Water Billing Management System

- A Case Study of Nagongera Town

BY

DONGA SAMUEL
BU/UP/2021/0900
TEL: 0789047660 / 0740840692
Email: dongasamuel3@gmail.com

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Supervisor
Dr: ANGOLE RICHARD
Department of Computer Studies
Faculty of Science and Education, Busitema University.

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DECLARATION

I **DONGA SAMUEL** declare that this report is my work the information inside the report has never been submitted to this department by any student or any sources of information.

Signature.....

Date.....2nd/September/2024

APPROVAL

I acknowledge this report was done under my supervision and it was done well.

Name: Dr. ANGOLE RICHARD OKELLO

Signature.....**Date**..2:09:2024

DEDICATION

Firstly, I thank the **Almighty God** who has successfully enabled me to complete the project report. I then dedicate this report to my inspiration of all times my daddy Pioto Stephen and my mother Goma Juliana. Sincerest appreciation to Pioto and family, my lovely brothers Pioto Andrew and Mwigo Maurice.

ACKNOWLEDGEMENT

First and fore most I would like to thank the **Almighty God** who has enabled me to complete my project successfully regardless of inevitable challenges here and there.
With a lot of gratitude, I extend my sincere appreciation to Dr. ANGOLE RECHARD OKELLO for the great work he did in order to see me through this project in which I acquired a lot of skills that are of great importance throughout my life. For if it was not him, I would not hit the top most of this great term regardless of the challenges he met, he was always by our side. Personally, he helped me to understanding and practicing a lot of computer programing software.
Lastly, I acknowledge all my friends the whole community of this great institution that made my life a success at BUSITEMA UNIVERSITY in Nagongera town.

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LIST OF ACRONYMS

NWSC: National Water and Sewage Cooperation.

MWE: Minster of Water and Environment

SSADM: Structured System Analysis and Design

RAD: Rapid Application Development

SAD: System Analysis and Design

RAM: Random Access Memory

UPS: Uninterruptible Power Supply

GUI: Graphical User Interface

SMS: Short Message Service

MNOs: Mobile Network Operators

LC1: local council one

IoT: Internet of Things.

ABSTRACT

Water billing management system is a computerized mechanism for providing water invoices to customers. This system can handle billing and reporting faults by sending it straight to the customer via any desktop application, as well as handing over the bill to the customer. In order to aid the company's expansion, I came up with a water billing management system with a desktop application. The system administrator will be able to send massages to customers when all the bills are getting low, accept payments, generate billing reports on the customer, and provide formal receipts. This will also serve as storage of billing information on a centralized database wherein, whenever the accounting department asked for billing reports periodically billing and collection has the ability to produce reports immediately. Water is one of the most crucial resources that humans require in their daily lives. Water, on the other hand, does not have the same level of management as electricity(Olsson 2015). For water, the overall usage in a building is determined, and a single bill is generated for everyone according to the meter number provided. As a result, there is no way for individuals to prevent water wastage. This results in ineffective management of water usage. Every user should be able to limit their water usage by understanding the situation. As a result, every customer will take water usage seriously in order to avoid extra charges. This provides you complete control over and management of your water usage. As a result, I came up this system which should be applied in every civilizalised community in order to minimize excessive water usage and to conserve water. Water monitoring is a crucial restriction for a variety of human uses. Humanity has undergone significant changes as a result of the technological revolution; access to information is now available 24 hours a day, 7 days a week, and from any location. Water billing management software also allows utility employees to focus their efforts on other duty. They can spend more time in the utility's customer service department answering resident issues on the complaint made. In this system, user will pay the amount in accordance with the usage of water. There is also automation in turn ON-OFF the water pump avoid wastage of water The statement of the issue Proper record management is of very important to each and every organization or company. In Uganda, most organizations have poor record management which leads them to having so many problems during auditing. The bill record is used to determine success or failure, and it will be utilized to make future decisions on whether to stick with the current business organization model or switch to a new one. The manual record keeping and billing is very slow. No proper security is usually provided to the record and so can be tempered with by any personal either intentional or accidental another issue with the manual arrangement of record keeping and billing is the natural disaster. Disasters like fire outbreak can cause damages or even total vanish of all records(Nikita Jalindar Dhumal June-2021).

CHAPTER ONE

INTRODUCTION

1.1: Background of the Study

The National Water and Sewerage Corporation (NWSC) is a water supply and sanitation company in Uganda. It is wholly owned by the government of Uganda under The Ministry of Water and Environment (MWE)(Nkambo 2022). NWSC is a national entity responsible for promoting and ensuring rational and sustainable utilization, development and effective management of water and environmental resources for the socioeconomic development of Uganda(Shillah 2018).

In Nagongera, in recent times results indicate that the current water billing system use postpaid, were customers of water pay the money after the water has been consumed and this makes many customers complain about the raising water bills were they do not know were the bills come from to raise(Best and Andreasen 1976). Also the current system make the customers take long process to register so that they can get the water for domestic use thereby going through the local council (LC1) and surveys are taken so that the water extended to the customers.

In Kenya Water billing management systems leverage cutting-edge technology to automate billing processes, monitor consumption, and provide real-time data insights. These systems utilize smart meters and Internet of Things (IoT) devices to collect accurate usage data, enabling water suppliers to generate precise bills and track consumption patterns efficiently.

Water billing management systems is essential for ensuring the sustainable utilization, accountability for the bills and conservation of water resources like reducing paper work. This systems encompass a diverse array of policies, practices, and infrastructure designed to efficiently manage water supply, distribution, billings, and payments within the town's boundaries (Bahri, 2012)

1.2: Problem Statement

Water billing systems around the world especially in developed nations have advanced over the years. This is seen with nations like Kenya that uses a prepaid billing system. Some nations however are still grappling with the traditional methods of billing. Uganda is not an exception. Currently, the NWSC in Uganda still relies on an old method of billing which involve employees of NWC moving to different households and reading meters then further billing them. This current method poises a number of challenges such as wrong records taken and customers doubt or even disagree on the amount of money paid for a certain liters to be used as presented by the employees. Therefore with this prepaid system, the customer is given control over their water needs and customers can track their payments, generate invoices, and also know their meter reading

Thereby the water billing management system was developed to clearly give the correct meter reading and help the customers interact with the Agent and Administrators easily so that customers get the invoices in real time.

1.3: purpose of the study

The purpose of the study is to develop the Water billing management system.

1.3.1 Specific objectives

1. To conduct an in depth review of existing literature and determine the requirements for the Water billing management system.
2. To design the Water billing management system based on identified requirements.
3. To implement the designs of the Water billing management system.
4. To test and validate the implemented Water billing management system.

1.4: Significance of the Study

Currently, the NWSC in Uganda still relies on an old method of billing which involve employees of NWC moving to different households and reading meters then further billing them. However, this method is outdated and inefficient. In Nagongera town, there is a need for a more sustainable approach to water billing to support broader water development. A study is underway to assess local strategies for water billing, aiming to provide actionable insights for residents. Effective water management practices can alleviate water scarcity, lower consumption, and enhance environmental sustainability. By implementing such practices, communities can secure water resources for present and future generations. This study aligns with efforts to improve water management and safety in Nagongera town, contributing to broader sustainable development objectives in Uganda.

1.5 Project Scope

This water billing management system will provide the customers with invoices after payments have been made and the water will flow automatically after minutes the payment has been made. The system was designed and developed to facilitate customers to manage and make payments using mobile money, bank and payway and receive alert massages in Nagongera.

This water billing management system encompasses an analysis of various water conservation approaches, payments using different method like mobile payment, bank and payway where a different reference number is produced for using to pay for both bank and payway payments, registering customers to use the system, registering agents who will manage the customers, make payments for different uses and handle faults in different locations in case of any issue around, meter reading of the customer he or she has paid for, sending massages(SMS) to the customers to alert them about the recharging and public awareness campaigns about any fault existing

This system was developed to access by the users in the Nagongera and easy the way for managing water use in that if the money paid for the units which are calculated in liters this will make the not to complain about any miss management of the water since each customer uses the

water bills paid for. The real technology is in the meter number were visual basic codes were put to ensure the water consumed is what is paid for. Using the visual studio community 2015 for my programing environment and MYSQL server as my storage for data and a user is authenticated before accessing the system.

This system took quite longer period than earlier estimated period. The entire development process took four (4) months to come up with the fully working system.

CHAPTER TWO

LITERATURE REVIEW

2.1: Introduction

This chapter presents state of the Art and state of the practice in Water billing management system. It described the following sections:

2.2: Water Billing Management System

A water billing management system is a software solution designed to streamline the process of billing and managing water usage for both residential and commercial customers. Which include
Meter Reading Automation; Integration with smart meters or automated meter reading devices enables accurate and efficient tracking of water usage.
Billing and invoicing; the system generates bills and invoices based on water consumption data, applying appropriate rates and any additional charges or discounts.
Payment Processing; Customers can make payments through various channels such as online portals, mobile apps, or in-person at designated locations. The system records and tracks payments for accurate account reconciliation.
Customer Management; Provides tools for customer account management, including updating personal information, viewing billing history, and managing service requests or inquiries.
Reporting and Analytics; Offers insights into water consumption patterns, revenue trends, and operational efficiency, enabling utilities to make data-driven decisions and optimize resource allocation.

2.3: Billing system

This water billing management system, is an integrated online desktop system that enables automation of the whole water billing cycle (Martins, 2013). The system comes with all features that help in management of customer's records, meters, meter readings, bills, and payments and generates invoices.

Meter reading is done through an entering the meter number and the data send to a desktop Application that computes for the given customer and sends invoices to consumers in real time after payments are made. Consumers pay cashless via bank, payway and the money transferred to the utility's bank account real time, eliminating loss of money due to theft and corruption (Grace, 2022). Use of the desktop Application makes meter reading faster, while the automatic computation of the bills via the system minimizes errors to zero.

Meter reading

With this free user-friendly interface, you can now determine your water consumption and generate an estimated bill on the meter. This is by subtracting the new meter reading from the old meter reading.

Figure 1 shows how the records are recorded for the billing systems.

2.3.1: Mobile Payments

Mobile money in Uganda offers a promising tool for one of the most enduring and widespread challenges on the continent: the provision of safe water.

The scale of the challenge can be seen in the fact that the number of mobile phone subscriptions will exceed the number of people with access to safe drinking water by 2013 (Boyle, 2013). At the same time, emerging mobile money options to pay for water services have the potential to increase revenue collection, which is needed for service providers to improve and expand access to water services. On the commercial side, this represents a market in which mobile network operators (MNOs) can potentially build or retain customers to boost transaction volumes, based on regular water consumption patterns (Basaure, 2016).

