

Abstract

The basis of this project was to develop a Mobile Bill Enquiry Application. The system development was initiated due to the fact that the current manual meter reading could not produce water bill statements in time and also some readings were estimated leading to revenue loss caused by underestimating the charge as well as over estimating which led to overcharging residents. The proposed system is an android application that will be used by Billing Clerks to capture and calculate bills on the go, residents will enquire bills balances using the application also it will allow the council to send notices to the residents and residents can send complaints to the council using the system. Several alternatives could be used for the development of the application such as outsourcing and improvement but the developer used in house development. Feasibility study was carried out so as to see if the project was technically, economically, socially and operationally feasible. As a result of the feasibility study the application development could commence. Information gathering methodologies such as questionnaires, interviews and observations were used in order to come up with user specifications as well as functional and non-functional requirements of the application to be developed. The application was developed using Android Studio, with Java as the back end and SQLite as the database. Testing of the application was done and the application met user requirements. The application was implemented using parallel changeover strategy because it does not interrupt the ongoing processes of the existing system.

Declaration

I, **Tinashe Mugodo (R121773)**, hereby declare that I am the sole author of this thesis. I authorize **Midlands State University** to lend this thesis to other institutions or individuals for the purpose of scholarly research.

Signature..... Date

Approval

This dissertation/thesis entitled “**Beitbridge Town Council Bill Enquiry**” by **Tinashe Mugodo** meets the regulations award governing the award of the degree of Bsc (Hons) in Information Systems of the Midlands State University, and it is approved for its contribution to knowledge and literal presentation.

Supervisor

Date/...../.....

Acknowledgement

Firstly, I would like to thank the Almighty God for this opportunity. I thank my fellow colleagues for the stimulating discussions that we had on application development, the sleepless nights we had working together to meet deadlines, and for all the fun we had in the last four years. I am grateful to my supervisor Mrs Zhou for her tireless effort in helping me with my research.

Last but not the least; I would like to thank my family, my parents and my sisters for supporting me spiritually throughout writing this thesis and my life in general.

Dedication

I dedicate this dissertation to my mother, classmates, Beitbridge Town Council and lecturers. I truly appreciate their love and support socially in my academic journey, if it has not been for them, as my pillar of strength, motivators and sources of inspiration it was not going to be easy for me to cope well. May the Lord richly bless them for making me excel.

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List of Acronyms

SQL	Sequential Query Language
UML	Unified Modelling Language
BTC	Beitbridge Town Council
DFD	Data flow Diagram
ERD	Entity Relationship Diagram
EERD	Enhanced Entity relationship Diagram
DB	Database
ROI	Return on investments
NPV	Net Present Value
ICT	Information and Communications Technologies
IDE	Integrated Development environment
AS	Android Studio

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Chapter 1 Introduction

1.1 Introduction

Beitbridge Town Council Mobile Bill Enquiry Application is an Android based application, it can run on any device with Android operating system. This application will be used in the Finance department mainly by water billing clerks to capture meter readings electronically and calculate water bill for each household on the go. Also the application will send notifications to residents as a reminder to settle their accounts and the residents can enquire bills using the application.

This chapter seeks to introduce a viable Mobile Bill Enquiry Application to the Information System impedance Beitbridge Town Council is facing. In this section will be focusing on the background of the study that is what prompted the development of the application and the Beitbridge Town council history, problem definition, objectives of the research ,methods and tools used to gather information and justifications for developing the application.

1.2 Background of the study

Computer systems provide a competitive edge for business to perform better in today's fiercely challenging, dynamic and volatile world. In Beitbridge there is a hundred percent data coverage anyone with a device that connect to the internet can access the internet in the town. In Zimbabwe all mobile network operators have the electronic wallet service such as Telecash from Telecel, Ecocash service from Econet and One wallet from NetOne these services allows easy payment of bills to any merchant anywhere around the globe and Beitbridge Town Council is registered . Currently Beitbridge Town Council is using a manual system to capture meter readings and residents can go for six months without receiving a bill statement from the council hence they default settling their accounts. It is from this background that led to the idea of developing a Mobile Bill Enquiry Application.

1.2.1 Background of the organization

Beitbridge Urban and Rural was governed by a single authority that is Beitbridge Rural District Council. Due to increased growth of Beitbridge, it was then seen as necessary to have a town council which would administer the operations of Beitbridge Urban. The town council was thus promulgated on the 27th day of July 2007. The Beitbridge town council is a stand-alone local government entity responsible for all local operations within its jurisdictions. A local authority is promulgated by the president through gazette section 4 of the Urban Council Act 29;15 and

also regulated by the urban councils act 29;15 and is itself a legal person that is cable of entering into deals and negotiates contracts on its own behalf and can be sued. Its operations are funded by revenue generated from its business operations, tariffs charged to local private business operations through to vendors and from the housing utilities rates and grants from government and other private organisation. It is a service industry which aims at providing the community with public goods such as, street lighting, fire brigade, ambulance and first aid, recreational services, water and sewerage reticulation among others.

Council business operations and activities are implemented through committee meetings as stipulated in Urban Council Act 29; 15 section 96. Committee adopt recommendations to be implemented by the employees of council. Beitbridge town council has standing committees which are, Finance committee, Health and Housing, Environmental Management Committee. The council committees comprise of councillors and are led by the council chairperson an equivalent to the mayor in municipalities. The sub committees are made up of three councillors each while one of them is the leader as committee chairperson. They are responsible for governing operations of the council and these are,

Full Council Committee

This committee is led by a council chairperson and comprises of both elected and appointed special councillors. This full council is for policy formulation and adoption of the council resolutions.

The Audit Committee

The composition of the Audit Committee are clearly defined in section 97 and functions in section 98 of the Urban Council Act 29:15

Terms of reference

- a) To investigate into and report on the way in which the finances of the council, its assets and human resources are being used.
- b) To determine whether the treasuries and assets of the council are used for intended purposes.
- c) To analyse reports of internal and external auditors and make appropriate recommendations.

