers	NOT NULL	20	

Table: CONSUMABLE_LOG

Each row represents one stock level observation for one consumable item, submitted by one attendant at one facility. Multiple rows are inserted per submission — one per consumable type logged. When ConsumableType is 'other', the CustomName attribute holds the user-defined item name; for all standard types CustomName is NULL.

Attribute	Description	Type	Domain / Allowed Values	Null	Default	Constraints
LogID	Unique identifier for each consumable log entry	Integer	Positive integers	NOT NULL	Autoincrement	PRIMARY KEY
FacilityID	The facility at which the stock was observed	Integer	Must exist in FACILITY	NOT NULL	—	FOREIGN KEY → FACILITY(FacilityID)
AttendantID	The attendant who submitted the stock observation	Integer	Must exist in USER where Role = attendant	NOT NULL	—	FOREIGN KEY → USER(UserID)
ConsumableType	The type of consumable being logged	Enumeration	{toilet_paper, soap, detergent, pads, other}	NOT NULL	—	—
CustomName	User-defined name for non-standard consumables	String	Any text, max 100 chars	NULL	NULL	Required when ConsumableType = 'other'
StockLevel	The observed stock level for the consumable	Enumeration	{full, half, low, empty}	NOT NULL	—	Values of 'low' or 'empty' trigger an ALERT_LOG entry
LoggedAt	Timestamp of the stock observation	Datetime	Valid datetime	NOT NULL	Current timestamp	—

Table 26 Showing consumable logs

Table: MAINTENANCE_REQUEST

Each row represents a maintenance issue reported at a facility. The Status attribute progresses through a defined lifecycle: pending → in_progress → resolved or rejected. UpdatedAt is set by the application each time a supervisor changes the status.

Attribute	Description	Type	Domain / Allowed Values	Null	Default	Constraints
RequestID	Unique identifier for each maintenance request	Integer	Positive integers	NOT NULL	Autoincrement	PRIMARY KEY
FacilityID	The facility at which the issue was observed	Integer	Must exist in FACILITY	NOT NULL	—	FOREIGN KEY → FACILITY(FacilityID)
AttendantID	The attendant who submitted the report	Integer	Must exist in USER where Role = attendant	NOT NULL	—	FOREIGN KEY → USER(UserID)
Category	The type of maintenance issue reported	Enumeration	{blocked_drain, broken_tap, broken_door, lighting, vandalism, other}	NOT NULL	—	—
Description	Optional free-text elaboration of the issue	Text	Any text	NULL	NULL	—
Status	Current stage in the maintenance lifecycle	Enumeration	{pending, in_progress, resolved, rejected}	NOT NULL	pending	Transitions enforced at application layer
CreatedAt	Timestamp when the request was first submitted	Date/time	Valid datetime	NOT NULL	Current timestamp	—
UpdatedAt	Timestamp of the most recent status change	Date/time	Valid datetime	NULL	NULL	Set by application on each status update

Table 27 Showing maintenance requests

Table: ACTIVITY_LOG

An append-only audit table. Rows are only ever inserted, never updated or deleted. Every significant system event — stock submissions, maintenance reports, status changes, account creations, and facility modifications — produces one row. If the associated user account is later deleted, UserID is set to NULL to preserve the audit record.

Table 28 Showing activity_logs

Attribute	Description	Type	Domain / Allowed Values	Null	Default	Constraints
LogID	Unique identifier for each audit entry	Integer	Positive integers	NOT NULL	Autoincrement	PRIMARY KEY
UserID	The user who performed the action	Integer	Must exist in USER	NULL	NULL	FOREIGN KEY → USER(UserID), SET NULL on delete
Action	Machine-readable code identifying the type of action performed	String	e.g. stock_log, maintenance, report maintenance, update user, create facility, create; max 100 chars	NULL	NULL	—
Details	Human-readable description of the specific action taken	Text	Any text	NULL	NULL	—
IP_Address	The IP address from which the action was performed	String	IPv4 or IPv6 address, max 45 chars	NULL	NULL	—
CreatedAt	Timestamp when the action occurred	Datetime	Valid datetime	NULL	Current timestamp	—

Table: ALERT_LOG

Records threshold-triggered events for audit purposes. A row is inserted when a consumable is logged as Low or Empty, or when a maintenance category deemed high-priority is submitted. This table does not directly deliver notifications to users; supervisor alerting is handled by the browser polling mechanism. Delivery Status indicates whether the alert was picked up by the polling endpoint.

Table 29 Showing alert_logs

Attribute	Description	Type	Domain / Allowed Values	Null	Default	Constraints
AlertID	Unique identifier for each alert record	Integer	Positive integers	NOT NULL	Autoincrement	PRIMARY KEY
Trigger-Type	The condition that caused the alert to be recorded	Enumeration	{stock_low,stock,empty, maintenance_high_priority}	NOT NULL	—	—
FacilityID	The facility at which the triggering condition occurred	Integer	Must exist in FACILITY	NOT NULL	—	FOREIGN KEY → FACILITY (FacilityID)
Message	Human-readable description of the alert condition	Text	Any text	NOT NULL	—	—
SentAt	Timestamp when the alert record was created	Datetime	Valid datetime	NULL	Current timestamp	—
DeliveryStatus	Whether the alert was acknowledged by the polling endpoint	Enumeration	{pending, sent, delivered, failed}	NULL	pending	—

Table: CONSUMABLE_THRESHOLD TABLE

The Consumable_Threshold table defines the stock control limits for consumable items within each facility. It enables the system to classify stock levels based on predefined percentages and supports automated monitoring and alert generation when consumables reach low or empty levels. The FacilityID attribute establishes a relationship with the Facility table, ensuring that each threshold configuration belongs to a specific facility.

Table 30 Showing consumable threshold

Attribute	Description	Type	Domain / Allowed Values	Null	Default	Constraints
Threshold ID	Unique identifier for each consumable threshold record	INT	Positive integer values	No	Auto Increment	Primary Key
FacilityID	Identifies the facility where the threshold applies	INT	Existing Facility IDs from Facility table	No	None	Foreign Key references Facility(FacilityID)
ConsumableType	Type/category of consumable item being monitored	ENUM	Soap, Tissue, Detergent, Sanitary Pads, Other	No	None	NOT NULL
MaxQuantity	Maximum quantity the facility can store for a consumable	INT	Positive integer values (≥0)	No	None	NOT NULL, CHECK (MaxQuantity ≥ 0)
FullPct	Percentage level indicating fully stocked condition	INT	0–100	No	100	NOT NULL, CHECK (FullPct BETWEEN 0 AND 100)
HalfPct	Percentage level indicating medium stock condition	INT	0–100	No	50	NOT NULL, CHECK (HalfPct BETWEEN 0 AND 100)
LowPct	Percentage level indicating low stock condition	INT	0–100	No	25	NOT NULL, CHECK (LowPct BETWEEN 0 AND 100)
EmptyPct	Percentage level indicating empty stock condition	INT	0–100	No	0	NOT NULL, CHECK (EmptyPct BETWEEN 0 AND 100)
CreatedAt	Date and time when threshold record was created	DATETIME	Valid date and time format	No	Current Timestamp	DEFAULT CURRENT_TIMESTAMP

CHAPTER FIVE: IMPLEMENTATION AND TESTING

5.1 Data Outputs

This section presents the implemented system outputs, including the user interface forms and screenshots of the KCCA Public Toilets Management System in operation. The system was implemented using HTML5, CSS3, JavaScript for the frontend, PHP 7.4+ for backend logic, and MySQL 5.7+ for database management, following the three-tier architecture designed in Chapter Four. The implementation focused on creating a mobile-optimized interface for toilet attendants and a comprehensive dashboard for supervisors and administrators.

5.1.1 System Forms

The following forms were implemented as core components of the system to facilitate data capture and user interaction.

5.1.1.1 Login Form

The login form authenticates all users (Attendants, Supervisors, and Administrators). It captures username/email and password credentials, validates them against the database, and redirects users to their respective dashboards based on role-based access control (RBAC). All passwords are hashed using Bcrypt with a cost factor of 12 before storage.

5.1.1.2 Attendant Consumable Reporting Form

This form allows attendants to log current stock levels using a quantity defined in the threshold. Attendants select a facility (automatically assigned to their account), choose a consumable type (Toilet Paper, Hand Soap, Detergent, Sanitary Pads), and indicate the stock quantity level using a color-coded scale: Full (Green), Half (Yellow), Low (Orange), or Empty (Red). An optional comment field is available for additional details.

5.1.1.3 Attendant Maintenance Reporting Form

This form enables attendants to report maintenance issues by selecting from predefined categories identified during data analysis: Broken taps, Faulty locks, Lighting issues, Blocked drainage, Broken toilet seats, and Cracked floors/walls. The form includes a mandatory category dropdown, an optional description field, and an option to mark the issue as high priority.

5.1.1.4 Facility Registration Form

This form is accessible only to supervisors and administrators. It captures new facility details including facility name, location (e.g., Old Taxi Park, Owino Market), unique facility code, and assigned supervisor contact information. The system automatically generates a facility ID upon submission.