A research group from Oxford University has evaluated such benefits from mobile water payments in a study of 20 different water service providers across Kenya, Tanzania, Uganda and Zambia (Krolikowski, 2013).

This first post explains the potential value of mobile money to the water sector, and highlights findings of benefits for customers and water service provider (WSPs), with challenges in customer adoption. The second post relates this to commercial interests of MNOs offering mobile water payments (Hope, 2011).

Strong potential benefits and understanding customer adoption on mobile payments

(Krolikowski A. , 2014), though customer adoption of mobile payments has been limited in most instances investigated, due to contextual challenges.

The majority of water service providers investigated have one to ten percent of their customers paying via mobile payments. (Mwalenga, 2015). The exception to this group is a small-scale and private service provider in Kiamumbi, Kenya with a 76% adoption rate.

Table 1 below different charges of water in different countries

Country	WSP	Mobile network operator	Served population	Mobile payment adoption	Months since launch
Kenya	Nairobi City WSC	Safaricom	2,250,607	4%	13
	Kisumu WASCO	Safaricom	181,512	8%	-
	Nanyuki WSC	Safaricom	57,252	1%	1
	Kiamumbi WT	Safaricom	2,922	76%	11
Tanzania	Dar es Salaam WASCO	Airtel Vodacom	2,380,000	1%	27
Uganda	National WSC	MTN UTL	2,426,502	10%	7
Zambia	Lusaka WSC	Airtel	1,285,270	-	-

Figure 2 shows different charges of water in deferent countries.

2.3.2: Why Do Water Bills Get So High?

Water loss: Last year, Uganda municipalities lost about shilling 9 billion worth of water due to leaky pipes. One community lost 38.7 percent of its water (Cruikshank, 2010).

Upgrades: It's expensive to replace deteriorating pipes, pumps, hydrants, and meters. The Chicago Tribune, citing the Illinois Department of Natural Resources, found that a quarter of pipes pumping water from Lake Michigan are more than 60 years old.

Billing frequency: Some communities may bill you once every few months, which means larger, albeit fewer, bills.

2.4: Water

Water is a liquid matter which is used for bathing, drinking, and cooking, while examples of indirect purposes are the use of water in processing wood to make paper and in producing steel for automobiles. The bulk of the world's water use is for agriculture, industry, and electricity (Olsson G. , 2015).

Most communities in Uganda and across the nation have municipal water service, meaning the local government runs the water system. However, in recent years, private companies have acquired hundreds of systems across the country, and that can be bad news for water customers.

2.4.1: How Your Water Usage Is Measured

Do you actually get metered for your water use? Some municipalities may only charge you a flat fee for your water service, which means you don't get charged for your actual water usage. This can lead to a lot of customers paying more than they should. It also takes away the incentive to be efficient. Why save water if you can't save money? Chicago's Meter Save program offers residents the chance to have a meter installed in their home so they can save water and money.

2.4.2: Consumption Rate

A total water consumption increased by 17.3 percent to 33.9 million cubic meters in 2022 from 28.9 million cubic meters in 2021 (Hourigan, 2022).

The total amount of water used in the economy rose to 253.5 million cubic meters in 2022 from the estimated amount of 220.4 million cubic meters in 2021.

He average water use per household per day registered an increase to 52.8 liters in 2022 from 52.6 liters in 2021. The average water consumption per household per day rose to 31.0 liters in 2022 from 30.9 liters in 2021," the report notes Water users in Uganda have resulted to fetching water in different source since the prices of water are high in many places in Uganda

Figure 3 shows the high consumption rate in Uganda

Figure 4 shows that the people have resulted to other means of finding water than taped water

2.5: System billing system

In today's digital age, efficiency and accuracy are paramount for water suppliers in Nagongera to manage their billing systems effectively. Water billing management systems have revolutionized the way water suppliers operate, offering advanced features and functionalities that streamline processes and enhance customer satisfaction. In this comprehensive guide by mobile payments, bank and payway we will delve into the world of water billing management systems for water suppliers in Nagongera, exploring their benefits, functionalities, and implementation strategies.

2.6: Online Desktop Systems

Online systems are computer programs or applications that are accessible through the internet. They allow users to interact with data and services remotely, from any device with a web browser and an internet connection (Rao, 2012). These systems enable users to interact with

data, perform tasks, and access services through a web interface. Examples of online systems include:

Websites: These are static or dynamic web pages that provide information or services to users. Web **applications:** These are interactive applications that run on a web server and can be accessed through a web browser. Examples include online banking systems, online shopping platforms, and social media sites.

E-commerce platforms: These are online systems that allow businesses to sell products and services online. Online learning platforms: These are systems that allow users to access educational resources and courses online.

Cloud-based applications: These are applications that are hosted on remote servers and can be accessed through a web browser

2.7: Loopholes of the Current System

Currently manual systems such as on desk face to face water billing management systems are in use in Uganda (Robert Biti, 2012), however the systems are characterized with weaknesses such as inaccurate customer records, long queues, late delivery of bills which has led to increased time wastage and customer dissatisfaction.

Other companies for example NWSC Limited have tried to merge with banks such as Nile Bank, Crane Bank in an effort to solve the problem of long queues. Clients with accounts in those particular banks can be able to pay their bills in those banks instead of having to go to NWSC offices.

2.8: Relevance of the Water Billing Management System

Prepaid NWSC is an example of an existing web based customer care and billing system for water customers (Mundu, 2012). It has got unique features such as self-login, registration, and water bill payment, billing information, customer service that is connection service, disconnection service, and change of billing address, rate comparison, payment-options and online meter reading. However with system, customers read their water meters online, which in Uganda may require modern or sophisticated technology such as use of a mobile phone which is expensive to acquire and implement.

Prepaid water meters promote efficient water usage, reduce non-payment risks, and provide flexibility and convenience for consumers.

Customers can also get water from home reducing on the moving of long distance to look for water sources so that they can get water for domestic use.

This Water billing systems utilize data encryption and comply with regulations to protect sensitive customer data and mitigate legal risks.

Integrating water billing systems with existing infrastructure requires careful planning and coordination. Water suppliers should work closely with technology providers like hydroelectricity power (HEP) to ensure seamless integration and compatibility with legacy systems.

Figure 5 shows a child carrying water from the borehole

2.9: Requirements for Developing a Water Billing Management Systems

Requirements form the basis for initiating any task. When there is a need, then we devise an action plan and proceed towards its accomplishment. Hence requirements for a software could be classified in two broad categories- functional, non- functional. The official definition of 'a functional requirement' is that it essentially specifies something the system should do.

The definition for a nonfunctional requirement is that it essentially specifies how the system should behave and that it is a constraint upon the systems behavior. One could also think of non-functional requirements as quality attributes for of a system.

2.9.1: Functional Requirements for Developing Water Billing Management Systems

Users of the Water Billing Management System namely customers had to be provided with the following functionality;

• Navigate the prices of the bills.

• Pay the bills.

• Make a complaint.

• Get the invoice of the paid bill

As the goal of the system was to make the bills paid by customers get a clear feedback about their payments made, the functionality provided through the Water Billing Management System was restricted to that which was most pertinent to accomplish the desired bills.

The Water Billing Management System enabled the admin to manage the bills. The functions afforded by the system provided admin with the ability of using a graphical interface. The functions accorded to the admin included;

• Add a new/update/delete agents.

• Add a new/update/delete customers.

• Delete payments.

• Manage payments.

• send SMS to customers to alert them about the payments.

2.9.2: Non - Functional Requirements for Developing Water Billing Management Systems

Non-functional requirements of a system are the quality attributes of a system, which enable it to effectively satisfy the needs of the users, the non-functional requirements include;

Usability: The system should provide an interactive user-friendly interface that is easily understandable for all users.

Availability: The System should be available at least during the agricultural produce store operating hours and must be recovered within an hour or less if it fails. The system should respond to the requests within two seconds or less.

Security: Only authorized users must be able to access the system and view and modify the data.

Dependability: The system should provide consistent performance with easy tracking of records and updating of records of the bills.

Maintainability: The software should be easily maintainable and adding new features and making changes to the software must be as simple as possible.

2.10: Implementation

The software requirements is the foundation of the entire development process of the project. Henceforth software requirements are the description of features and functionalities of the target system. In other words, they can be obvious or hidden as well as expected or unexpected from the client's side of view. Therefore the features needed to develop the water billing management system are given below

An operating system is a software which acts as an interface between the end user and the computer. It supports a computer's basic functions, such as scheduling tasks and controlling

peripherals. Some examples include versions of Microsoft Windows (including windows 10, 8, 7). For this system I was more interested in the windows 10 operating system software.

The technology used is referred to as studio community 2015 and the language as visual basic which is an open source that is especially suited for desktop application development. In addition windows forms for building web pages and desktop applications also was used.
The bills system requires a database to store, update as well as inserting the customers' payments, names, and addresses. For this system, a database management system namely MySQL server management studio was used. MySQL is an open-source relational database management system that organizes data into one or more data tables in which data types may be related to each other. The main reasons for this specific database management system was due to its flexibility, scalability and the level of data protection it provides.

2.11: Testing the Water Billing Management system

This testing required no knowledge of the inner design of the code or logic. System testing was performed on the entire system in context of the functional requirements and system requirements. System testing was carried out to ensure that the customers, agents and administrators cannot submit empty fields especially those that are mandatory.

CHAPTER THREE

METHODOLOGY

3.1: Introduction

This chapter talks about the system design, data collection methods, sampling strategies and data analysis that was used in the study. The main method of system development that will be used is the Rapid application development approach.

3.2: Area of Study

This study was conducted in the in National water and sewage cooperation where the in Nagongera town council in Tororo district. (NWSC) was chosen due to the existing problems identified by the system, above all, it is near and data can be collected easily. Since water is an essential I had to carry out this study so that I can easy the customers way to water usage and payment.

3.3: Population and Sampling

This study involved 9 respondents from whom data was collected namely; 6 customers, 2 agents, and one manager. Non probability sampling was used as it involved nonrandom selection based on convenience allowing me to easily collect data from the respondents.