The Finance and Staffing Committee

The committee comprises of three councillors and the head the section led by a councillor

Terms of reference

- a) The preparation of estimates and expenditure
- b) Determination of the level of tariffs and charges for various services
- c) The finances of council including investments, loans, assessment rates, cash flow statements, income and expenditure statements, statement of financial position and any other final statements as required by council and standards
- d) Council's insurance portfolio
 - All forms of licencing
 - All matters pertaining to the initiation and administration of tenders for the procurement of goods and services in terms of section 211 of the Act
 - Disposal of assets
 - Appointment of Auditors in terms of section 304 of the Act

The Environmental Management and Works Committee

The committee comprised only of three councillors and the head the section led by a councillor

- a) Environmental pollution, water pollution control
- b) Preservation of trees and environment, land cultivation and control thereof and
- c) Environmental impact assessment reports
- d) Land acquisition
- e) Town Planning- Layout plans, surveys, local plans, master plans and general control of development
- f) Roads and storm drains, sewerage and water reticulation;
- g) Town water supplies
- h) Electrical services, including street lighting and general electricity reticulation
- i) Fire brigade services
- j) General maintenance council vehicles, plant and equipment
- k) Implementation of council projects

Health and Housing Committee

The committee comprised only of three councillors and the head the section led by a councillor.

Terms of references

- a) Environmental health services- refuse collection and disposal, street lighting, street cleaning, pest control, infectious diseases control, cemeteries etc.
- b) Preventive health services- clinics, hospitals and administration thereof;
- c) Housing and community services – housing development and allocation, hall, parks, stadium, swimming baths and pools and other recreational facilities.
- d) Social welfare activities
- e) Stands allocations, development and repossession and approval of building plans.

Departments

This section mentions and summarises the roles and objectives of various departments within the organisation.

Administration

The department is responsible for all operations of the local authority which cannot be specially attributed to any other department. It is responsible for all the legal aspects, human resources and payroll, housing issues, governing the organisation.

Departmental Objectives

- To ensure smooth running of the local authority.
- To manage all legal aspects that pertain to the various operations of council which include business and company laws, food and beverage laws, housing laws, labor laws, among others.
- To ensure to organization is adequately staffed.

Finance

The department is responsible for all the accounting work and financial management.

Departmental Objectives

- Provide all the relevant, necessary and timely information for performance evaluation and decision making.
- Save guide the resources of organization and of the public at large
- Ensure accountability of the organization.

Internal Audit

The department is responsible for setting, implementation and monitoring financial controls. They also ensure internal audit controls in place are adhered to.

Departmental Objectives

- Safe guiding organization's resources through implementation of adequate controls
- Ensuring audits of organization's accounting work and that it is in line with organizational, legal and IPSAS standards.

Engineering

The department is responsible for all developments and maintenance of such items as, roads, sewerage, water, vehicles, equipment and machinery, stand servicing, etc.

Departmental Objectives

- To ensure sustainable development
- To ensure the town council keeps moving, be a lubricant to all its field operations.
- International standard town planning, development and building

1.2.2 Organizational Structure

An organizational structure is a drawing that displays the different positions of people working in an organization, it depicts top management and the different departments of the organization (Pilbeam et al, 2008) .The local authority’s management structure is governed and defined by the Urban Councils Act, Chapter 29.15.

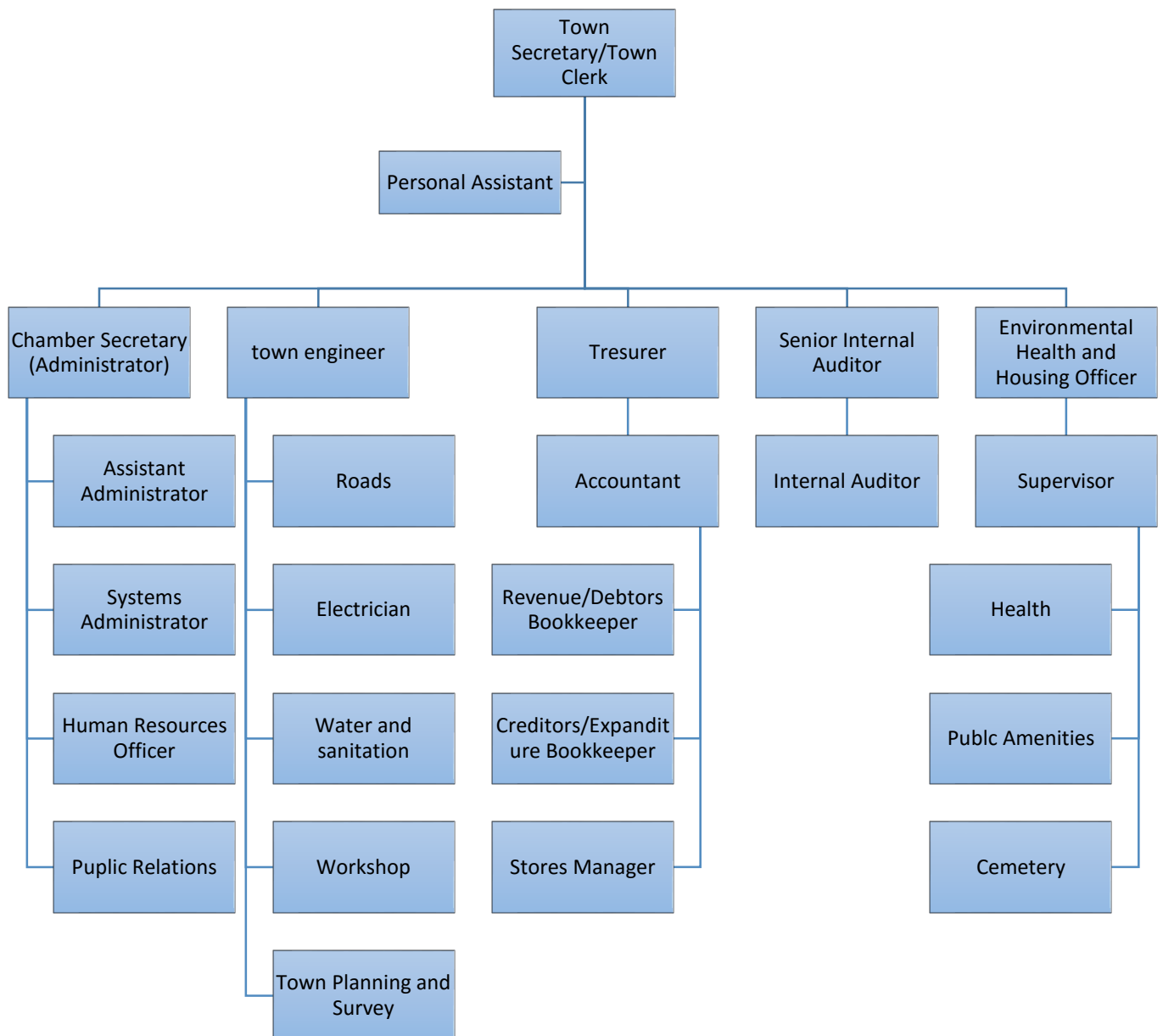


Fig 1.1 Organogram of Beitbridge Town Council.