5.1.1.5 Attendant and supervisor Registration Form

Administrators use this form to register new attendant and supervisor accounts. The form captures attendant name, phone number assigned facility, and a temporary password. The system generates a unique username and encrypts the password before storage. The credentials are displayed once for sharing with the attendant.

5.1.1.6 Maintenance Request Update Form

Supervisors access this form when responding to maintenance reports. The form displays the original maintenance request details and allows the supervisor to update the status (Pending, In Progress, Resolved, Rejected) and add resolution notes. The system automatically timestamps each status change and logs the action for audit purposes.

5.1.1.7 Report Generation Form

This form allows supervisors to generate operational reports by selecting a date range (start date and end date), report type (consumable usage trends, maintenance frequency, response time analysis), and specific facility or all facilities. Reports can be previewed on screen or exported as CSV files.

5.1.2 System Screenshots

The following screenshots illustrate the implemented system interfaces.

System Login Interface

Description: The login page (figure 14) features a clean, centered form with fields for Username/Email and Password. The interface includes a "Login" button and a "Forgot Password?" link for password recovery assistance. The background incorporates the KCCA color scheme (blue and white) for institutional branding.

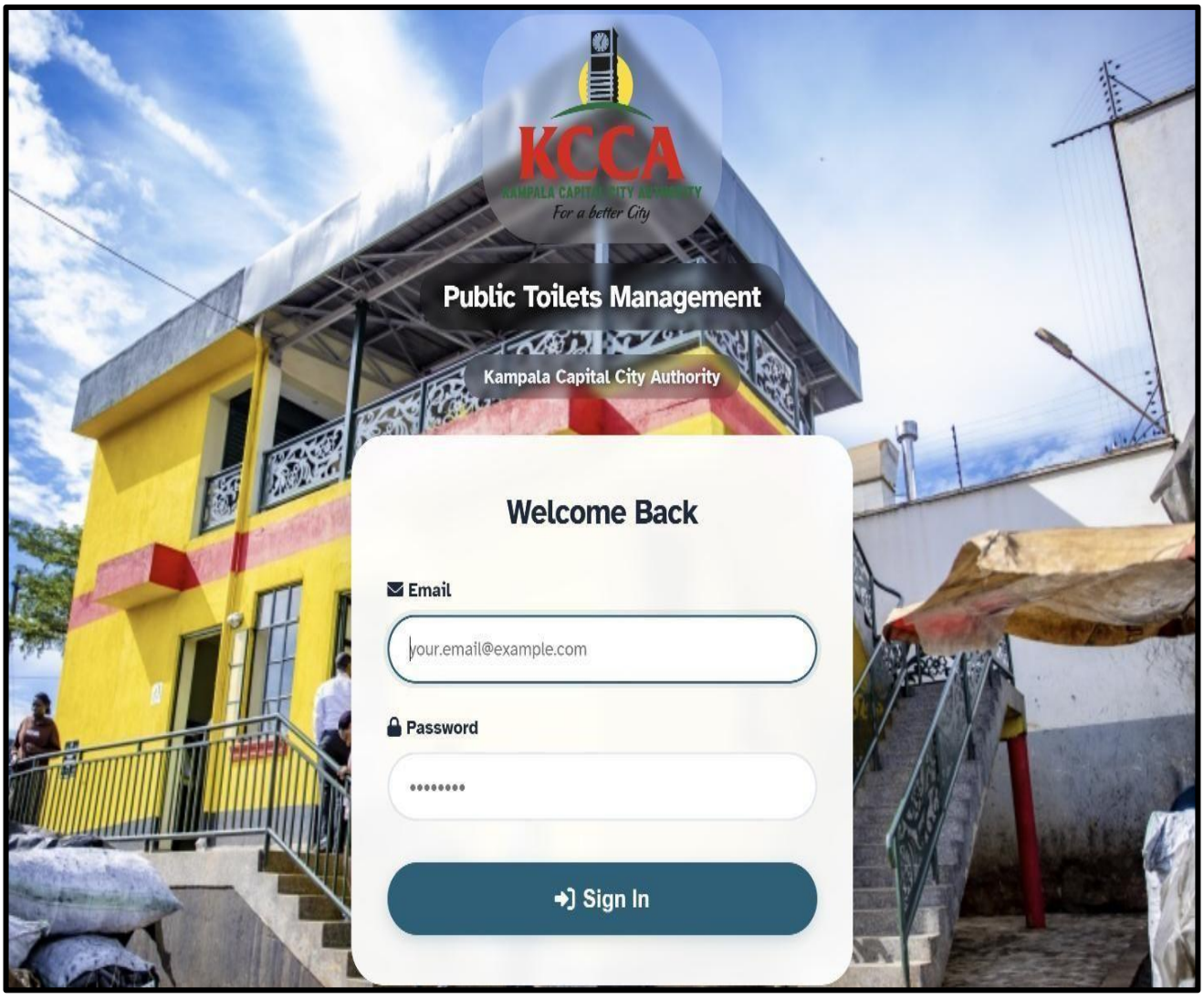


Figure 14: Login page

Attendant Dashboard (Mobile View)

Description: The attendant dashboard (figure 15) is optimized for mobile devices with large, touch friendly buttons. The interface displays the attendant's assigned facility name at the top, followed by two primary action buttons: "Report Consumables" and "Report Maintenance". Below the action buttons, a summary shows recent reports and their statuses.

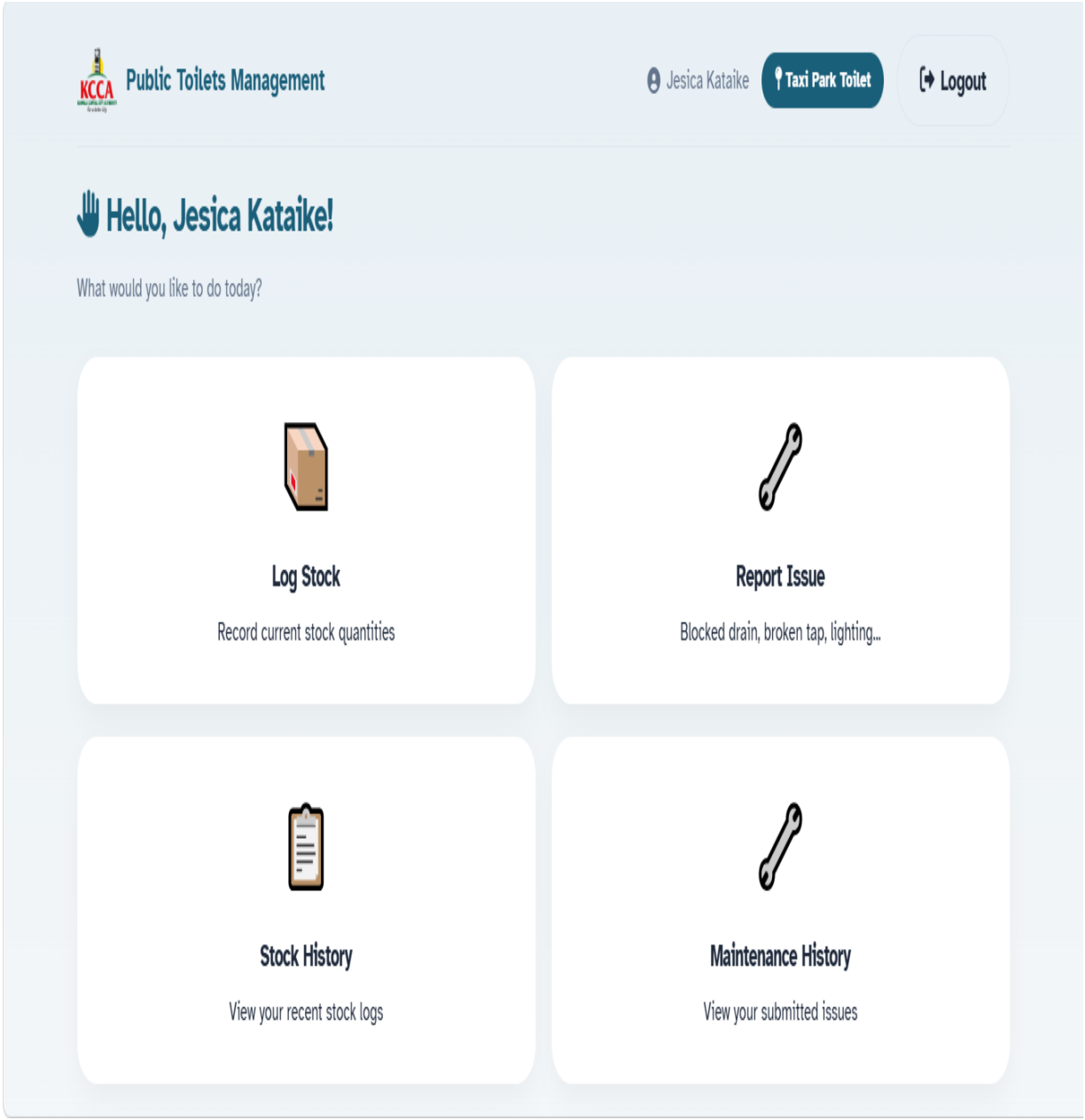


Figure 15: Attendant dashboard

Consumable Reporting Interface (Attendant)

Description: This screen shows the consumable logging interface. Each consumable item (Toilet Paper, Hand Soap, Detergents, Sanitary Pads) is displayed with four color-coded level buttons. The interface uses simple icons alongside text labels to support users with primarylevel education. A "Submit Report" button is located at the bottom (figure 16).