3.4: Data Collection

This explains the different methods that shall be used by the researcher. A number of steps, procedures and tools that will be employed are as shown below;

3.4.1: Observation

This technique was used to gather accurate information about how the system actually operates particularly about processes. This technique enabled me to systematically observe and record the behavior and characteristics of operations and processes in the water industry. The method gave me more detailed and context related information, permits the collection of information, permits tests of the reliability of the responses to the view operations of a system as they are actually occurring, and can adapt to events as they occur. It is important in that; I saw exactly what is being done, it allowed the validity of facts and data to be checked, it is relatively inexpensive and I obtain data describing the physical environment of the task.

3.4.3: Interviews

This is the most commonly used and normally most useful fact-finding technique used by the researchers to collect information from the participants face to face. There can be several objectives of using interviewing such as finding out facts, generating user interest and feelings of involvement, identifying the requirements and gathering ideas and options. Interview technique is credited in the following ways; it allows an interviewer to follow up an interesting comment made by interviewee, it also allows the interviewer to adopt or re-ward questions during

interview, it allows interviewer to observe interviewee's bodily language, interviewee can also respond freely and openly to questions. However, it has drawbacks such as Very time consuming and costly, and therefore maybe impractical, Success is dependent on communication skills of interviewee.

3.4.4 Document Review

This tool used to understand what has been written on the subject matter of billing. A thorough review of the documents shall be used in the company's with the intent to study how things are done and discover areas where improvement is necessary. It can enable the researcher to investigate gaps, problems and benefits of the existing system. A number of documents shall be reviewed including customer charts, registers, periodic reports and books among others. This method was used because; It is inexpensive due to the availability of data, it permits examination of trends over the past, does not interrupt program, and there are few biases about information. From the above available data technique, I used document reviews to understand what has been written on the subject matter of capacity water paying system.

3.5: System Design

The Water billing management system is a desktop application that is completely developed using visual studio. The system consists of an admin panel that provides user name and password through which the company start doing their job of registering customers, agent and managing prices, sending alert massages to customers. Thereafter the customers can visit the page and pay bills for water usage.

The system is to have a home page where multiple options allow the customer to pay their bills read the meter. In addition, the system has a system agent who has the right to add and manage customer accounts as well as manage the bills for the users. Furthermore the structure of the system is to be divided into three main components i.e. the billings which allows the water flow customers. Secondly, the desktop application system which provides the functionality for customers to read their meter and pay if the units are done.

The final component which is the water billing management system that is to be used by the people to pay for water.

3.5.1: Customers

This component outlines the functions to be used every time a customer pay bills, make complaints check meter reading. Thus this simplifies the billing process.

Make a complaint.

Pay bills.

Check the meter number.

Check prices to pay for.

Chose the method of payment.

3.5.1: Agent

This component outlines the functions to be used every time an agent pay bills, manage complaints check meter reading. Thus this simplifies the management process.

Manage Billing.

Check meter number.

Pay bills.

Manage complaints.

Add, Delete and Edit customers.

3.5.3: Admin

This component outlines the functions to be used every time administrator pay bills, manage complaints check meter reading mange the agents. Thus this simplifies the management process.

Manage Billing.

Check meter number.

Pay bills.

Manage complaints.

Add, Delete and Edit customers.

Manage payments.

Alert the customers on payments.

Delete, Edit, and Add agents.

3.6: User Interface Specifications

This implies that each of the components mentioned above will have unique interfaces and are described below.

3.6.1: Billing System

This billing system make sure that customers pay for water before they receive the water for their use.

It also helps to regulate the water consumption rate and makes sure the water is use in a responsible manner. This helps to conserve the environment as well.

3.6.3: Water billing management System

It ensures that water is managed well, payments are made and accounted for when asked by the accounting department.

3.7: System Analysis and Design

First of all system analysis and design is a process of collecting and interpreting facts, identifying the problems and decomposition of a system into its components. There are different types of system design but most preferably the logical design was used for this study. Logical design is an abstract representation of data flow, inputs and outputs of the system thus it describes the inputs, outputs, databases and procedures all in a format that meets the user requirements. The diagrams used for this system include the context diagram as well as the user case diagrams.

3.7.1: context diagram

Relationships were established between the data items to show how the different entities relate with the system. The context diagram therefore shows the basic interaction of the system with its environment.

3.7.2: Use Case Diagram

This is a graphical depiction of a user's interaction with a system. It shows various use cases and different types of users the system is to have and will often be accompanied by other types of diagrams as well. Henceforth use cases are represented with a labeled oval shape where stick figures represent actors in the process i.e. the admin, the customer, as well as agents a line between the actor and use case.

Customers

Customer name_ this is the name of the customer registered to use the water.

Customer Address_ this is the location where the customer come from.

Customer Phone_ this the contact of the customer to use while registering.

Customer Password_ this is the password which the user will use to login the system if registered.

Joining date_ this is the date that shows when the user was registered into the system.

Customer Category_ this shows the types of product purchased for in the system.

Number of users_ this show the number of users for water at the time of registering.

MeterNO_ this is the meter number of the user is to use for making payments for the every customer.

Billing

Billings are made by the customer, agent or an administrator.

MeterNO_ this is the number to use by the customer for making payments.

Fast Name_ this is the surname of the person reporting the system.

Consumption DM_ this is for describing if the system is doing well or no.

Billing date_ this shows when the bill was made.

Payment_ this shows the mode of payments for the customers.

Tax_this shows the number of taxes to pay while making the billing process.

Agent

The agent should be registered by the administrator.

AgentID_ this is the identification number of the agent.

Agents Name_ this is the name of the agent to be registered.

Agent address_ this is the location where the agent is to work from.

User name_ this is the name an agent uses to access the system.

Agent password_ this is the password of the agent to use will registering

Payments

This is where payments are made to.

Customer name_ this is the name of the customer how is making payments.

Meter No_ this is the meter number where payments are made too.

Contact_ this the contact where the payments will be dedicated from.

Units_ this is the number of units paid for use.

Reporting faults and complaints:

This is the where the complaints about the product is made so that one can get help.

Reporters name_ this the name of the customer making complaints.

Reporter's address_ this is the location where the user is making a complaint from.

Area to repaired_ this is the area were the reporter whats help to be repaired.

Date of reporting_ this is the date when the complaint was made.

Describe the fault_ this is the actual problem of the customer to be addressed.

3.8: Implementation

This chapter provides an overview of the implementation process in which the logical structure is to be converted to physical architecture through coding and development of the system. Henceforth, the frontend and backend of the system shall be developed and tested.

3.8.1: Software Requirements

The software requirements is the foundation of the entire development process of the project. Henceforth software requirements are the description of features and functionalities of the target system. In other words, they can be obvious or hidden as well as expected or unexpected from the client's side of view. Therefore the features needed to develop the water billing management system are given below

3.8.2: Operating System

An operating system is a software which acts as an interface between the end user and the computer. It supports a computer's basic functions, such as scheduling tasks and controlling peripherals. Some examples include versions of Microsoft Windows (including windows 10, 8, 7). For this system I was more interested in the windows 10 operating system software.

3.8.3: Technology

The technology used is referred to as studio community 2015 and the language as visual basic which is an open source that is especially suited for desktop application development. In addition windows forms for building web pages and desktop applications also was used. Window form are and easy to use this make it easy to drag and drop the common controls which are important in validating inputs as well as verifying any user input before submitting it to the server. Henceforth it ensures functionality of the web pages.

This is a new technology that is used by visual basic and MYSQL server management studio as the super sever to authenticate the users in the system. This is secure in a way that is the user does not exist in the server then the system has to close. This will ensure that the right users use the system.

3.8.4: Database

First of all, database is a container for storing and retrieving data. The bills system requires a database to store, update as well as inserting the customers' payments, names, and addresses. For this system, a database management system namely MySQL server management studio was used. MySQL is an open-source relational database management system that organizes data into one or more data tables in which data types may be related to each other. The main reasons for this specific database management system was due to its flexibility, scalability and the level of data protection it provides.

3.9: Rapid Application Development

Rapid application development (RAD) is a methodology that focuses on developing applications rapidly through frequent iterations and continuous feedback.

RAD approach to software development puts less emphasis on planning and more emphasis on an adaptive process. Prototypes are often used in addition to or sometimes even instead of design specifications

3.10: Testing

All components of the system was tested to ensure proper functionality. They were integrated to form a fully functional system.

System testing involved testing software or hardware connected on a computer, integrated system to evaluate the system's compliance with its specified requirements. This testing required no knowledge of the inner design of the code or logic. System testing was performed on the entire system in context of the functional requirements and system requirements. System testing was carried out to ensure that the customers, agents and administrators cannot submit empty fields especially those that are mandatory. This was done by leaving some fields empty to see whether the system can send an alert message.

Validation was done to ensure that data fed into the system satisfied the pre- determined formats and complied with stated length and character requirements including other defined input criteria. For example, a field that requires a date was not to allow letters. For accurate validation, sample data should be into the system to find out if the system is able to respond correctly to the test data fed into the application that is if it is correct or incorrect data. Different stakeholders were left to interact with the system to find out its validity.

CHAPTER FOUR

FIELD STUDY AND SYSTEM DESIGN

4.1: Introduction

This chapter presents the results from field study. It highlights the strengths and weakness of the current system. This chapter describes system requirements (user requirements, functional requirements, and non-functional requirements) and the design of the system (system architecture, context diagram, data flow diagram, entity relationship diagram and the flow chart diagram).

4.2: System Study and Analysis.

The study was carried out at National water and sewage corporation, Nagongera. The main purpose of the study was to find out the challenges faced by customers at the water usage. It involved studying the existing system to identify its strengths and weaknesses. The information acquired from the study was done by employing a number of data collection methods including observation an interview were analyzed to give the basis to design a new system.

4.2.1: Findings from Interview

The customers tend to disagree with the receipts presented to them and they tend to go cutting cut the pipes and fetch the water before reaching the meter this is due to the unstable price give to the customers. This in return reduce the taxes generate for the country

4.3: Current Water Billing System

Currently manual water billing systems are in use in Uganda today, were the agents of water move house to hose to look for the payment recodes of people. This is error prompt such as inaccurate customer records, long queues, and late delivery of bills which has led to increased time wastage and customer dissatisfaction.

4.4: Strength of the Water Billing System

This water billing system is improving things like and meters, using new technology for billing, and managing money well. They're also talking with customers more and making sure rules are followed. Sometimes, companies work together to make things even better. But there are still problems like water leaks and fixing stuff, so they need to keep checking and fixing things to make it work well.