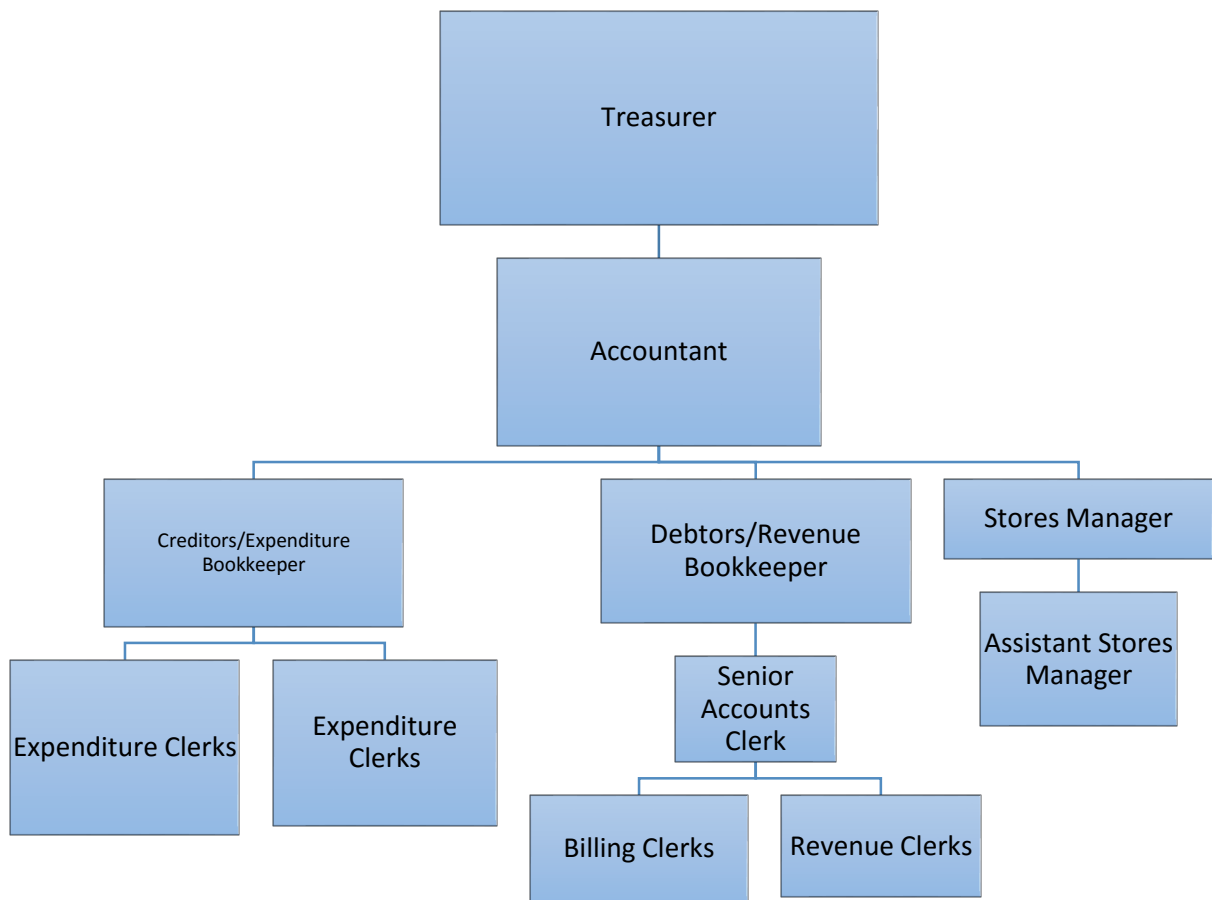


Fig 1.2 Organogram of Finance Department

1.2.3 Vision

To be a modern investor friendly metropolitan city providing sustainable and excellent service to its community.

1.2.4 Mission Statement

To deliver quality service to the community through effective participation.

1.3 Problem definition

Problem definition is a written way of capturing the key issues concisely and systematically making assumptions limitation and goals explicit (Robinson, 2004). Beitbridge Town Council is using a manual system to record meter readings, the Billing Clerk will record the meter digits on a paper, and the Senior Accounts Clerk will have to input the meter reading into the system for billing this led to duplication of work. The senior Accounts Clerk will be swamped with large volumes of data to capture, data capturing is a time consuming activity hence the council fails to print statements for each house since the data will be incomplete. Also council is losing revenue by estimating water charges using previous month's information in some instances the residence will be overcharged hence this clashes with the core values of the council which advocate for transparency in the council operations. The council is failing to provide residence with up to date bill when they enquire.

1.4 Aim

The aim of the project is to develop a system that allows electronic capturing of meter readings and allows residents to enquire bills online.

1.5 Objectives

To develop a system that

- Manage water bills calculation by capturing meter readings on the go and calculating amount owed by residents.
- Facilitate online bill enquiry and bill payment on the go through the use of an android application
- Enhance interaction between the Council and Residents through the use of a chat platform where residents can air their views concerning the services they are receiving and the council can post notices on upcoming events.
- Manage Residents user accounts by creating a database of residents.

1.6 Methods and Instruments

These include the data gathering methodologies which are the techniques used to acquire data to be used in the development of the system and Instrument are the software's used in the development of the application and documentations .

1.6.1 Data Gathering Methodologies

Data collection is an important aspect of any type of research study. Inaccurate data collection can impact the results of a study and ultimately lead to invalid results. Data collection methodologies such as, interviews questionnaires and observations.