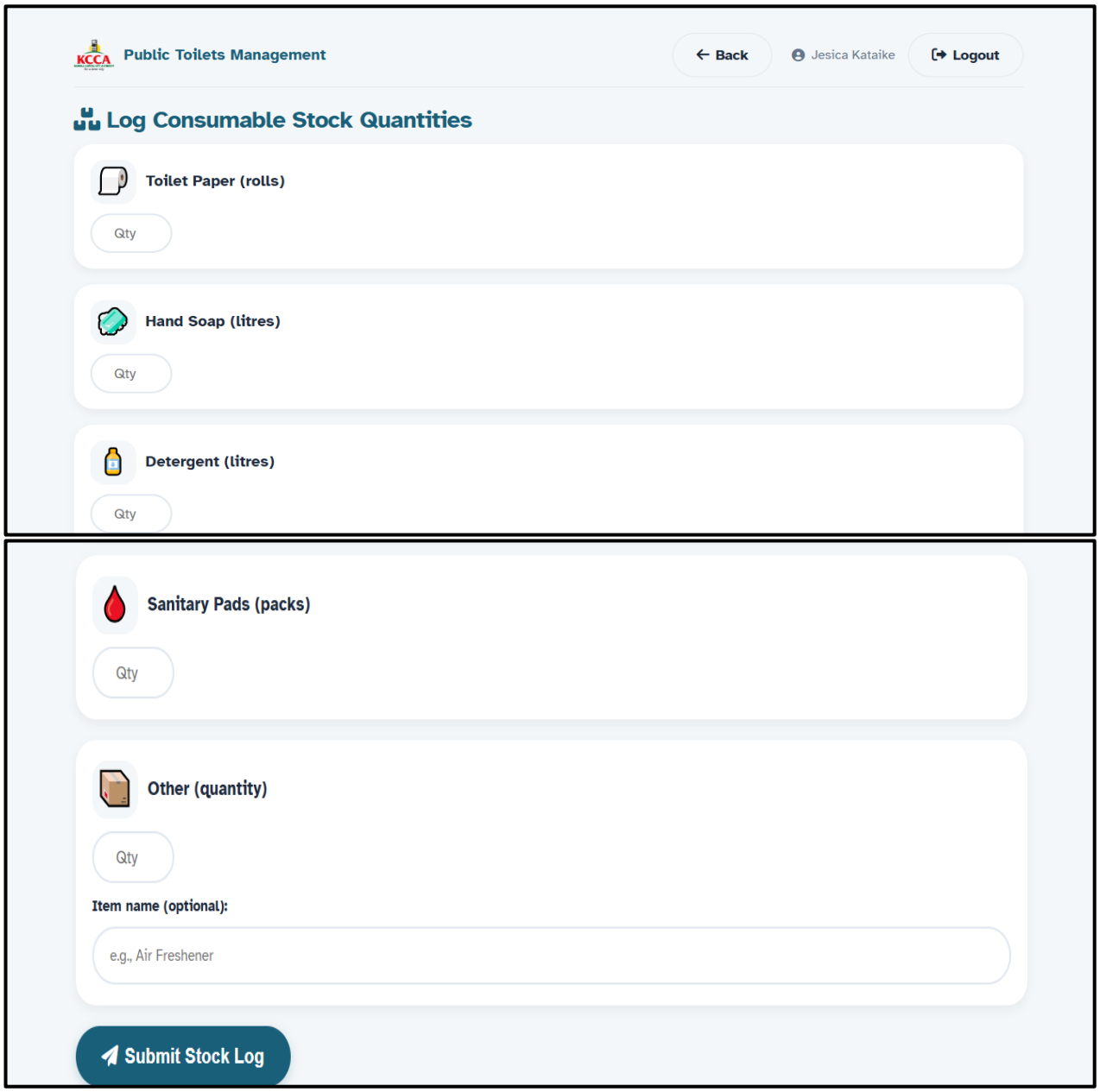


Figure 16: Log consumable stock page

Maintenance Reporting Form (Attendant)

Description: The maintenance reporting form displays a dropdown menu with predefined issue categories identified from field research (Broken taps, Faulty locks, Lighting issues, Blocked drainage, Broken toilet seats, Cracked floors/walls). Below the dropdown is a text area for optional comments and a checkbox for marking high-priority issues. A "Submit Request" button completes the action (figure 17).

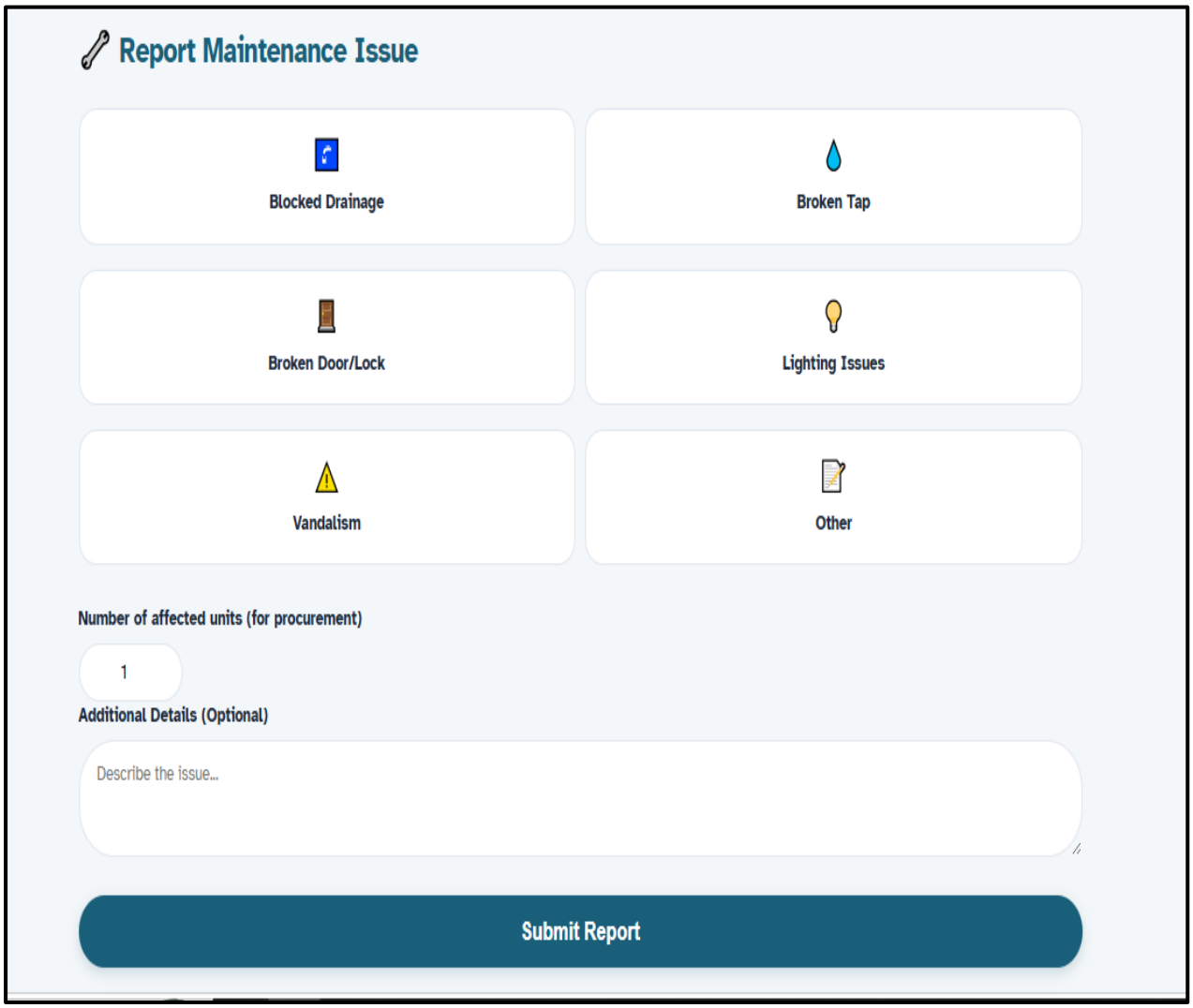


Figure 17: Report maintenance issue page

Supervisor Dashboard - Facility Overview

Description: The supervisor dashboard (figure 18) presents a grid of facility status cards, each color-coded based on overall facility health. Green cards indicate all consumables are adequate, yellow indicates some items are low, orange indicates critical shortages, and red indicates empty stocks or unresolved high-priority maintenance issues. The dashboard also displays the total number of active maintenance requests and the date of last update per facility.