4.5: Weakness of the Current Water Billing System

Currently, there are manual water billing management systems in use in Uganda, were the agents of water move house to hose to look for the payment recodes of people. This is error prompt such as inaccurate customer records, long queues, and late delivery of bills which has led to

increased time wastage and customer dissatisfaction. And this leads to inaccurate Billing Sometimes, bills are not correct, leading to confusion and disputes between customers and water utilities.

4.6: Advantages of Water Billing Management System

Accuracy: Water billing systems eliminate manual errors, ensuring accurate billing and reducing disputes.

Efficiency: Automated processes streamline billing operations, saving time and resources for water suppliers.

Data Insights: Real-time consumption data allows for informed decision-making and proactive leak detection.

Customer Satisfaction: Enhanced transparency and billing accuracy improve customer trust and satisfaction.

4.7: Features of Water Billing Management System

The system contains customer, agents and administrators are to use this water billing management system.

4.8: User Requirements

This system enables the users to payments using mobile money, bank, payway and so that one can access the water.

4.9: Functional Requirements

Users of the Water Billing Management System namely customers had to be provided with the following functionality;

• Navigate the prices of the bills.

• Pay the bills.

• Make a complaint.

• Get the invoice of the paid bill

As the goal of the system was to make the bills paid by customers get a clear feedback about their payments made, the functionality provided through the Water Billing Management System was restricted to that which was most pertinent to accomplish the desired bills.

The Water Billing Management System enabled the admin to manage the bills. The functions afforded by the system provided admin with the ability of using a graphical interface. The functions accorded to the admin included;

• Add a new/update/delete agents.

• Add a new/update/delete customers.

• Delete payments.

• Manage payments.

• send SMS to customers to alert them about the payments.

4.10: Non-Functional Requirements

Non-functional requirements of a system are the quality attributes of a system, which enable it to effectively satisfy the needs of the users, the non-functional requirements include;

Usability: The system should provide an interactive user-friendly interface that is easily understandable for all users.

Availability: The System should be available at least during the agricultural produce store operating hours and must be recovered within an hour or less if it fails. The system should respond to the requests within two seconds or less.

Security: Only authorized users must be able to access the system and view and modify the data.

Dependability: The system should provide consistent performance with easy tracking of records and updating of records of the bills.

Maintainability: The software should be easily maintainable and adding new features and making changes to the software must be as simple as possible.

4.11: Hardware/ Software Requirements

Hardware Requirements

The hardware requirements include;

i. A Universal hard disk drive.

ii. A hard disk of at least 8GB.

iii. Random Access Memory (RAM) not less than 1GB.

iv. An uninterruptible power supply (UPS).

Software Requirements

The software specifications required on the computer system include;

i. visual studio community 2015.

ii. Windows 10 or higher version.

iii. The system should have 32/64 bits Operating System.

4.12: System Development Approach

The requirements determined were used to design the Water Billing Management System. The major development approach to be employed for this project is the Structured System Analysis and Design methodology. SSADM followed the waterfall life cycle model starting from the feasibility study to the physical design stage of development. One of the main features of SSADM is the intensive user involvement in the requirements analysis stage.

4.13: System Design

The design follows system development methods. In this study, Rapid Application Development derived from Structural System Analysis and Design Methods was invoked. The design stages included; system architecture, Context Diagram and Use Case Diagrams

4.13.1: System Architecture

System architecture refers to the high-level structure and organization of a complex system. It encompasses the design of a system's components, their relationships, and how they work together to achieve the overall goals and objectives of the system (Gharajedaghi, 2011).

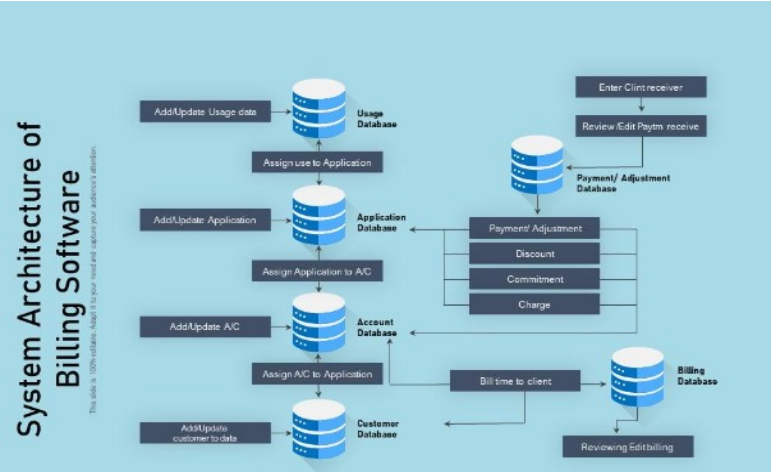

Figure 6 System Architecture of water billing management system

The system user first interacts with the user interface which provides him/her with means to place a request to the database which maybe customer, agents or administrator. The request is passed to server which processes it and include a command to link the available database, the query is executed by the database through the MYSQL serve engine which acts as a tool to transform the request to a format both the database and the server can understand. The results are passed to the user through the same process. The Water billing management System proposed in the study was designed using a four layered architectural pattern which included;

Presentation layer: This represented the various ranges of devices that were used to access the Water Billing Management System via the internet. Water Billing Management System modules. This layer represented the key features which consisted of; Administrator module, agent module and Customer module.

Server: This showed the server used during implementation.

Storage service: This layer covered the rapid and storage of data or information using a rational data base management system like MySQL server management studio which was used in this case.

4.13.2: Context Diagram

A context diagram is a high-level overview of the system that shows its interactions with external entities. It is like a map that outlines the system's boundaries and its key relationships with the outside world (Branch, 2011).

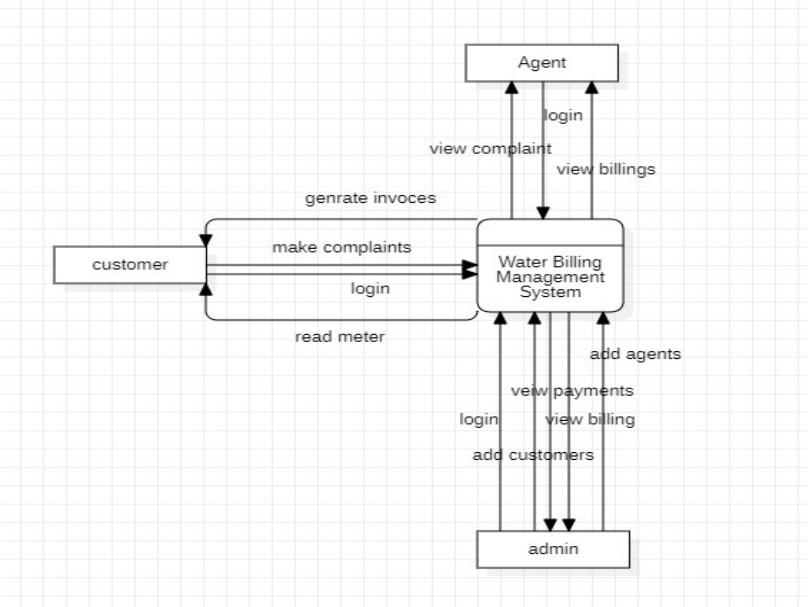

Figure 7 context diagram water billing management system

This diagram showed the general overview of the system, and its interactions with external entities. The main external entities were the administrator and other system users.

4.13.3: Use case diagram

A use case diagram is a graphical representation of the interactions between users and a system. It visually depicts the functionalities of a system and how users will interact with it to achieve their goals.

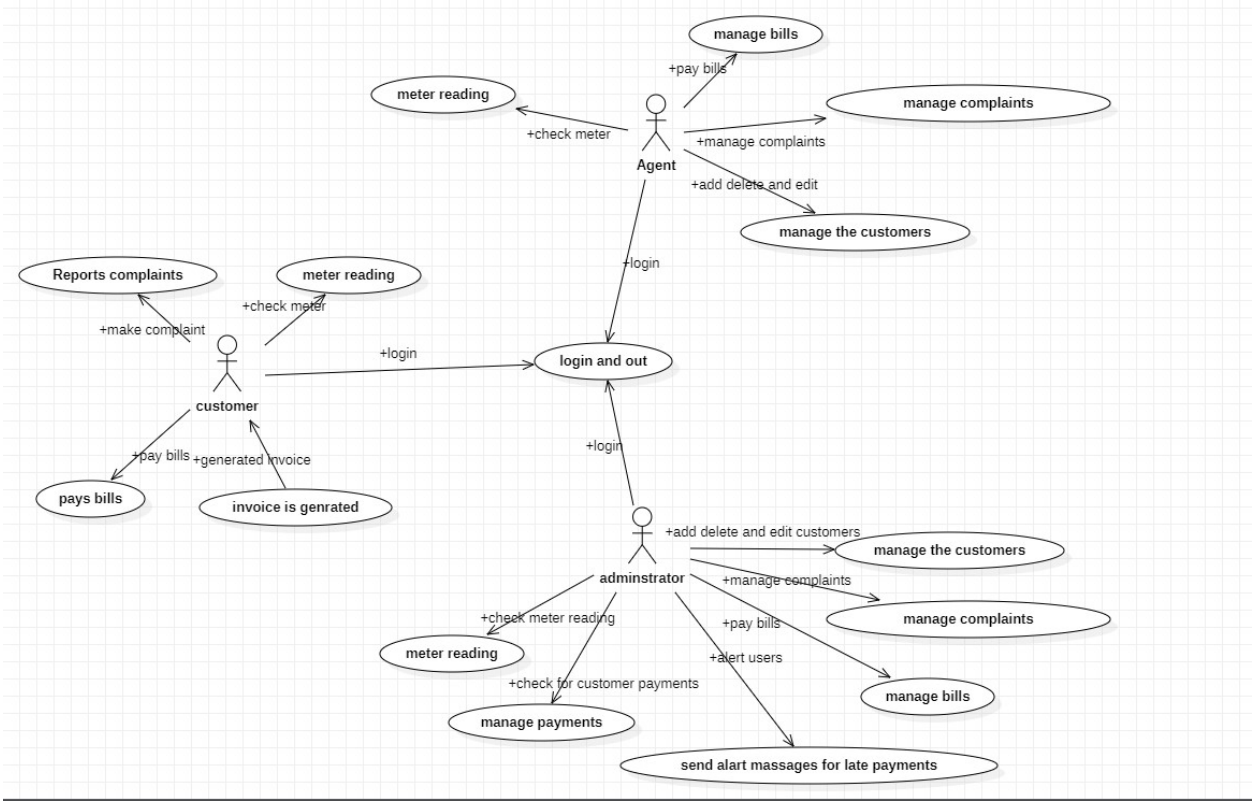

Figure 8 use case diagram for the water billing management system

The use case diagram showed the different activities performed by the three types of users namely admin, delivery agent and the customer in the system.