Interview the Treasurer and any other staff member in the finance department will be interviewed.

Questionnaires will be distributed to council staff and residents.

Observation will be conduct in the field and at the council revenue office.

1.6.2 Development Tools

Software Development is a complex and often difficult process requiring the synthesis of many disciplines. From modelling and design to code generation, project management, testing, deployment, change management and beyond. In this project will be using the following software development tools;

Eclipse an integrated development environment, this will provide a platform to develop the application in Java programming language and XML.

Android Developer Tool it compiles and produces the executable dot apk file that will be installed and run on the mobile phone.

Microsoft Visio it a drawing and vector graphics tool which will be used to draw UML diagrams ,data flow diagrams .It can be used for analysis and design drawing since software developers can use Visio to draw UML diagrams to visualise their designs.

SQLite is a software library that implements a self-contained, server less, zero configuration, transactional SQL database engine.

Microsoft office 2013 a powerful word processor program, which will be used for all the application documentation editing.

1.6.3 Proposed Work Plan

Activity	Duration Period
Chapter1	14 days(17-28 August 2015)
Chapter 2	11 days(28 August-04 September 2015)
Chapter 3	10 days(04-14 September 2015)
Chapter 4	11 days(14-25 September 2015)
Chapter 5	15 days(26 September-10 October 2015)

Table 1.1 proposed system work plan

1.7 Justification

The proposed system will speed up the issuing of water bill statements since the calculation will be done instantly on site. The system will reduce paper work and duplication of work since the meter reading data will be captured electronically and instantly updated to the main server also this will reduce stationery costs. Bill Enquiry and Notification system will allow the public to send their complaints to the council, this feature will help the council to improve service delivery to the community and also council will cut advertising expenses by sending public notices as notifications to the residents.

1.8 Conclusion

This chapter gave an overview into the system being develop and provided the background and problem definition. The problem statement was used to draw up a solution which entails the aim and goals of this project. Thus the project aims to improve the council revenue collection and could also be adopted in other councils.

Chapter 2: Planning phase

2.1 Introduction

Planning is an activity defining intentions and choosing the most suitable means of attaining them before taking action (Harrington, 2007). It considers the business worth the application will bring to the council thus is it money-making or unprofitable in the future by assessing the benefits derived from the project to the costs of the project. Will outline the scope of the project and recognize the benefits that accumulate by adopting the new application. The planning phase involves identifying the business value brought by implementing the proposed application, the feasibility of the project whereby an analysis is done to evaluate if the organization has the resources needed in the development of the application and a cost benefit analysis will be done to evaluate the financial risks associated with developing the new application against the benefits that may accrue.

2.2 Why develop the system

The mission statement of Beitbridge Town Council reads “To deliver quality service to the community through effective participation”. From this background there is need for an application designed to allow real time calculation of bills for each household on the go, that is each household will be given the bill amount instantly after the meter reading has been done. This application will assist in improving the revenue collected from water bill payments since most residents fail to pay their bills on time due to late delivery or lack of water bill statements. Hence the application will allow effective participation from the community which will lead to quality service delivery.

2.3 Business value

In today's dynamic competitive corporate environment, organizations are increasingly demanding that Information Technology investments show business value through quantifiable results (Harris,2008). Business value is defined as all forms of value that define the condition of the organization in the long-run .The proposed system will improve the service delivery for both the residents and the residents since residence will be able to send complaints to the council via the application ,the complaints can be water pipe burst or sewerage overflow. This will help the council to respond to faults fast since resident can notify the council on the go.

Also council will be able to improve its revenue collection since the meter readings will be captured electronically and updated to the system, this will reduce costs associated with bill estimation which led to overcharging and undercharging residents.

2.4 Feasibility Study

Too often, people invest money in business information systems only to find out later that there is insufficient satisfaction for the product or that it is not the type that they want to buy. To reduce this risk of failure and losing money, a detailed valuation of the requirement, importance and practicality of the project should be carried out first. This assessment is known as doing a feasibility Study (Burch,2000).A feasibility study is a short focused study that aims to evaluate if the proposed system contribute to the overall objectives of the organization and can the system be implemented using the current technology and within given costs and schedule constraints(Sommerville, 2006).The purpose of feasibility study is to examine the development in depth to be able to give information that warrants the development of the new application or displays why the proposed project should be implemented. It helps to examine if the application is viable given the council resource limitations also it assist in finding out whether expertise and finances are available for the development of the application.

2.4.1 Technical Feasibility

It evaluate the realism of the project as well as the technological ability of the organization for developing the new application (Valacich, 2012). A computer application should be useful to develop and easy to maintain (Keyes, 2003).It is vital that the required expertise is present to examine code and design. It also aids in identifying the suitable software and hardware requirements needed for application development and implementation.

2.4.1.1 Technical Expertise

It involves assessing the experience of staff that is required to effectively implement the application development, risk of failure is reduced if the project is led by personnel who have dealt with similar project in the past .In this case the organization has the required technical expertise required provided by the System Administrator who has vast experience in application development.

2.4.1.2 Hardware

According to Mall (2009) hardware refers to all tangible components of a computer system, in this case it refers to the physical components of the android devices such as processors and RAM.

Item	Minimum	Recommended	Availability
RAM	32mb	512mb	Yes
Memory	128mb	1GB	Yes
Operating System	Android 4.4KitKat	Android 5.0	Yes
Processor	ARMv4	ARMv7	Yes

Table 2.1 Android device specifications

2.4.1.3 Software Requirements

Software refers to computer programs and associated documentation (Sommerville,2006).In order to develop the proposed application we use various software tools listed in the table below. The required software are available on the Internet free of charge, and android devices and computers are available locally.

Software Required	Version Required
Eclipse Ide	Luna
SQLite	1.1
Android Sdk	4.4.3

Table 2.2 Software requirements

2.4.2 Economic feasibility

This includes the ability of the application to produce financial benefits(Badnu,1996).Cost benefit analysis is a vital aspect of assessing the economic feasibility of the project, the physical and intangible features of a project should be translated into monetary terms to enable a steady basis of valuation. According to Rixom (2006) economic feasibility is determined by identifying costs and benefits associated with system, assigning values to them calculating future cash flows and measuring the financial worthiness of the project.