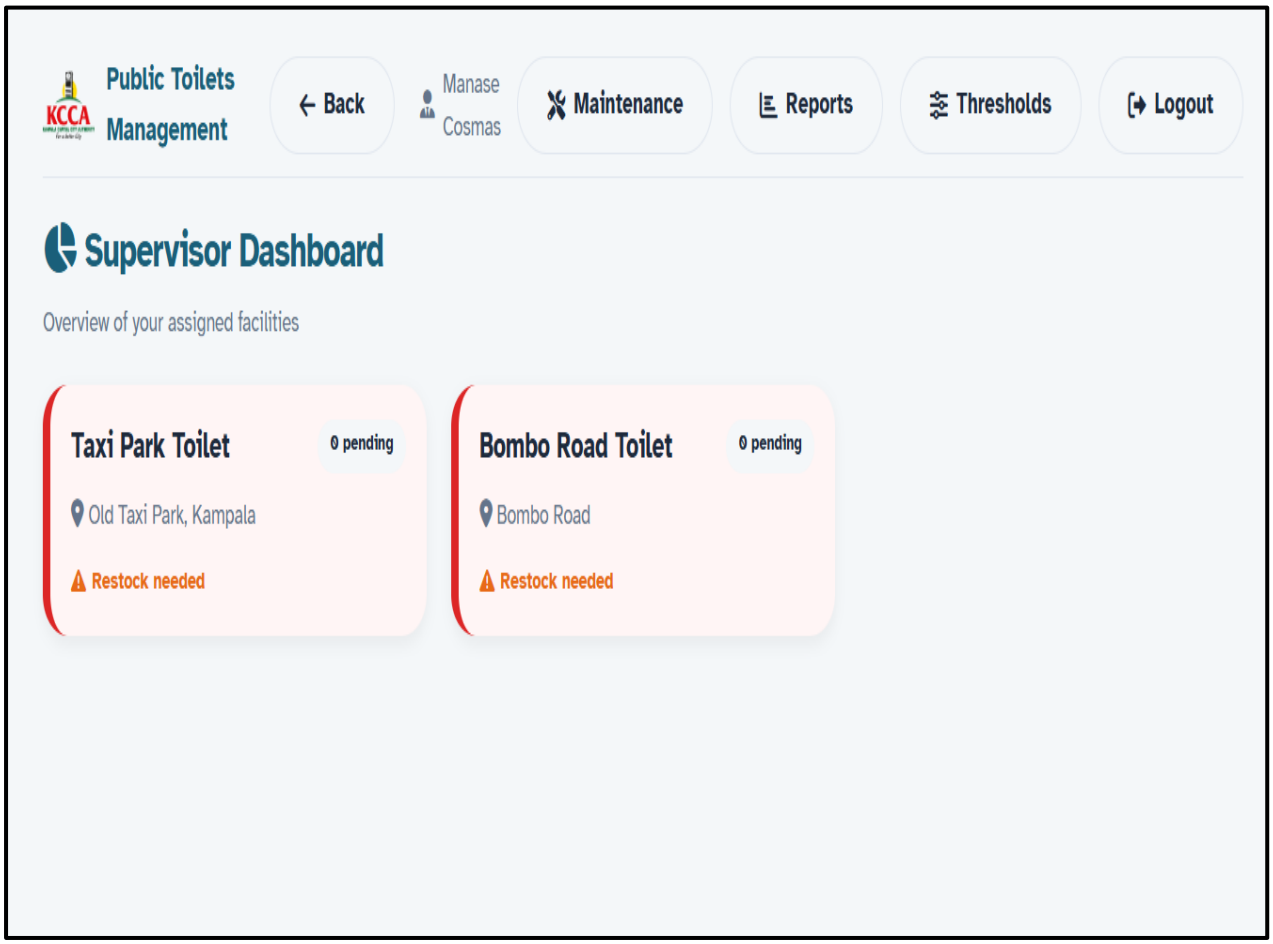


Figure 18: Supervisor dashboard

Detailed Facility View (Supervisor)

Description: Clicking on a facility card expands to show individual consumable level indicators (color-coded bars for each consumable type) and a list of pending maintenance requests with columns for issue type, date reported, days pending, and current status. Buttons for "Update Status" and "View History" are available for each request(figure 19).

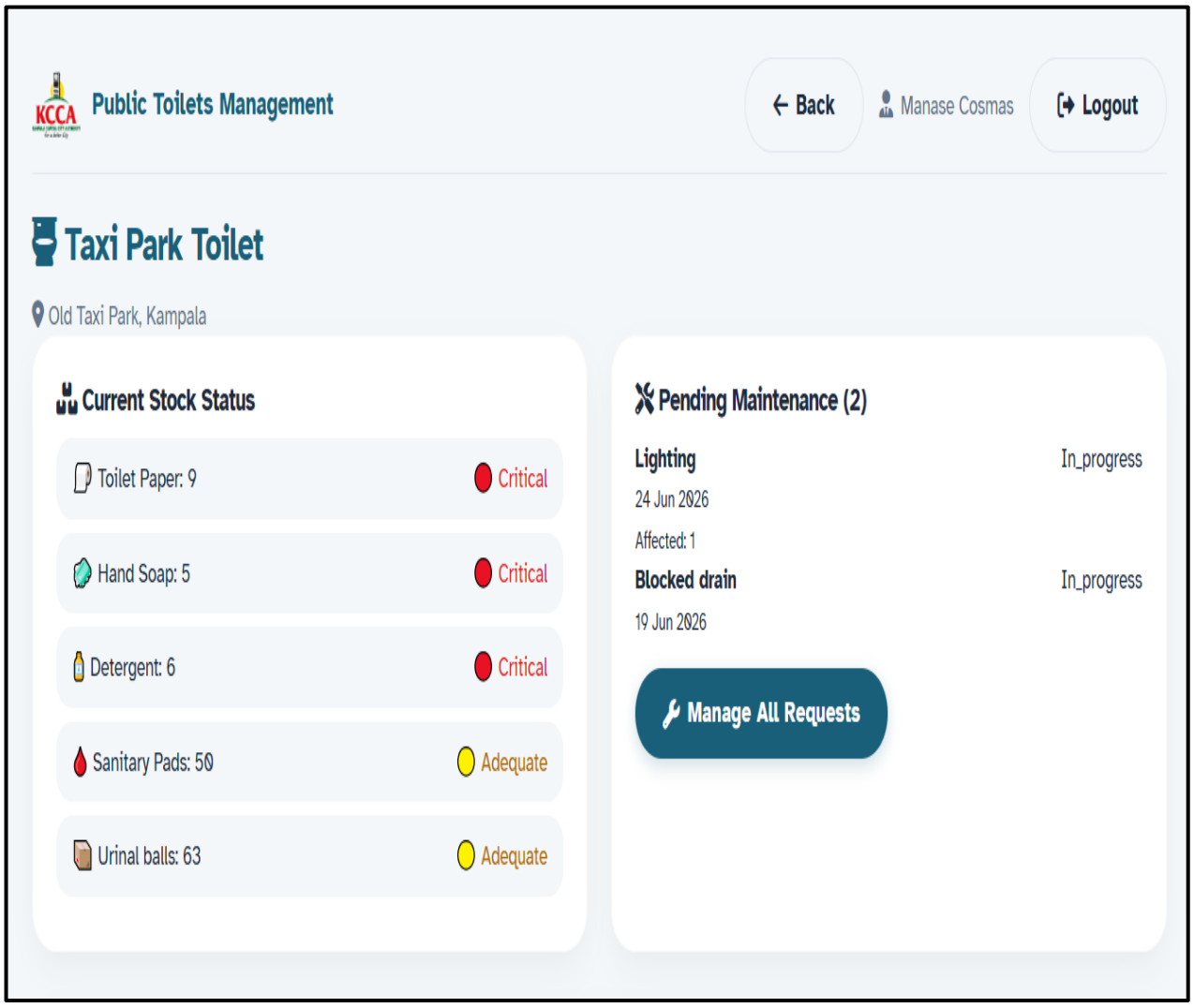


Figure 19: Individual consumable levels and a list of pending maintenance requests.

Maintenance Request Management (Supervisor)

Description: This interface displays all maintenance requests across all supervised facilities in a sortable table. Columns include Facility Name, Issue Type, Date Reported, Days Pending, Status, and Actions. Status can be updated inline using a dropdown menu (Pending, In Progress, Resolved, Rejected). The table highlights request unresolved after 3 days in red text.