4.13.4: Programming Tools for the Water billing management system

The programming tools included;

• Visual Studio community

• MySQL server management studio

• Visual basic

4.13.5: Implementation and Testing

This is where the actual development of the Water billing Management System happened which included developing the Graphical User Interface (GUI), implementing the using visual studio community 2015.

4.13.6: Coding and testing

Coding involved transforming the identified structural design specifications into actual working computer codes after which each function was designed, a test was performed to ensure that it worked properly as per the set user expectations. Coding was done using visual basic and my MYSQL server management studio as my server.

4.13.7: System Documentation and Training

The system was documented after all the tests had been performed to serve as a reference point to the system administrator to maintain the system throughout its productive life and the customers. Training of the system users was done after the testing of the system.

CHAPTER FIVE

IMPLEMENTATION AND TESTING

5.1: Introduction

This area focused on fulfilling the use of the requirements i.e. functional and non-functional requirement into a working / running system. It furthermore presented implementation of the design presented in Chapter Four.

5.2: Interface Design

The goal of user interface design is to make the user's interaction with the system as simple and efficient as possible, in terms of accomplishing user goals. It is also the way through which a user interacts with an application or a website. It mainly focused on the looks and style of how a system appeared to the user referring to the customer and administrator in this case. The functional and non-functional requirements that were implemented for the Water Billing Management System include: For the customer, he/she was able to view meter reading and and pay money using the mobile money, bank and payway where the reference is generated for both bank and payway.

5.3: Interface for Customer Billing

User login

This form enables users to login the system.

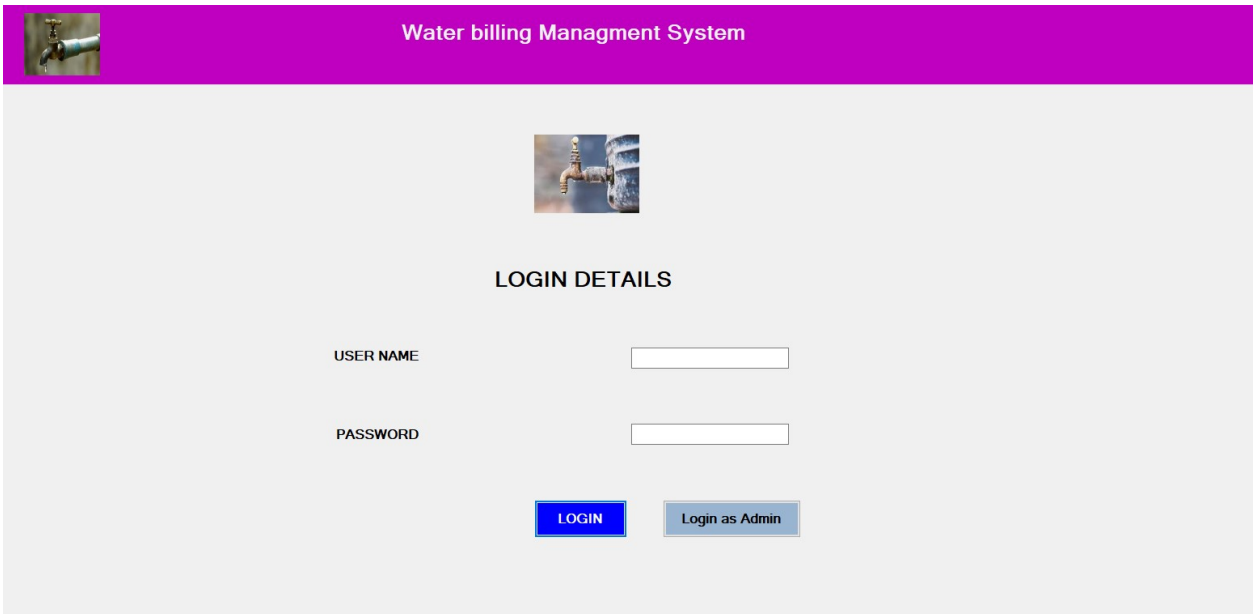

Figure 9 shows the user login form for the Water billing Management system

User login in

The user is able to pay with this system were bills are made.

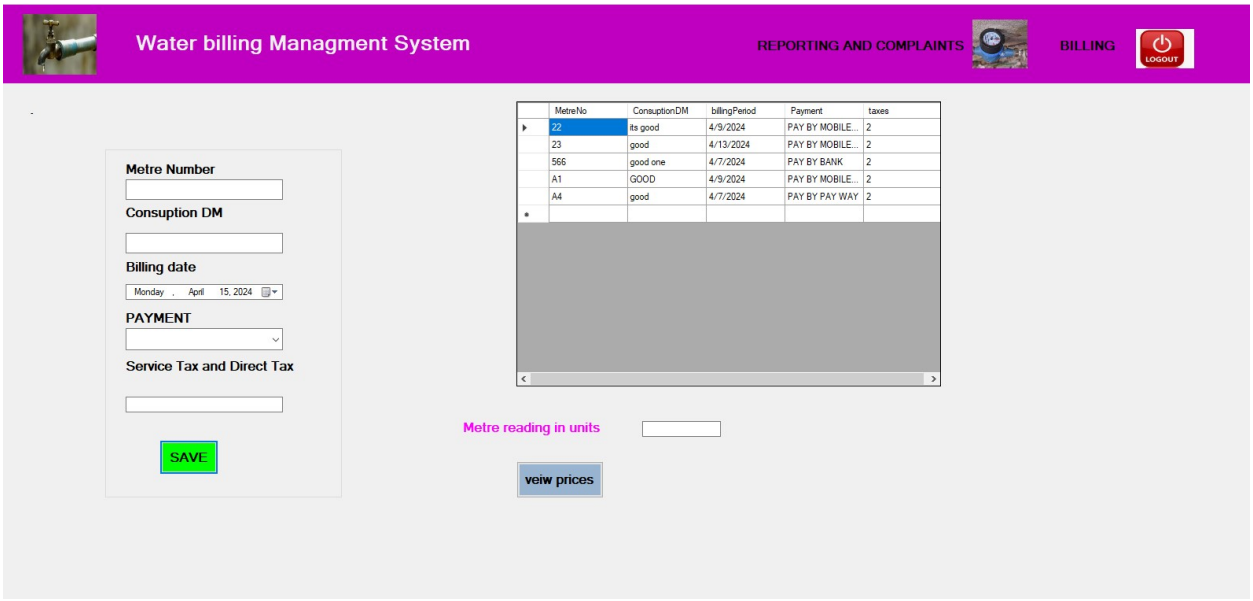

Figure 10 show the billing form the Water billing Management system

Reporting faults

In this form the user is able to report any fault in the system.

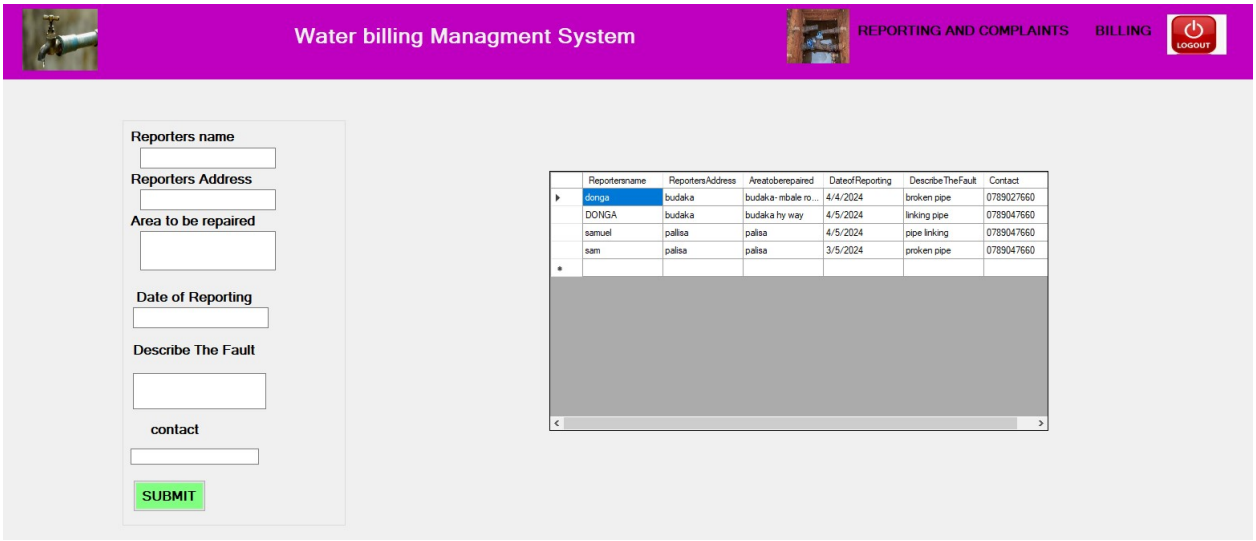

Figure 11 shows the reporting form of the billing form for the Water billing Management system

Welcome form.