2.4.2.1 Cost Benefit Analysis

This is a logical methodology used in approximating the benefits and costs that a particular project gives to the organization (Valacich, 2012). This technique is used to determine choices which deliver the best method for the implementation of the proposed system by calculating benefits and cost of a project. The main purpose of this analysis is to decide if the proposed application is a good investment. The cost and benefits that accrue from a project are expressed in monetary terms and they will be adjusted for their net present value.

Year		0	1	2	3	4	5
		2015	2016	2017	2018	2019	2020
Costs							
Android devices	5@200	1000					
Backup Server		500					
Network infrastructure							
Firewalls		1750	1750	1750	1750	1750	1750
Software							
Antivirus		800	800	800	800	800	800
Cloud server		2000	2000	2000	2000	2000	2000
Labor							
Staff		6500	6500	6500	6500	6500	6500
Training		2000	2000	2000	2000	2000	2000
Advertising and user awareness		3000	3000	3000	3000	2000	2000
Maintenance and Support							

Hardware maintenance and upgrade			1000	1000	1000	1000	1000
Software maintenance and upgrade			2000	2000	2000	2000	2000
Total by Year		18000	21000	21000	21000	21000	21000
Total Costs		123000					
Benefits							
Reduced labor costs			6500	6500	6500	6500	6500
Reduced stationery			3500	3500	3500	3500	3500
Increased revenue			23000	23000	23000	23000	23000
Subtotal		0	33000	33000	33000	33000	33000
Net Cash Flow		-18000	12000	12000	12000	12000	12000
Total Benefits	165000						

Table 2. 3 Cost Benefit Analysis

2.4.2.2 Return on Investment

This is an accounting measure of performance used to assess the investment productivity so to compare the profitability of different potential investments (Randall, 2001). Return on Investment measures the amount of return on an investment comparative to the investment cost. To compute return on investment, investment gain is divided by investment costs, and the output is a percentage.

To find the ROI, first calculate the average net benefit as follows:

$$\frac{(\text{Total benefits}-\text{Total cost}-\text{depreciation})}{\text{Useful life}} = \text{Net benefit}$$

$$\frac{165000-123000}{6} = 7000$$

$\frac{\text{(Net benefit)}}{\text{Total initial investment}} = \text{Return on Investment}$

$$\frac{7000}{18000} * 100 = 38.8\%$$

In the first year the project has made a return on investment of 38.8% which is quite favorable hence the management decide to implement the project based on this result among other factors.

2.4.2.2 Net Present Value

This is an accounting ratio used to compares the initial outlay invested to the present value of the future inflows of cash(Randall, 2001), it assesses an investment by adding a discounting factor to its future cash inflows present values and reducing the amount of the initial outlay from the total (Needles, et.al 2011).

Formula for calculating NPV discounting factor.

$$PV_n = Y \times \frac{1}{(1 + i)^n}$$

$$PV1 = 18000 * 1 / (1 + .12)^1 = 0.893$$

$$PV2 = 18000 * 1 / (1 + .12)^2 = 0.797$$

$$PV3 = 18000 * 1 / (1 + .12)^4 = 0.712$$

$$PV4 = 18000 * 1 / (1 + .12)^2 = 0.636$$

$$PV5 = 18000 * 1 / (1 + .12)^5 = 0.567$$

Year	Discounting Factor at 12%	Cash Flows	NPV
0	1	(123000)	(123000)
1	0.893	18000	10716
2	0.797	18000	9564
3	0.712	18000	8544
4	0.636	18000	7632
5	0.567	18000	6804
Net Present Values			79740

Table 2.4 Net present value calculations

The proposed project is economically feasible since it has a positive net present value showing that future net receipts at present day value exceed the initial cost of the initial investment.

2.4.3 Social feasibility

Social feasibility pursues to address the effect the proposed application pose to the organizations external environment thus outside the workplace and analyses if the project will benefit stakeholder (Badinu, 1996). The proposed system will improve family time for employees since workloads are reduced hence, they will be able to enhance their social lives and increase interaction with others family included. And also the project will reduce or eliminate walking distance of residents since it will assist them in enquiring bill as well as settle their accounts using the application. Potential council suppliers will be notified via the application if the council want to procure goods and services thus make the application socially feasible to be implemented.

2.4.4 Operational feasibility

It is the process of assessing the degree to which a proposed system solves business problems or take advantage of business opportunities (Valacich, 2012). Every computer application development project must meet the requirements and expectations of the council. It is imperative that the system be accepted by the user and be operational (Keyes, 2003).An operationally viable application has management and employees who are willing to use, operate and support it. Operational feasibility takes into account the need to meet certain system performance requirements such as response time for frequent online transaction, number of concurrent users it must support, reliability and ease of use (Reynolds, 2014).The organizations already has computers and a System Administrator who is experienced in application development, which gives an advantage on user training since there will be no need to hire an external consultants. Majority of the workforce possess computer skills and literacy they use smart phones with android operating system.

2.5 Risk Analysis

A risk is an unplanned event that can occur and when it occur it will have a undesirable impact on the objectives of an organization (Vose,2008).Risk analysis can help describing the level of uncertainties a decision possesses . Software risks can be categorized in six dimensions these include, users, requirements, project complexity planning and control, team organizational environment.

2.5.1 Users

Software risks posed by user include, to change, conflicts between users and lack of cooperation from users .In this case the Billing Clerks may resist the proposed system fearing

that the system will led to termination of employment by the organization so as to cut costs hence there is need for proper education and training for the staff so as to inform them on the advantages the proposed system bring to the organization as a whole. Also conflicts may arise amid the implementation of the system as to who will use the system first in the organization. More so, the staff at Beitbridge Town Council may fail to cooperate with the developer hence there is need for proper announcement to all staff involved to cooperate such that the system developed will meet the user requirements.

2.5.2 Requirements

Requirements are the objectives of developing a system, if the users change the requirements more frequently it becomes difficulty for the system to meet the proposed deadline hence there is need to thoroughly state all requirements prior the development of the new system so as to avoid delays caused by changing requirements.

2.5.3 Project complexity

Technology is ever changing, hence new software's and hardware are being developed every year, some of these software's and hardware may be new to the developer and the System Administrator.