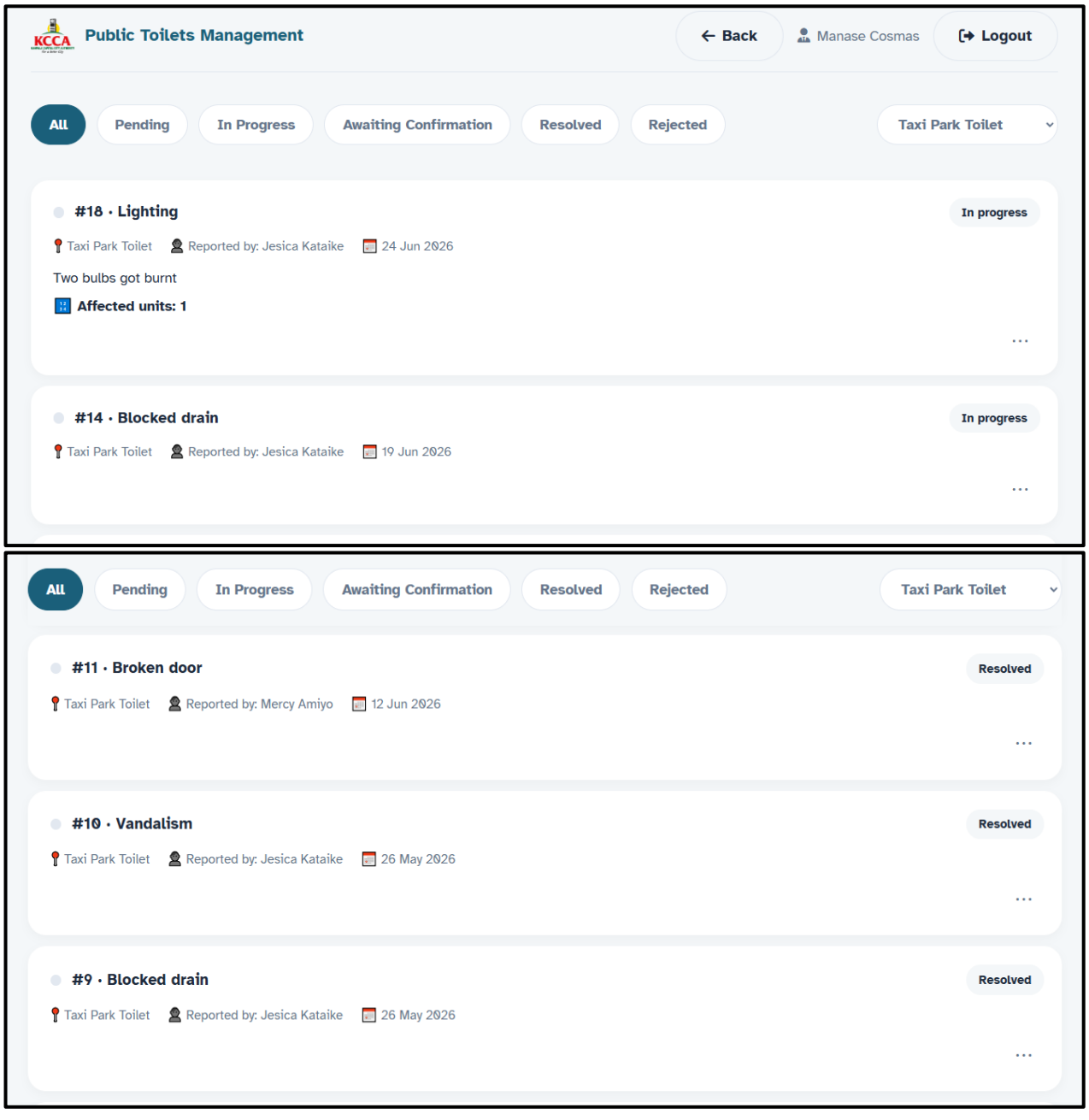


Figure 20: Maintenance requests page

Report Generation Interface (Supervisor)

Description: The report generation screen provides date pickers for start and end dates, a dropdown for report type (Consumable Usage Trends, Maintenance Frequency, Response Time Analysis, Facility Performance Summary), and a facility selector (individual facility or all facilities). A "Generate Report" button displays the report in the browser, and an "Export CSV" button allows data download.

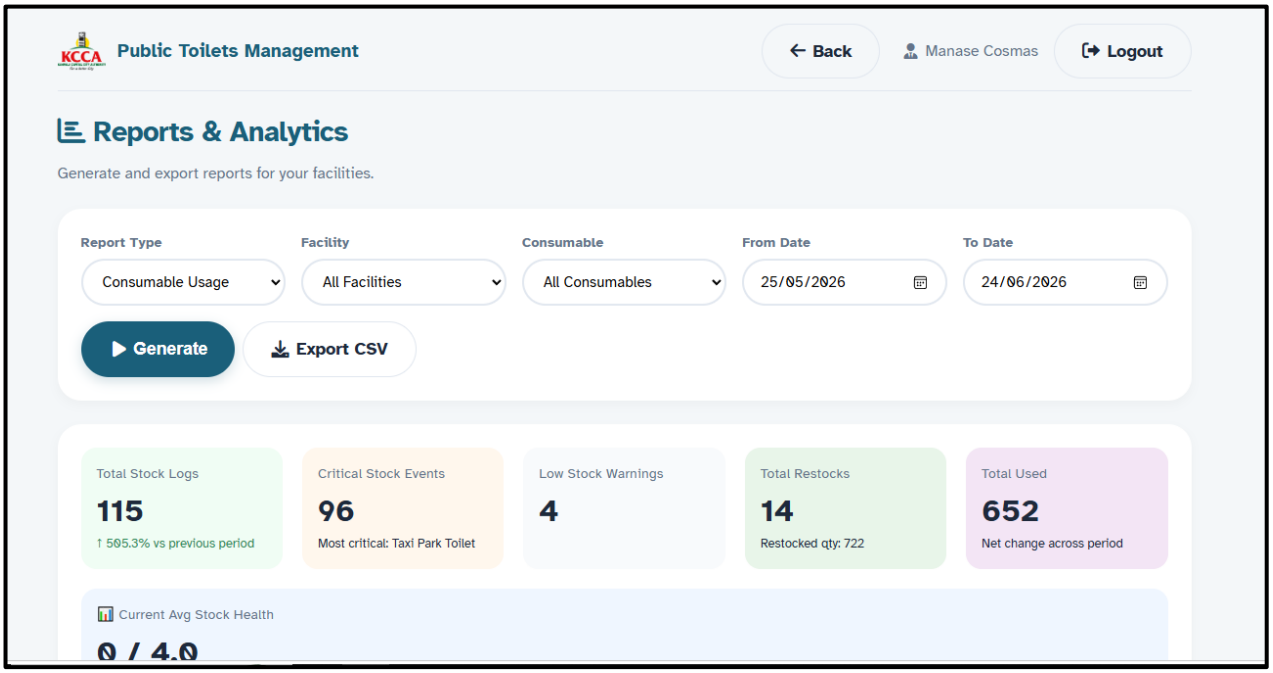
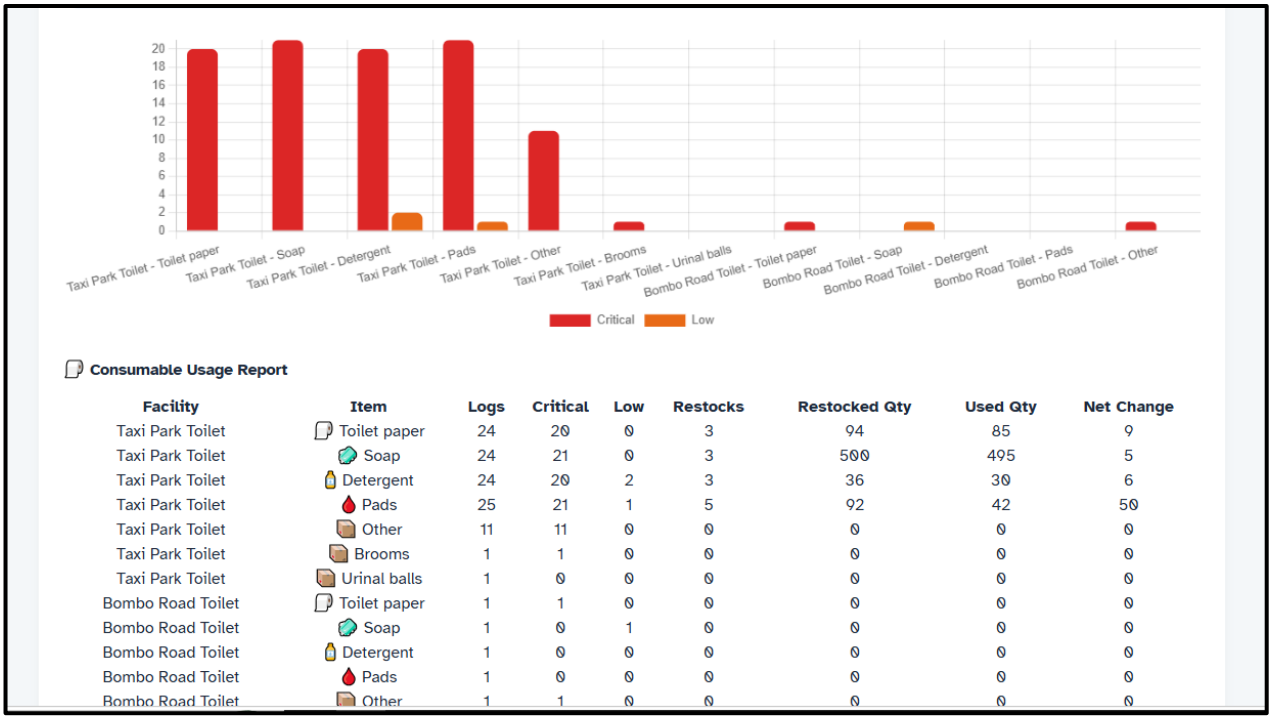