This form shows the welcome form for the agent when he or she login

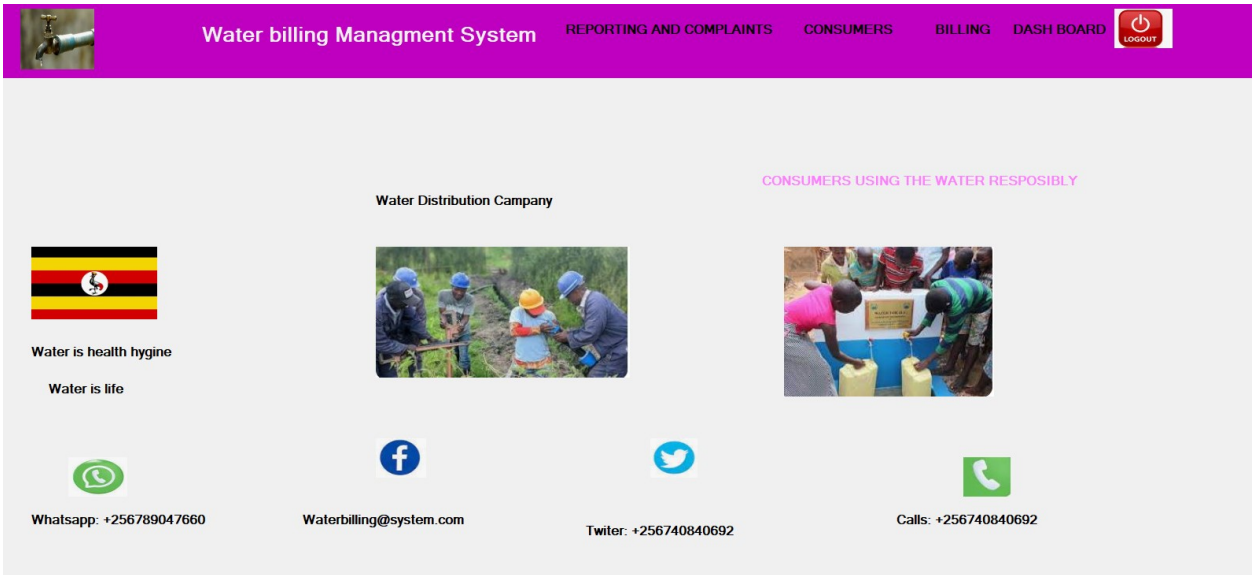

Figure 12 shows the welcome form the Water billing Management system

Registering the customer

This form shows how the administrator can register the new user

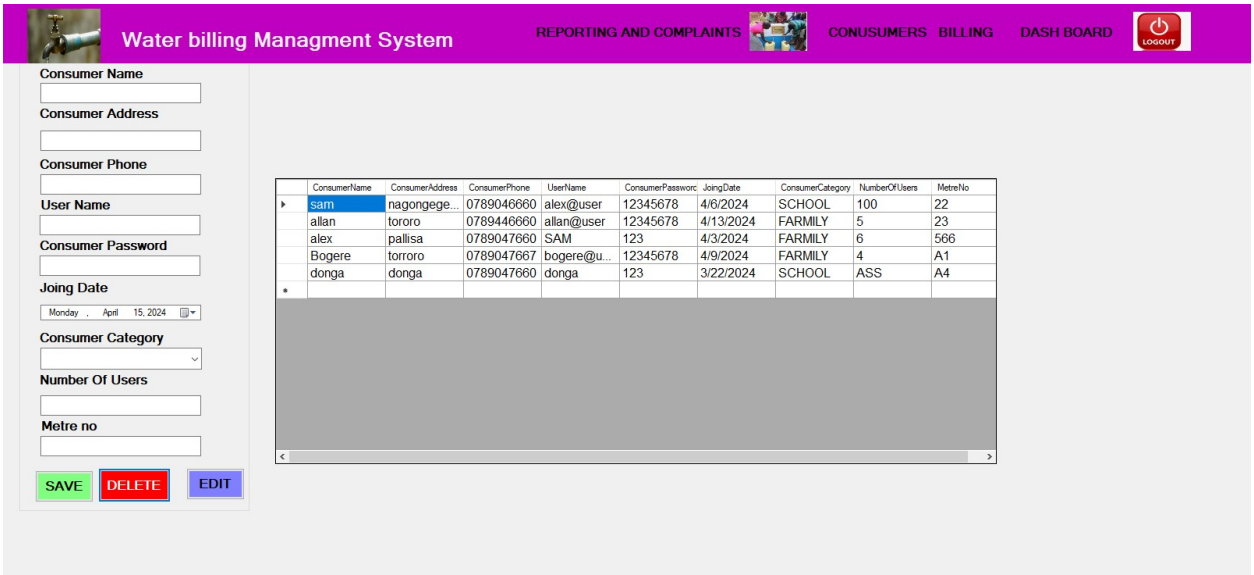

Figure 13 shows the customer registration for the Water billing Management system

Dashboard

This shows the dash board where all the uses in the system are seen from this from.

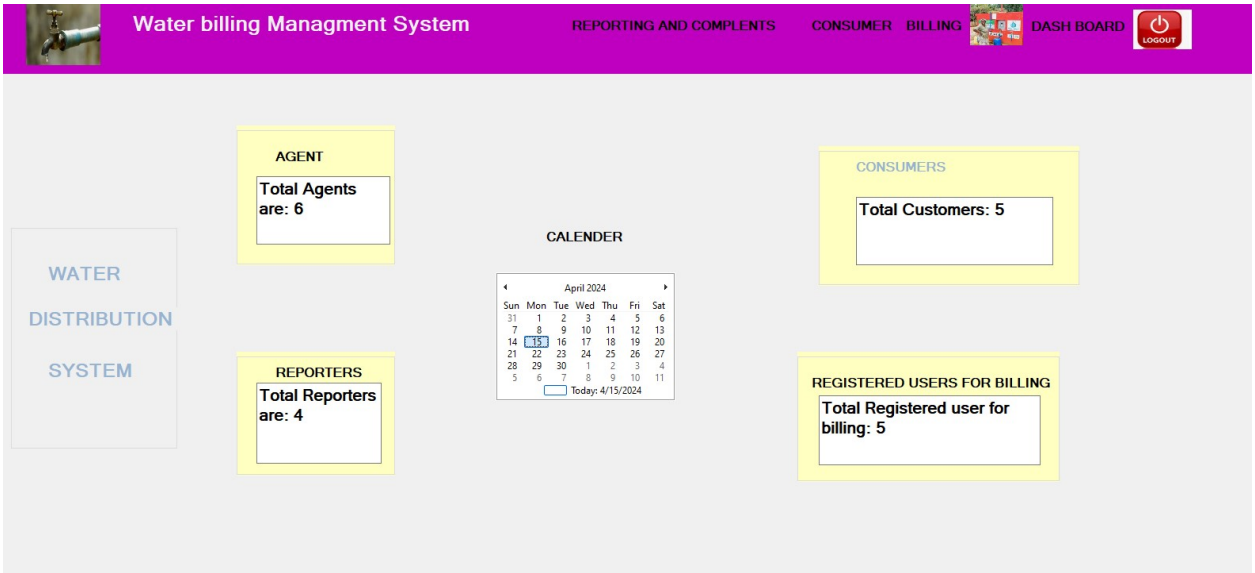

Figure 14 shows the dash board for the Water billing Management system

Agents form

This form shows the agents form where the agents added to the form

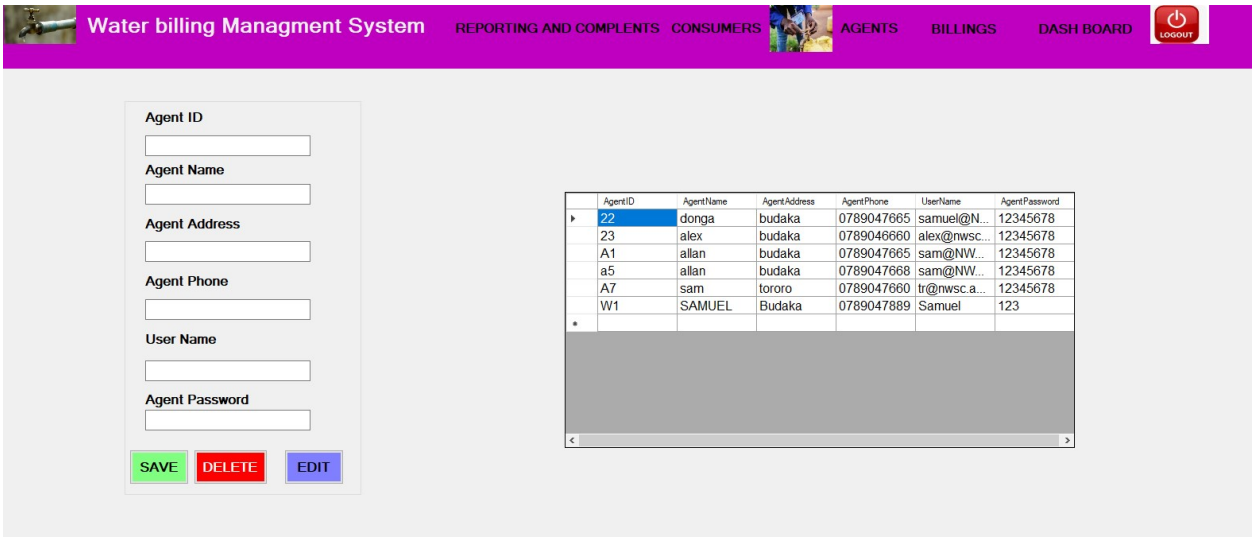

Figure 15 shows the agents additions in the Water billing Management system

Reference generation

This shows how the user's bank payment reference code is generated.

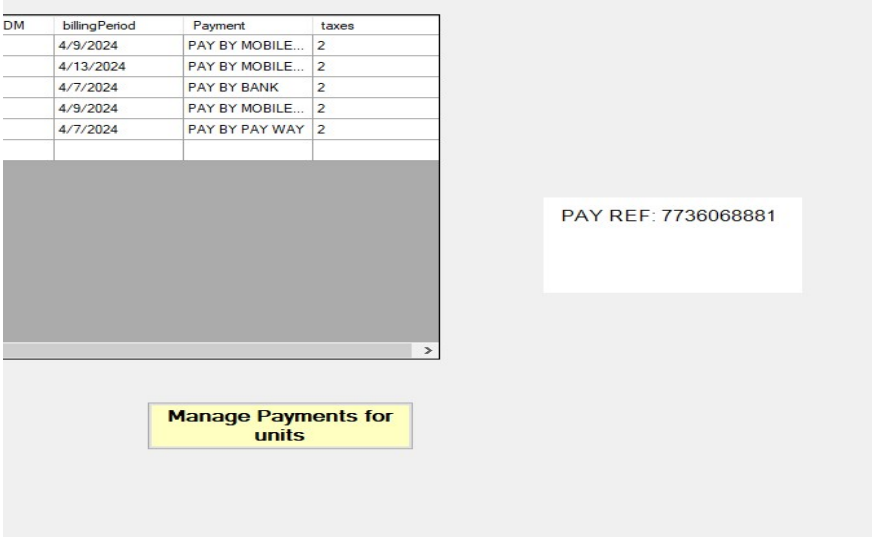

Figure 16 shows the bank reference generated

Payway reference code

This shows how the payway reference code is generated.