2.5.4 Planning and Control

Planning is the cornerstone for a project to succeed, if the project is poorly planned there is high chance of failure hence there is need for thorough planning before the project is started, if estimates are made there should be based on previous successful similar projects since random guesses are not reliable. There is need for clear communication of project activities to all parties involved such everyone know what to do and when to do a task.

2.5.5 Team

Software development requires experienced and skilled personnel if the project is spearhead by in experienced it is likely to fail, to avoid this an organization can outsource the project development.

2.5.6 Organizational environment

During the course of a project the organization may change its management and this may affect the project negatively in other cases the organization can undergo restructuring, this may led to termination of employment for a key staff member in the project team hence there is need for proper documentation such that if staff members change there will be written record of what needs to be done in order for the project to proceed.

2.6 Work Plan

This is an important tool for safeguarding that the project manager and project team know what they need to do to complete the project, it shows the activities, and start and end date for each activity as well as the duration of each activity.

Activity	Start	End	Duration Period
Proposal	17-08-15	28-08-15	14 days
Feasibility	28-08-15	04-09-15	11 days
Analysis	04-09-15	14-09-15	10 days
Designing	14-09-15	25-09-15	11 days
Implementation	26-09-15	10-10-15	15 days
Maintenance	10-10-15	Ongoing	Ongoing

Table 2.5 proposed system work plan

2.6.1 Gantt Chart

This is a project activity timeline view that helps in tracking activities of a project (Pressman, 2001). It makes it easier for all personnel involved in the project to track activities thus they will be well informed on which tasks to do and how long will the task take to complete such that the project deadline will be met.

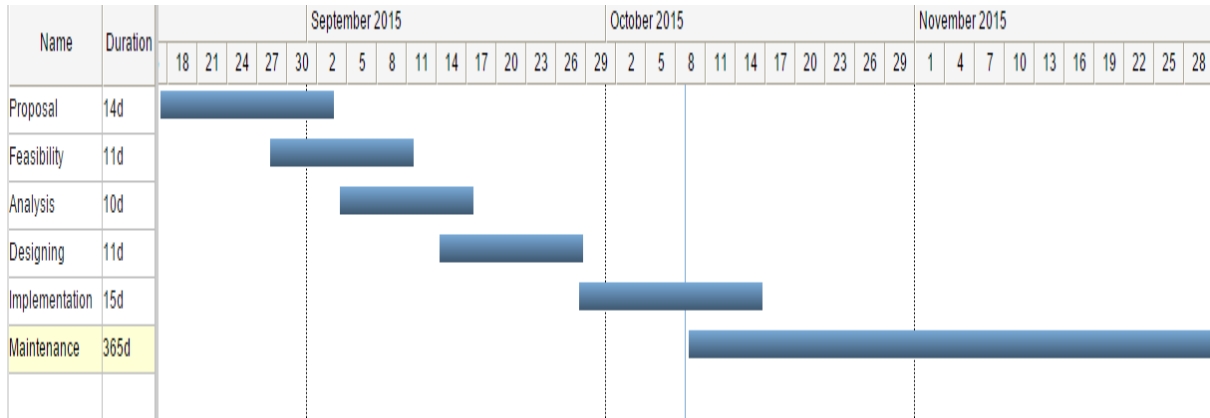


Fig 2.1 Gantt chart for Proposed System

2.7 Conclusion

All the feasibility study necessary in order for the start of the application development has been carried out .It from this background that the project is socially ,technologically and operational feasible .The next stage is to look analysis of the current system in relation to data gathered using various gathering techniques.

Chapter 3 Analysis Phase

3.1 Introduction

Analysis is the first stage of full scale system development, it will determine what the system will do. In this stage the development team will investigate the current system and the specific business needs for developing a new system (Shelly and Rosenblatt 2012). The information will be gathered using various methods which include interviews and questionnaires. It will also look at the information processes that the current system does, the processes will be depicted in a data flow diagram and context diagram, it is from this analysis weaknesses of the existing system are identified and the need for development of an application to address the current research problems posed by the existing system.

3.2 Information Gathering Methodologies

Successful software projects are the ones which meet user requirements. In order to determine the requirements the data must be gathered from the users using various data gathering techniques as, interviews and questionnaires. The technique used for data gathering depends on the type of data to be gathered and the user or the information provider and the type of access the researcher has to the users (Lazar, 2001). Interviews and questionnaires were used to collect data from various stakeholders so as to better understand the system and the problems or inefficiencies in the current system.

3.2.1 Interview

An interview is the most common data gathering technique used by System Analysts when gathering system data from users it is used to gather information that is difficult to obtain through questionnaires and observation (Debasish, 2009). Interviews come in various format, it can be structured face to face interview employing an interview schedule whereby a standard schedule with interview question is used for each respondent, in which the same questions are asked to all respondents (Sapford, 2006). Unstructured interview is whereby the interview probe the interview any question that comes to mind during the interview this type of interview require a skilled interviewer for it to be effective. The Treasurer, Senior Accounts Clerk and Billing Clerk were interviewed on the 25th of September 2015. The interviews were conducted to these three staff members because both are in the finance department, they are the ones who use the current system thus they will shade more light on aspects which cannot be fully articulated in questionnaires. Also it was easy to schedule an interview session with them since there job description requires them to be in the office. During the interview the interviewees

were asked to give a brief description of the current, as well as to site problems associated with the current system and proposed recommendations were also asked. A copy of the interview questions is appended at the back under appendices section

Interviews helped in gathering data that was difficult to gather using questioners'. For instances accounting processes which are done after capturing meter details are complex they could not be thoroughly answered on a questionnaire .Interviewees were asked the same questions this assists in gathering consistent feedback which will helped in making informed data analysis Also it ensured question asked were fully understood such that correct data is gathered, since interviews are done verbally the interviewer recite questions in terminology that an interviewee understands and respondents responded giving much detail as they can. However In a structured interview the interviewer has to stick to the schedule, there is no room to ask other important aspects brought out by the respondent. Also it is time consuming since the interviewee may not be readily available all the time hence you have to wait until they available.

3.2.1.1 Findings from Interview.

The interviewees where conduct on three key personnel of the system that is the Treasurer, Accounts Clerk and the Billing Clerk.