Figure 21: repot generation page



Facility	Item	Logs	Critical	Low	Restocks	Restocked Qty	Used Qty	Net Change
Taxi Park Toilet	Toilet paper	24	20	0	3	94	85	9
Taxi Park Toilet	Soap	24	21	0	3	500	495	5
Taxi Park Toilet	Detergent	24	20	2	3	36	30	6
Taxi Park Toilet	Pads	25	21	1	5	92	42	50
Taxi Park Toilet	Other	11	11	0	0	0	0	0
Taxi Park Toilet	Brooms	1	1	0	0	0	0	0
Taxi Park Toilet	Urinal balls	1	0	0	0	0	0	0
Bombo Road Toilet	Toilet paper	1	1	0	0	0	0	0
Bombo Road Toilet	Soap	1	0	1	0	0	0	0
Bombo Road Toilet	Detergent	1	0	0	0	0	0	0
Bombo Road Toilet	Pads	1	0	0	0	0	0	0
Bombo Road Toilet	Other	1	1	0	0	0	0	0

Figure 22: repot generation page

Administrator Panel - User Management

Description: The administrator panel displays all registered system users in a table with columns for Username, Full Name, Role (Attendant/Supervisor/Admin), Assigned Facility, and Status (Active/Inactive). Administrators can add new users, edit existing user details, reset passwords, and deactivate accounts. An "Audit Log" button provides access to system activity logs.

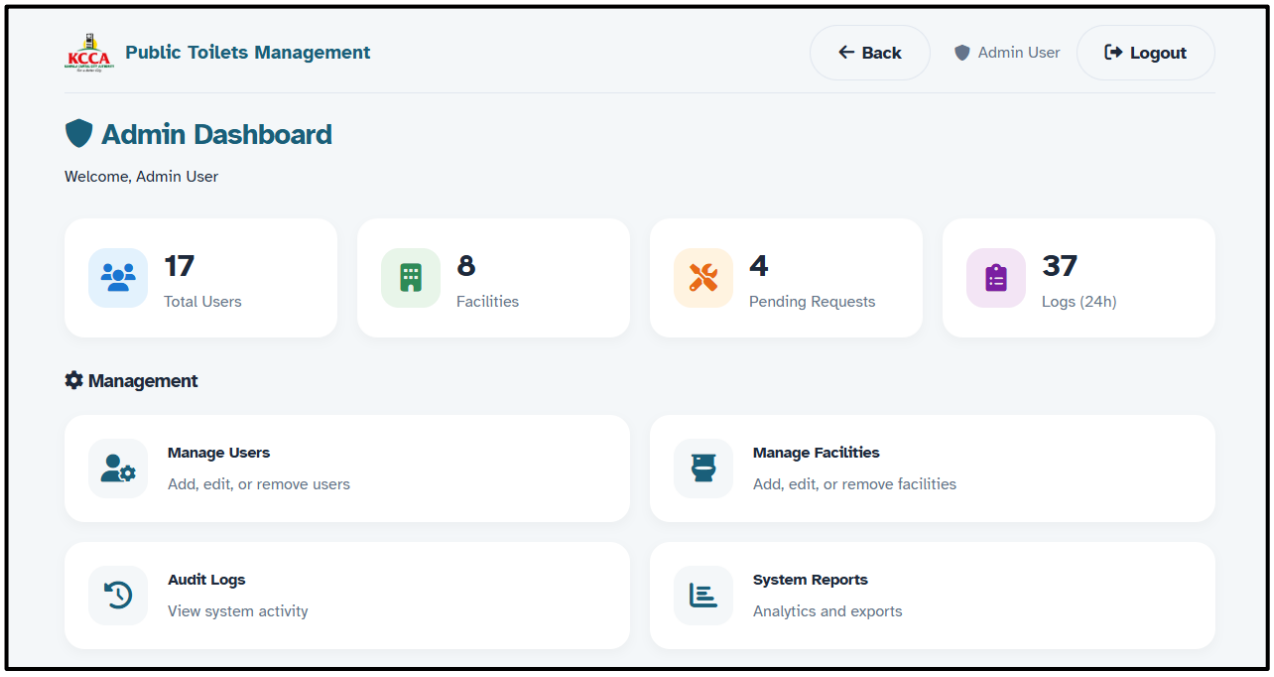


Figure 23: Admin Dashboard

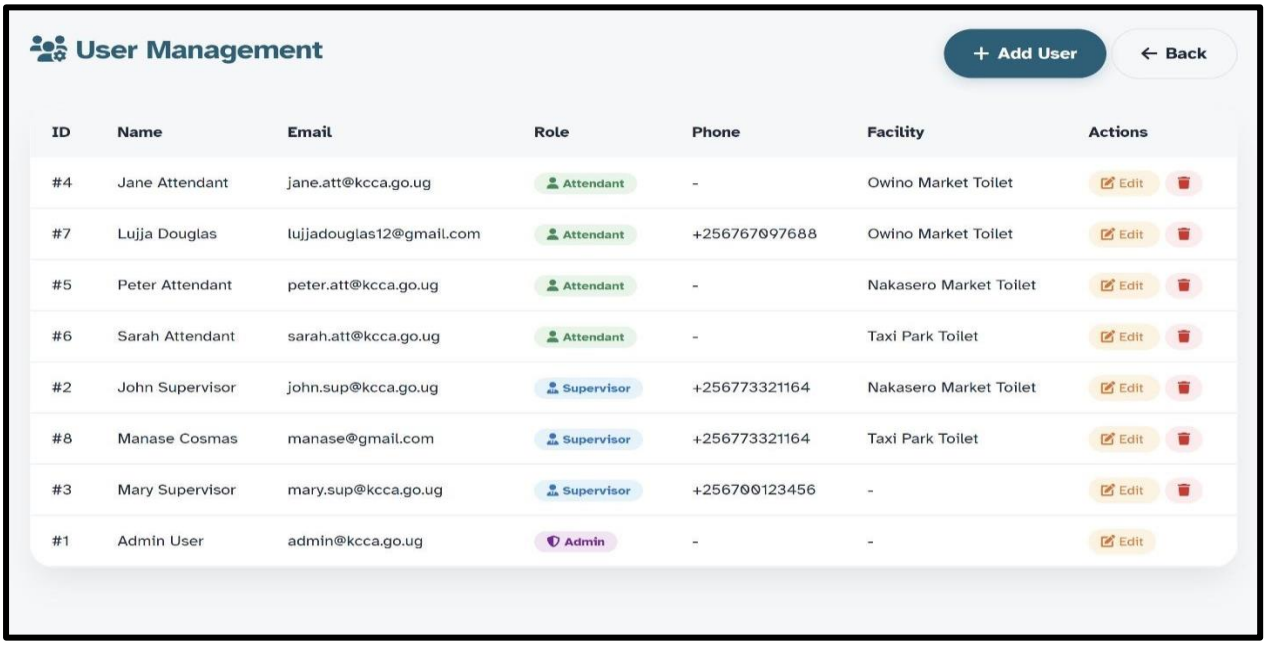


Figure 24: User Management

5.2 System Testing

System testing was conducted to ensure that the KCCA Public Toilets Management System functioned correctly, met user requirements, and operated reliably under expected conditions. Testing followed the methodology outlined in Chapter Three, employing unit testing, integration testing, and system testing

5.2.1 Testing Environment

Table 31 The testing environment replicated the production specifications:

Component	Specification
Server	WAMP Server (Apache 2.4, PHP 7.4, MySQL 5.7) running on Windows 10
Client (Supervisor)	Desktop computer with 4GB RAM, Google Chrome browser
Client (Attendant)	Android smartphones (Samsung, Tecno, Itel) with Chrome browser
Network	Localhost for unit/integration; simulated 3G/4G for mobile testing

5.2.2 Unit Testing

Unit testing was performed on individual system modules to verify that each component functioned correctly in isolation. Test cases were developed for critical functions including login authentication, consumable reporting, maintenance reporting, status updates, and report

Table 32 Unit Test Cases and Results

Test ID	Module	Test Case	Expected Result	Actual Result	Status
UT-01	Login	Valid attendant credentials	Redirect to attendant dashboard	Dashboard displayed	Pass
UT-02	Login	Valid supervisor credentials	Redirect to supervisor dashboard	Dashboard displayed	Pass
UT-03	Login	Invalid password	Error message; stay on login page	"Invalid credentials" shown	Pass
UT-04	Login	Non-existent username	Error message; stay on login page	"User not found" shown	Pass
UT-05	Consumable Report	Attendant submits "Empty" for toilet paper	Record saved to consumable log table; alert triggered	Log stored; alert flag set	Pass
UT-06	Consumable Report	Missing consumable selection	Validation error; submission blocked	"Select a consumable type" error	Pass
UT-07	Maintenance Report	Attendant selects "Broken taps" with comment	Record saved; status = "Pending"	Record saved with comment	Pass
UT-08	Maintenance Report	No category selected	Validation error; submission blocked	"Please select an issue type"	Pass
UT-09	Status Update	Supervisor changes status to "In Progress"	Request status updated; timestamp recorded	Status and timestamp updated	Pass
UT-10	Status Update	Supervisor adds resolution notes	Notes appended to request record	Notes saved correctly	Pass
UT-11	Report Generation	Generate CSV for last 7 days	CSV file downloads with correct data	File generated with 14 records	Pass
UT-12	Report Generation	No date range selected	Error message; generation blocked	"Select date range" error	Pass

All unit tests passed successfully. The login module correctly enforced role-based redirection, and the validation controls on forms prevented incomplete submissions.