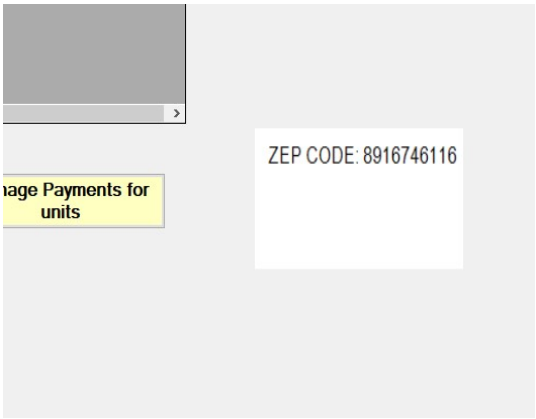

Figure 17 show the payway reference generated

Mobile Payment form

This shows how the payments are made using mobile money

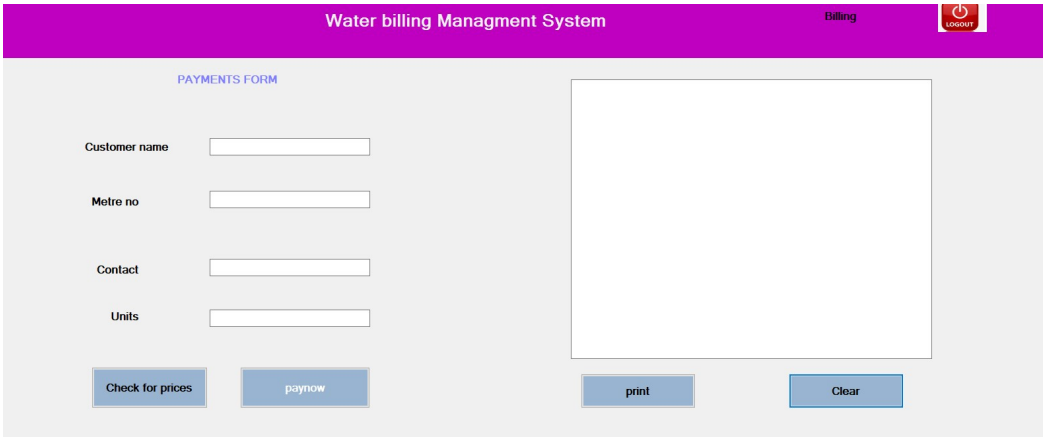

Figure 18 shows the form for mobile payments in the Water billing Management system

Payment invoice is generated

This show how the invoice in generated after payments are done.

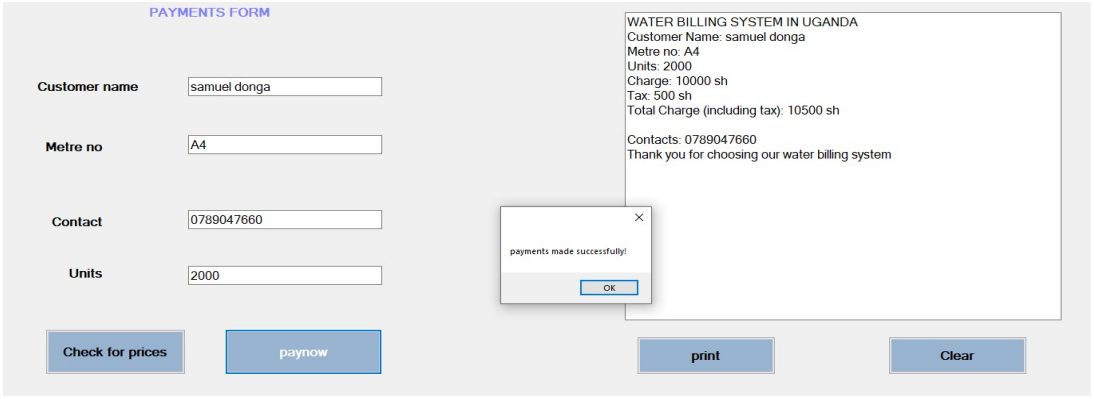

Figure 19 shows the invoice generated in the Water billing Management system after payments

Check for the prices before the payments are done

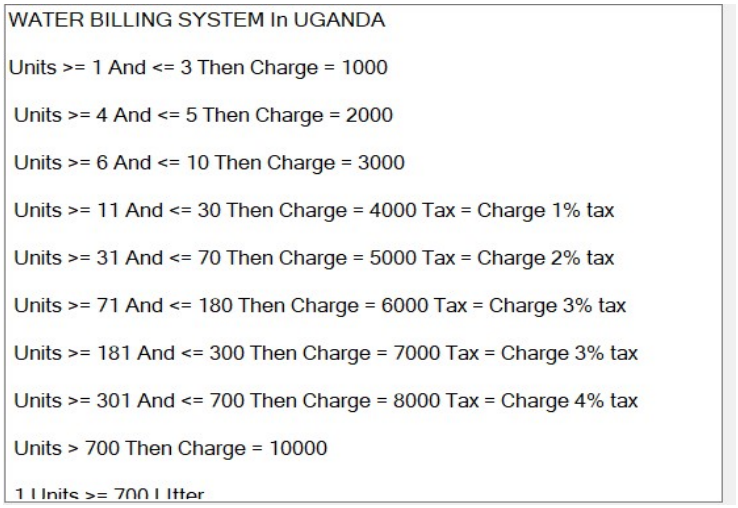

Figure 20 shows how to check for the payments in the Water billing Management system

Login admin

This shows how the admin logs in the system using its details.

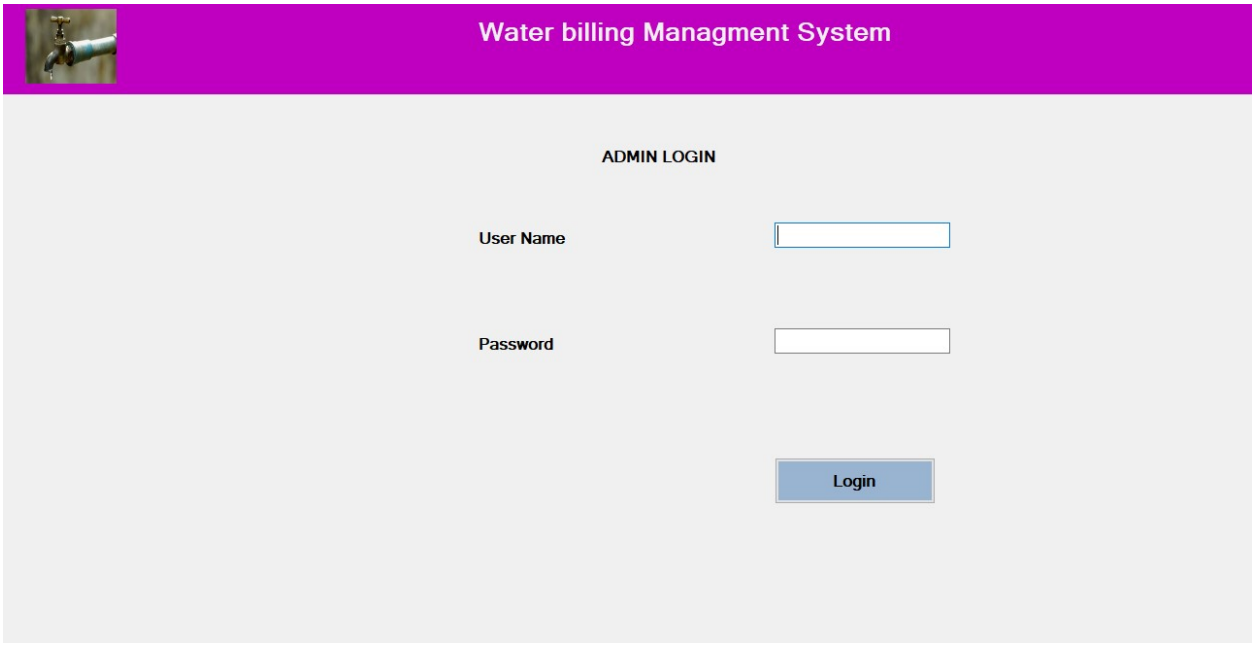

Figure 21 shows the login form for the administrator in the Water billing Management system

Manage payments

Administrator can manage the payments from this form.

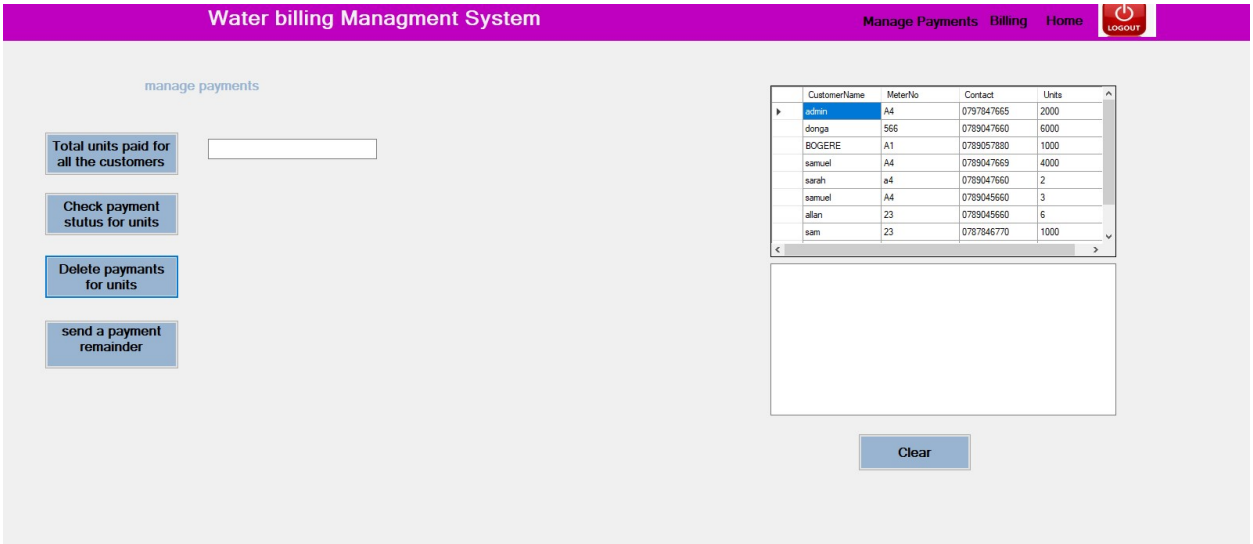

Figure 22 shows how the admin can manage the payments.