3.2.1.2Treasurer Feedback

The Treasurer described the current system as not efficient enough since the council is owed a large sums of money by the residents. He proposed the development of a Mobile Bill Enquiry System since it will help in solving the current problem of late bill statements delivery.

3.2.1.3 Senior Accounts Clerk

The Senior Accounts Clerk also described the manual system as not being efficient and transparent to the residents ,since she receive a lot of complaints from residents who claim that their water bill are being overcharged by the council since some bills are calculated using estimates. Hence she supported he development of a new application.

3.2.1.4 Billing Clerk

The Billing Clerk described the current system as not being efficient since it led to duplication of work for both the Senior Accounts Clerk and the Billing Clerks since data collected manually

will also need to be captured electronically .Hence he supported the development of the new app which will calculate residents bill on the go and update records in the system instantly.

3.2.2 Questionnaires

Questionnaires is a tool used to collect data, it provide a consistent interview across all stakeholders are asked appropriate questions in the same way (Gillham,2007). This technique is useful in gathering data from a wide sample in the case the residents in Beitbridge are dispersed questionnaires have a high chance of reaching a large number of residents as compared to interviews. One hundred questionnaires were distributed on the 23rd and 25th of September at the council head offices and sub offices to staff members and the residents since both are users of the proposed system. The questionnaire include questions such description of the current system and how effective is the system. Also suggested improvement to the current system were asked. Questionnaire eliminates interviewer bias, in an unstructured interview an interviewer can ask leading questions which result in the respondent uttering responses which the interviewer is seeking in this case resident and staff filled in the questionnaires in privacy. Large amount of data were collected from large sample at low cost since eighty five of the issued questionnaires were filled in and returned. It was easy to quantify the data gathered by calculating the difference between issued questionnaires and returned scripts. However there is no guarantee of response since questionnaire are issued to volunteers, some people saw it as a waste of time and refused to fill in and It limited the response from the people since the answer was limited to the check box and few blank spaces under each question.

3.3 Analysis of existing system

A thorough analysis of the existing system was conducted using information gathered from the various data gathering techniques, this analysis gave an insight on how the current system operates and the entities involved in the system. Beitbridge Town Council is currently using a Manual Meter Reading System. The current system involves a Billing Clerk and Senior Accounts Clerk. The Accounts Clerk issue a meter reading schedule to the Billing Clerk .This schedule guide the Billing Clerk when conducting his duties since he walks door by door capturing meter readings on a paper it contains information on which residential area to visit and houses which are to be disconnected from the water supply. After capturing all meter readings, the information is submitted to the Accounts Clerk who is responsible for capturing the information into a computer. After all the readings have been captured the System Administrator will print water bill statements which will be distributed to the residents. In the

event that residents did not receive their statements, they will have to visit the nearest council to enquire for the bill if the reading is captured in the system a statement will be printed if not the resident will be advised to pay an amount equivalent to last statement bill amount.

3.4 Process Analysis

It involves an in depth analysis of the system process which include the following components of a system inputs, processing and output The processes will be depicted an activity diagram.

Inputs refers to all data that is operated on in a system, in this case meter reading data is the main input of the system. Personal details such as the resident name, surname, address and account number are vital since they are used in identifying accounts detail this information will also be printed on the bill statement. Also this information will be used when residents enquire bills and settle their accounts. A meter schedule form part of the input since it gives important details on how the meter reading will be conducted

Processing is the conversion of input to give output, the current system is made of processes such as meter reading which is the main thrust of the system .After the meter readings have been captured the data is submitted to the Senior Accounts Clerk who is responsible for capturing the details electronically so as to update and calculate the bill amounts to be paid by each account holder. More so bill enquiry is a process whereby resident enquire bill amounts.

Output this the results outputted by the system, water bill statements will be printed and distributed to the residents.

3.4.1 Activity Diagram

An activity diagram is concerned with activities and actions. An activity is a non- atomic execution within a state machine (Bittner and Spencer, 2003).It is like a data flow since it features data stores, activities and flows (Hay,2003) .The activity diagram of the current system is shown below