5.2.3 Integration Testing

Integration testing verified that different system modules worked together correctly without errors. The test focused on data flow between the presentation tier (browser), application logic tier (PHP), and data tier (MySQL).

All integration tests passed, confirming that data flowed correctly between system modules and that the database transactions-maintained consistency under concurrent operations.

Table 33 Integration Test Scenarios and Result

Test ID	Scenario	Modules Involved	Expected Result	Actual Result	Status
IT-01	Attendant reports low stock; supervisor views alert	Consumable Report → Database → Supervisor Dashboard	Stock level appears as "Low" on dashboard with yellow indicator	Displayed correctly	Pass
IT-02	Attendant reports maintenance; supervisor updates status	Maintenance Report → Database → Status Update → Database	Request appears in supervisor queue; status change reflected in attendant view	End-to-end flow functional	Pass
IT-03	Multiple attendants report simultaneously from different facilities	Concurrent Reporting → Database → Dashboard Aggregation	All reports recorded; dashboard shows aggregated view	All 5 concurrent submissions saved	Pass
IT-04	Supervisor generates report after multiple consumable logs	Consumable Logs → Database → Report Generator	Report includes all logs within date range	Complete data included	Pass
IT-05	Maintenance unresolved after 3 days	Maintenance Request → Cron Job → Supervisor Alert	Request highlighted in red on dashboard	Highlighting functional	Pass

5.2.4 System Testing

System testing evaluated the complete integrated system against the functional and nonfunctional requirements specified in Chapter Four (Section 4.5). The system was tested as a whole to verify that all requirements had been achieved.

Table 34 System Testing Results against Functional Requirements

Requirement ID	Requirement Description	Test Method	Result	Status
FR-01	Secure login for attendants	Attempted access without credentials	Access denied	Pass
FR-02	Log stock levels (Full/Half/Low/Empty)	Attendant submitted all four levels	All levels recorded correctly	Pass
FR-03	Report maintenance from predefined categories	Attendant reported each category	All 6 categories selectable and saved	Pass
FR-05	Confirmation message on submission	Submitted report after submission	"Report submitted successfully" shown	Pass
FR-06	Attendant view request status	Attendant viewed "My Requests" page	Status displayed correctly	Pass
FR-08	Supervisor dashboard with color-coded status	Accessed dashboard with test data	Green/Yellow/Orange/Red cards displayed	Pass
FR-09	Real-time alerts for Low/Empty stock	Attendant reported "Empty"	Alert appeared within 2 seconds	Pass
FR-10	Display pending maintenance requests	Supervisor opened dashboard	Pending requests listed correctly	Pass
FR-11	Update maintenance request status	Supervisor changed status to "Resol ed"	Status updated; attendant notified	Pass
FR-14	Generate reports on consumable usage	Supervisor generated 30day report	CSV exported with correct trends	Pass

Table 35: System Testing Results against Non-Functional Requirements

Requirement ID	Requirement Description	Test Method	Result	Status
NFR-01	Attendant app loads under 3 seconds on 3G	Chrome DevTools (3G throttling)	Average 2.4 seconds	Pass
NFR-02	Supervisor dashboard loads under 5 seconds	Broadband speed test	Average 1.8 seconds	Pass
NFR-04	Passwords stored using secure hashing	Database inspection	Bcrypt hash observed	Pass
NFR-05	Role-based access control enforced	Attempted attendant access to admin pages	Access denied	Pass

CHAPTER SIX: DISCUSSION, RECOMMENDATIONS, FUTURE WORK AND CONCLUSIONS

6.1 Discussion

The KCCA Public Toilets Management System was developed as a web-based application aimed at improving the management of public toilet facilities under Kampala Capital City Authority. The system was designed to support consumable tracking, maintenance reporting, and supervision of toilet facilities in a more efficient and organized way.

During testing, the system performed well in all its main functions. Users were able to log in successfully, submit consumable reports, report maintenance issues, and access dashboard updates without errors. The data entered by attendants was successfully stored in the database and displayed correctly on the supervisor and administrator dashboards.

Overall, the system improved communication between attendants and supervisors and reduced reliance on manual reporting methods. It also improved record keeping and accountability since all activities are stored in the system and can be tracked whenever needed.

6.2 Limitations

The system depends on a stable internet connection because it is fully web-based, which may affect usage in areas with poor connectivity.

The system may experience slower performance when many users access it at the same time without optimization.

The current system has basic user roles (attendant, supervisor, administrator), which may not fully support more complex organizational structures.

As the amount of data increases over time, system performance may reduce if database optimization is not properly implemented.

6.3 Recommendations and Future Work

The system should be improved to work even when internet connection is weak or unavailable. An offline data entry feature should be introduced so that attendants can still record consumable levels and maintenance issues. The data can then be synced once the internet is restored. This will reduce dependency on constant internet access.

A mobile application version of the system should also be developed. Most toilet attendants use smartphones. A mobile app would make it easier and faster for them to submit reports compared to using a web browser.

The system should be optimized to handle many users at the same time without slowing down. This will ensure supervisors can still access dashboard information quickly, even during busy periods.

The system should include automatic notifications. For example, supervisors should be notified immediately when consumables are low or when a maintenance issue is reported. This will reduce delays in response.

Stronger security should be added because the system stores important operational data. Twofactor authentication should be introduced to prevent unauthorized access.

The system should also be improved to support more facilities and larger amounts of data as KCCA expands its operations. This will ensure the system remains useful in the future.

Finally, better reporting tools should be added. These will help supervisors easily identify patterns in consumable usage and common maintenance problems. This will improve planning and decision-making.

6.4 Conclusion

The KCCA Public Toilets Management System successfully achieved its objective of improving the management of public toilet facilities through a web-based platform. It replaced the manual reporting system with a more efficient digital approach that improves communication, monitoring, and record keeping.

Although the system has some limitations, especially related to internet dependency and scalability, it provides a strong foundation for improving sanitation management. With further enhancements, the system can significantly improve service delivery and operational efficiency within KCCA-managed facilities.

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APPENDICES

Appendix I: Data collection instrument for Toilet Attendants

Introduction

This data collection instruments have been designed to gather comprehensive information for the development of the KCCA Public Toilets Management System. The instruments aim to collect data from various stakeholders including KCCA supervisors and toilet attendants across different public toilet facilities in Kampala. All information will be kept confidential and used for academic purposes only.

The data collected will be used to:

1. Understand current manual practices in consumable usage and maintenance monitoring
2. Identify challenges and gaps in the existing management system
3. Gather functional and non-functional requirements for the proposed system
4. Document facility characteristics and operational contexts

Questionnaire for Toilet Attendants

Instructions: Please tick (✓) the appropriate response or write in the space provided. Your honest responses will help us design a system that meets your needs.

Section A: Demographic Information

1. **Facility Name:** …….....…….....……
2. **Location:**

□ Taxi Park

□ Market

□ City Center

□ Other: ……

3. **Gender:**

□ Male

□ Female

4. **How long have you worked as a toilet attendant?**

□ Less than 1 year

□ 1-3 years

□ 4-6 years

□ More than 6 years

5. **What are your daily tasks as a toilet attendant? (Tick all that apply)**

□ Cleaning facilities

□ Checking consumable levels

□ Reporting maintenance issues

□ Collecting user fees

□ Recording usage data

□ Other: .....

6. **How do you currently track the levels of consumables?**

□ Mental note

□ Paper records

□ Verbal reporting to supervisor

□ Not tracked

□ Other: .....

7. **How often do you check consumable levels?**

□ Multiple times daily

□ Once daily

□ Every few days

□ Weekly

□ When I remember

8. **How do you report maintenance issues?**

□ Tell supervisor in person

□ Call supervisor

□ Write in a logbook

□ Wait for supervisor visit

□ Don't report

9. How do you know when to reorder consumables?

□ When completely finished

□ When supervisor tells me

□ Based on usage patterns

□ When users complain

10. What do you frequently restock?

□ Item Never

□Toilet Paper

□ Hand Soap

□ Detergents

□ Sanitary Pads

□ Water

11. What are the most common maintenance problems you encounter? (Rank top 3: 1=Most Common)

□ Broken taps

□ Faulty locks

□ Lighting issues

□ Blocked drainage

□ Broken toilet seats

□ Cracked floors/walls

□ Other.....