Send massages to the customers to alert them while the units are getting low

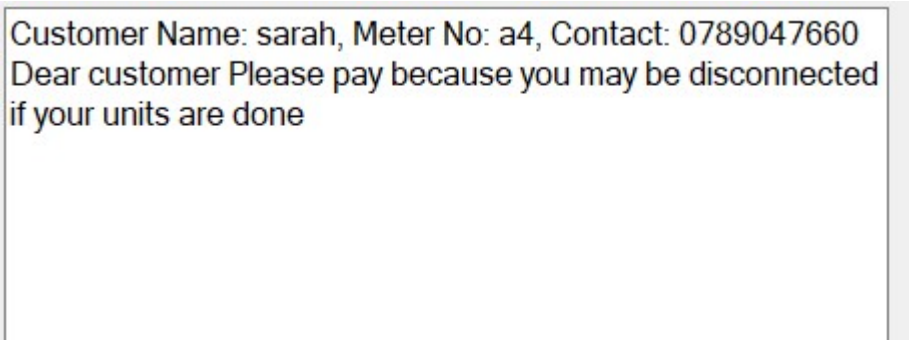

Figure 23 shows one of the customers with low payment to be worked on

Check for payments for the records made to a given meter number.

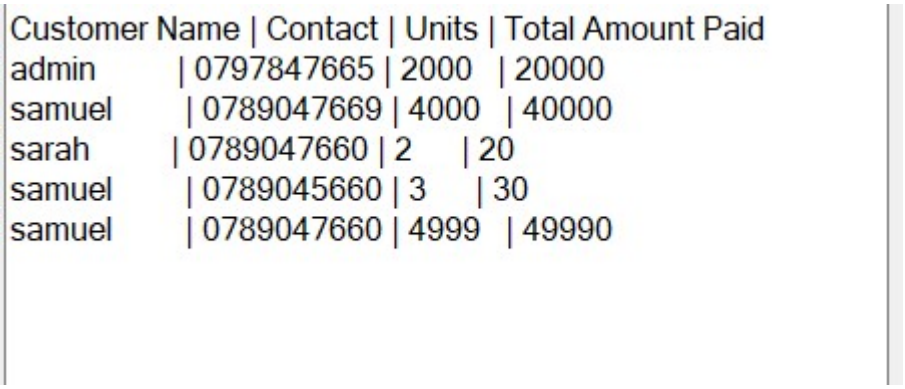

Figure 24 shows the records of the one meter number paid for

Admin can check for all payments made in the system

Figure 25 shows the all the payments retrieved from the system

5.4: Data Storage

The system automatically stored the billing, customer, payments and agent details, as well as the information of name, date, billing, and payments into the system and the administrator is able to manage the payment made and billing for various customers.

Database

All the date is stored in this databases in the Water Billing Management System and they can be retrieves if the user input the correct details.

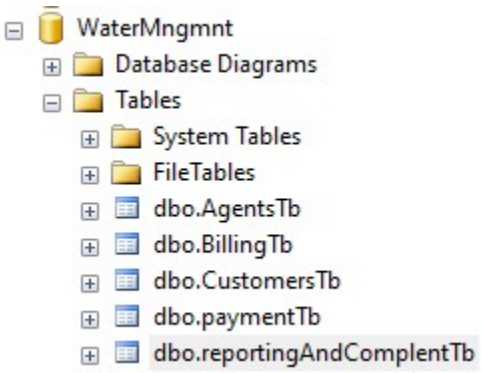

Figure 26 shows all the tables in the water billing management system

Agents table

This table stores all the Agents in the in the Water Billing Management System and they can be retrieves if the user input the correct details.

Column Name	Data Type	Allow Nulls
AgentID	varchar(10)	☐
AgentName	varchar(30)	☐
AgentAddress	varchar(20)	☐
AgentPhone	varchar(10)	☐
UserName	varchar(30)	☐
AgentPassword	varchar(20)	☐
		☐

Figure 27 shows the tale of agents in water billing management system

Billing table

This stores all the billings made by all the uses in the Water Billing Management System.

	Column Name	Data Type	Allow Nulls
🔑	MetreNo	varchar(10)	☐
	ConsuptionDM	varchar(50)	☐
	billingPeriod	date	☐
	Payment	varchar(50)	☐
	taxes	int	☐
			☐

Figure 28 shows the table of billings in water billing management system

Customer registration table

This stores all the customers registered in the Water Billing Management System and they can be retrieves if the user input the correct details.

	Column Name	Data Type	Allow Nulls
▶	ConsumerName	varchar(30)	☐
	ConsumerAddress	varchar(30)	☐
	ConsumerPhone	varchar(10)	☐
	UserName	varchar(30)	☐
	ConsumerPassword	varchar(20)	☐
	JoingDate	date	☐
	ConsumerCategory	varchar(20)	☐
	NumberOfUsers	varchar(20)	☐
🔑	MetreNo	varchar(10)	☐
			☐

Figure 29 shows the table of customer's registration in water billing management system

Payments table

This table stores all the payments made in the Water Billing Management System and they can be retrieves if the user input the correct details.

Column Name	Data Type	Allow Nulls
CustomerName	varchar(30)	☐
MeterNo	varchar(10)	☐
Contact	varchar(10)	☐
Units	int	☐
		☐

Figure 30 shows the table of payments table in the water billing management system

Complaint and faults table

This table stores all the complaints made in the Water Billing Management System and they can be retrieves if the user input the correct details.

Column Name	Data Type	Allow Nulls
Reportersname	varchar(30)	☐
ReportersAddress	varchar(30)	☐
Areatoberepaired	text	☐
DateofReporting	date	☐
DescribeTheFault	text	☐
Contact	varchar(10)	☐
		☐

Figure 31 shows the table of complaints in water billing management system

5.5: System Testing

The entire system was tested using codes, class modules and modules. This stage of implementation ensured accuracy and efficiency operation of the system before it was given to the users. It required a series of different tests which varied at different system levels. The system tester assumed that if all parts of the system were correct then the goal would have finally been achieved. Testing is the process of executing the program in order to identify errors or bugs. Testing shows the software errors. Therefore, testing was done after completion of the system. This was done in two formats including Unit testing and Integration testing.

5.5.1: Unit Testing

Unit testing was done on individual codes of the system to ensure that they fully yield the functional units. This was done by examining each unit, for example the code for paying for the bill. This was done to ensure that the payment was made in the billing side as it was 0 without errors. Successfully achieving that encouraged me to go ahead with integration testing after all the identified errors were worked on individually.

5.5.2: Integration Testing

This was done after all the different modules had been put together to make a complete system. Integration aimed at ensuring that all the modules of the system worked hand in hand and that they could be integrated to form a complete working system.

5.5.3: Validation of the System

Validation of the system was done in order to confirm whether the system met its intended requirements and functionalities as intended. It involved a series of evaluations to ensure that the system is correct, consistent, complete, traceable and secure. Functional validation was done in order to test the system's core functionalities and ensure they meet the specified requirements. Non-functional validation was also done to test the system's performance, usability, security, compatibility and other quality attributes or non-functional aspects. Integration validation was also done to test how well the system interacts with other systems it depends on.

CHAPTER SIX

DISCUSION OF RESULTS, CONCLUSION RECOMMENDATION AND FUTURE WORK

6.1: Introduction

In this chapter, I concluded the findi ngs for developing Water Billing Management System in relation to the set objectives and methodology. The study found that the bills are miss entered into the system and the if the agents come back to ass again the bills are not matching with the customers' bills.so there is need to use this computerized system which will enable the correct collection of the bills paid

6.2: Discussion of Results

The water billing management system in Nagongera encompasses various features aimed at streamlining billing processes and enhancing customer satisfaction. It includes:

Meter Reading Automation; Integration with smart meters enables accurate tracking of water usage, minimizing errors (Li, 2011, November).

Billing and invoicing; the system generates bills based on water consumption data, applying appropriate rates and additional charges, if any (Ashna, 2013, March).

Payment Processing; Customers can pay through various channels, including online portals and mobile apps, ensuring convenient and timely payments (Smolarczyk, 2018).

Customer Management; Tools for managing customer accounts, updating information, and handling service requests enhance customer service (Buttle, 2019).

Reporting and Analytics; Insights into consumption patterns and revenue trends enable utilities to make informed decisions and optimize resource allocation (Bhattarai, 2019).

The integrated online desktop system facilitates automation of the entire billing cycle, reducing errors and improving efficiency (Alirezaei, 2022). Meter reading is expedited, and bills are generated in real-time, promoting cashless transactions and minimizing revenue loss due to theft or corruption.

The use of mobile payments in Uganda presents opportunities for increased revenue collection and improved customer service (Gutierrez, 2014). However, adoption rates among customers vary, with some challenges hindering widespread acceptance.

Despite these advancements, challenges such as water loss due to leaky pipes and outdated infrastructure persist. Upgrades are costly, and billing frequency may affect the size of bills (Palaniappan, 2007). Nonetheless, efforts are being made to address these issues, such as

merging with banks to offer alternative payment options and incentivizing water conservation through metered billing.

6.3: Conclusion

Water Billing Management System should be deployed for use since most of the users agreed that the system performs its functions that suit their needs especially when it came to addressing majority of the challenges that the existing manual reading of the meter presented as already discussed in this write up in the previous chapters, specifically in problem statement well-stated in chapter 1. This implies that the Water Billing Management System is deemed fit for adoption in Nagongera town.

6.4: Recommendations

I recommend that my Water Billing Management System should be adopted by the different customers in Nagongera especially those that are still operating manually to support better meter reading, and to furthermore reduce on the overall paperwork involved in the outbound process. I also recommend the government to adopt my Water Billing Management System so that it can be deployed in various sectors reduce paperwork, enable proper record keeping and tracking of transactions I recommend my Water Billing Management System to be adopted by different academic institutions as a point of reference for development of similar systems, and for study purpose too.

6.5: Limitations and Future Work

• The system has been optimized for few desktop devices and therefore more work should be done to optimize the system so that various desktop users can be able to access it.

• The researcher should try to integrate other Application Programming Interfaces (API's) such as the API to enable notification of system users via SMS.

• System maintenance should be done through in order to improve on the system performance.

• The researcher should try using other programming languages so as to improve on the system.

• The system should be hosted on a commercial web-hosting platform in order to enhance its security and improve on its accessibility to the users.

• Other features should be added to the system such as more responsiveness and support for dark mode, since it is a present trend for desk top.

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The budget plan is below as follows;

Item	**Amount**
Transport	40000/=
Food	50000/=
Shelter	50000/=
Research	500000/=
Water	10000/=
Total	**5150000 /=**

Table 2 shows the budget plan for the research work.