12. How long do maintenance issues typically take to be fixed?

□ Same day

□ 2-3 days

□ Within a week

□ More than a week

□ Never fixed

13. What challenges do you face in your daily work? (Tick all that apply)

□ Inadequate supplies

□ Slow maintenance response

□ Difficult users

□ Low pay

□ Lack of recognition

□ Poor facility condition

□ Lack of communication with supervisors

□ Other.....

14. Do you own a mobile phone?

□ Yes

□ No

15. If yes, what type of phone?

□ Basic phone (calls/SMS only)

□ Smartphone (with internet)

16. Do you have access to the internet on your phone?

□ Yes

□ No

□ Sometimes

17. Do you have any suggestions for improving how toilets are managed?

Appendix II: Data collection instrument for KCCA Supervisors/Management

Introduction

This data collection instruments have been designed to gather comprehensive information for the development of the KCCA Public Toilets Management System. The instruments aim to collect data from various stakeholders including KCCA supervisors and toilet attendants across different public toilet facilities in Kampala. All information will be kept confidential and used for academic purposes only.

The data collected will be used to:

1. Understand current manual practices in consumable usage and maintenance monitoring
2. Identify challenges and gaps in the existing management system
3. Gather functional and non-functional requirements for the proposed system
4. Document facility characteristics and operational contexts

Interview Title: Assessment of Current Public Toilet Management Practices

Target Respondents: KCCA Supervisors responsible for overseeing public toilet

facilities

Interviewer Name……

Date: ...../…... /2026

Facility/Section: .....

Supervisor's Years of Experience: .....

Section A: Demographic Information

a) What is your job title?

b) How many years have you worked with KCCA?

c) How many public toilet facilities do you currently supervise?

d) Describe the current process of monitoring consumables in the facilities under your supervision?

1. How often do you conduct inspections?
2. Who is responsible for reporting stock levels?
3. How is information recorded and communicated?

e) How do you currently track maintenance issues in the toilets?

1. How are faults reported?

2. What is the typical response time?

3. How do you prioritize maintenance requests?

f) What records or documentation do you currently maintain?

g) What format (paper/digital)?

1. How long are records kept?

h) How do you currently determine when to restock consumables?

1. What triggers reordering?

2. Who authorizes procurement?

3. Is there a formal restocking level system?

i) What communication methods do you use to coordinate with attendants?

1. How often do you communicate?

2. What challenges do you face in communication?

j) What are the main challenges you face with the current monitoring system?

k) What information do you wish you had access to that you currently don't?

l) Is there anything else you would like to share about the current system or your expectations?

1. How often do facilities under your supervision experience stock-outs of consumables?

□ Daily

□ Weekly

□ Monthly

□ Rarely

2. What is the average time taken to address a reported maintenance issue?

□ Within 24hrs

□ 2-3 days

□ 4-7 days

□ More than a week

3. Have you experienced cases of misreporting or fraud in consumable usage?

□ Yes

□ No

Appendix III: Attached is a document for authorization of data collection from KCCA management (Directorate of public health and environment



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Facebook: www.facebook.com/cocismak

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

DEPARTMENT OF INFORMATION TECHNOLOGY

KCCA CITY AUTHORITY ENVIRONMENT PUBLIC HEALTH AND 17 MAR 2026 RECEIVED

05th March 2026

To: Directorate of Public Health and Environment at KCCA

Dear Sir/Madam,

RE: RECOMMENDATION/INTRODUCTION LETTER

This is to introduce to you five undergraduate students taking a Bachelors of Information Systems and Technology (BIST) Course at the College of Computing and Information Sciences who are requesting to carry out research for their final year project in your Unit.

NAMES	REG.NO	STUD.NO	EMAIL	CONTACT
MANASE LOKWEN COSMAS MORI	23/X/23001/PS	2300723001	manaselokwencosmasmori@gmail.com	773321164
SSEBUGENYI GIDEON	23/U/17387/EVE	2300717387	ssebugenyigideon@gmail.com	767097688
LUJJA DOUGLAS	23/U/10769/PS	2300710769	lujjadouglas13@gmail.com	765707027
NAMULEME DAISY	22/U/3615/EVE	2200703615	diasynamuleme57@gmail.com	771207433
KATAIKE JESCA NORAH	23/U/26715/PS	2300726715	jescakataike10@gmail.com	742473832

The final-year project is a prerequisite for completing their undergraduate degree. It is envisaged that the research undertaken will contribute positively towards their studies and the development of your unit.
Your positive assistance will be appreciated.

Yours sincerely,

Dr. Evelyn Kigozi Kahiigi
Senior Lecturer

Recommendation/Introductory letter from the college of computing and information sciences, Makerere University.



KCCA
KAMPALA CAPITAL CITY AUTHORITY
For a REF: DPHE/KCCA/1302/01

DIRECTOR PUBLIC HEALTH
AND ENVIRONMENT

13th March, 2026

To
Mr. Manase Lokwen Cosmas Mori
Mr. Ssebugenyi Gideon
Mr. Lujja Douglas
Ms. Namuleme Daisy
Ms. Kataike Jesca Norah
Makerere University
KAMPALA

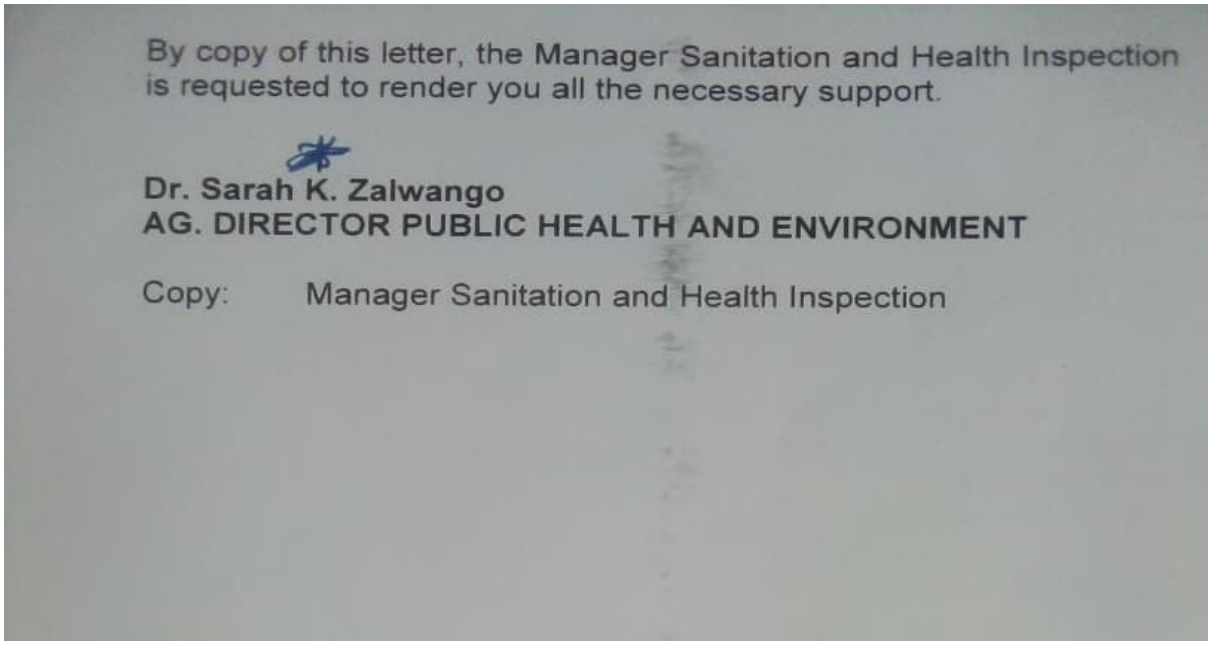
ADMINISTRATIVE CLEARANCE

Reference is made to your letter dated 05th March, 2026 on the above subject matter.

This is to inform you that permission has been granted to you to conduct research on **"KCCA PUBLIC TOILETS MANAGEMENT SYSTEM)"** for a period of two (02) from 16th March, 2026 to 18th June 2026.The above permission is granted to you on the following conditions:

1. Participation in your study is voluntary and the informed consent process should be observed at all times.
2. You will provide a report to the office of the Director Public Health and Environment of your findings.
3. You will strictly adhere to the study protocol and make no changes without informing the Director Public Health and Environment.

P. O. Box 7010 Kampala – Uganda
Plot 1 – 3 Apollo Kaggwa Road
Toll free line: 0800299000
Email: info@kcca.go.ug
KCCAUG
WWW.KCCA.GO.UG



By copy of this letter, the Manager Sanitation and Health Inspection is requested to render you all the necessary support.

Dr. Sarah K. Zalwango
AG. DIRECTOR PUBLIC HEALTH AND ENVIRONMENT

Copy: Manager Sanitation and Health Inspection

Authorization letter from KCCA directorate of public health and Environment