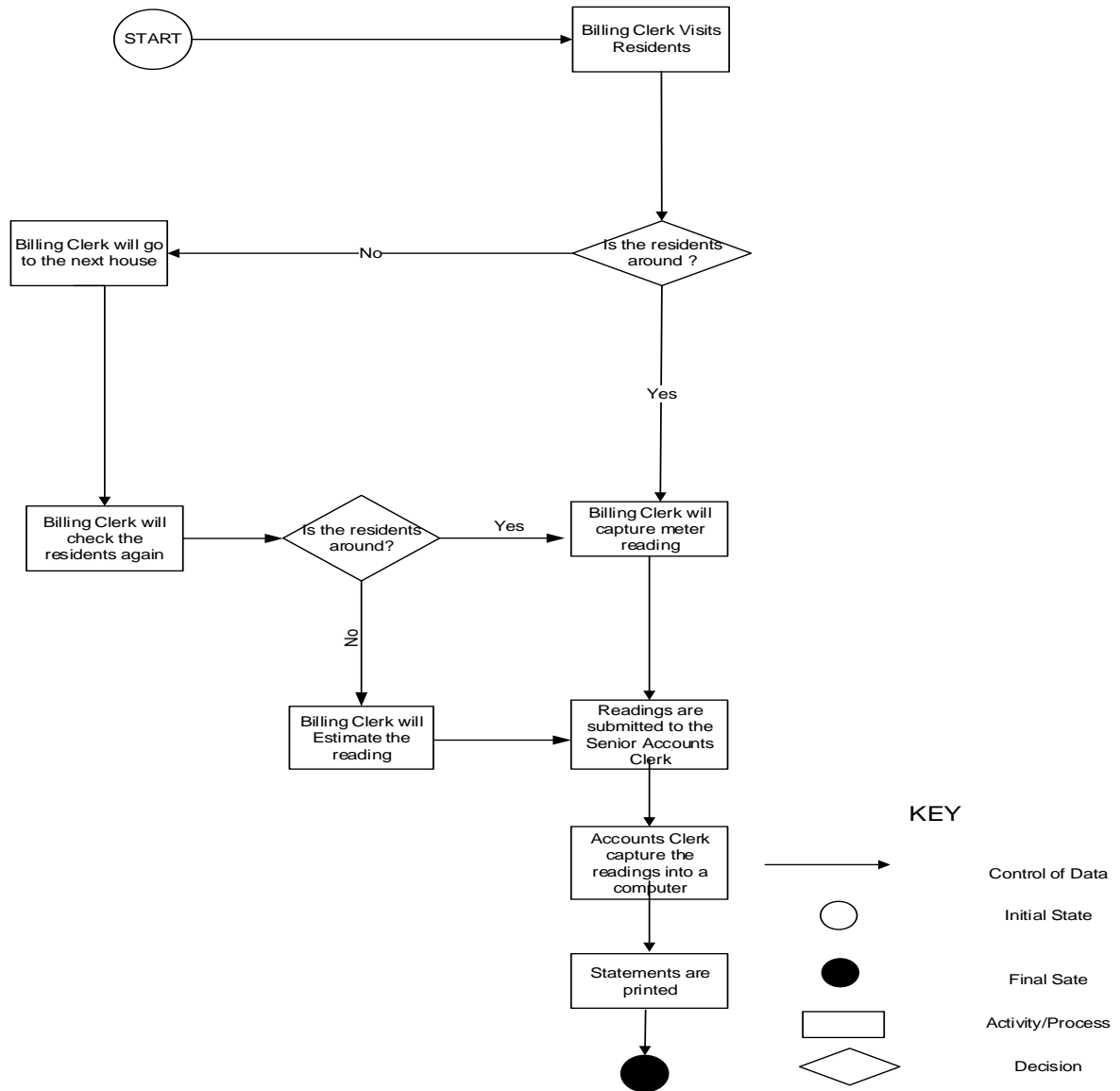


Fig 3.1 Activity Diagram of existing system

3.5 Data Analysis

Data analysis can be described as a process of extracting compiling and assessing data using analytical and logical techniques to scrutinize each element of data provided so as to obtain constructive information that can be used to make decisions and conclusions (Nordstrom and Robben ,1995).

3.5.1 Context Diagram

It shows the boundary of the system under consideration as a high level process and its environment showing how the entities interact with the system (Dixit and Kumar2007) .These entities are Billing Clerks, Residents as depicted in the context diagram below.

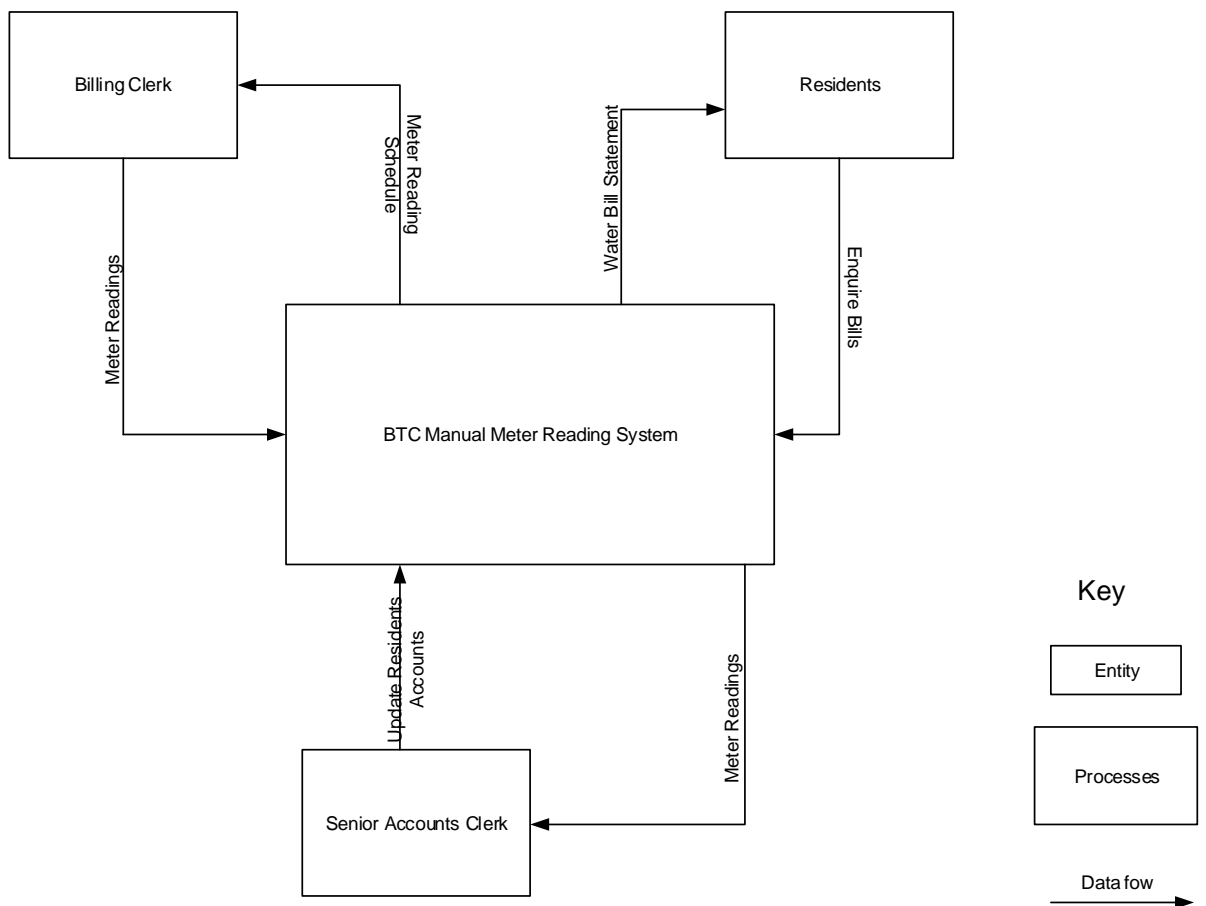


Fig 3.2 Context Diagram for current system

3.5.2 Data Flow Diagram

A Data-Flow Diagram is a graphical visualization of the movement of data through an information system. Data Flow Diagrams are one of the three essential components of the structured-systems analysis and design method (Shelly and Roseblatt, 2012).

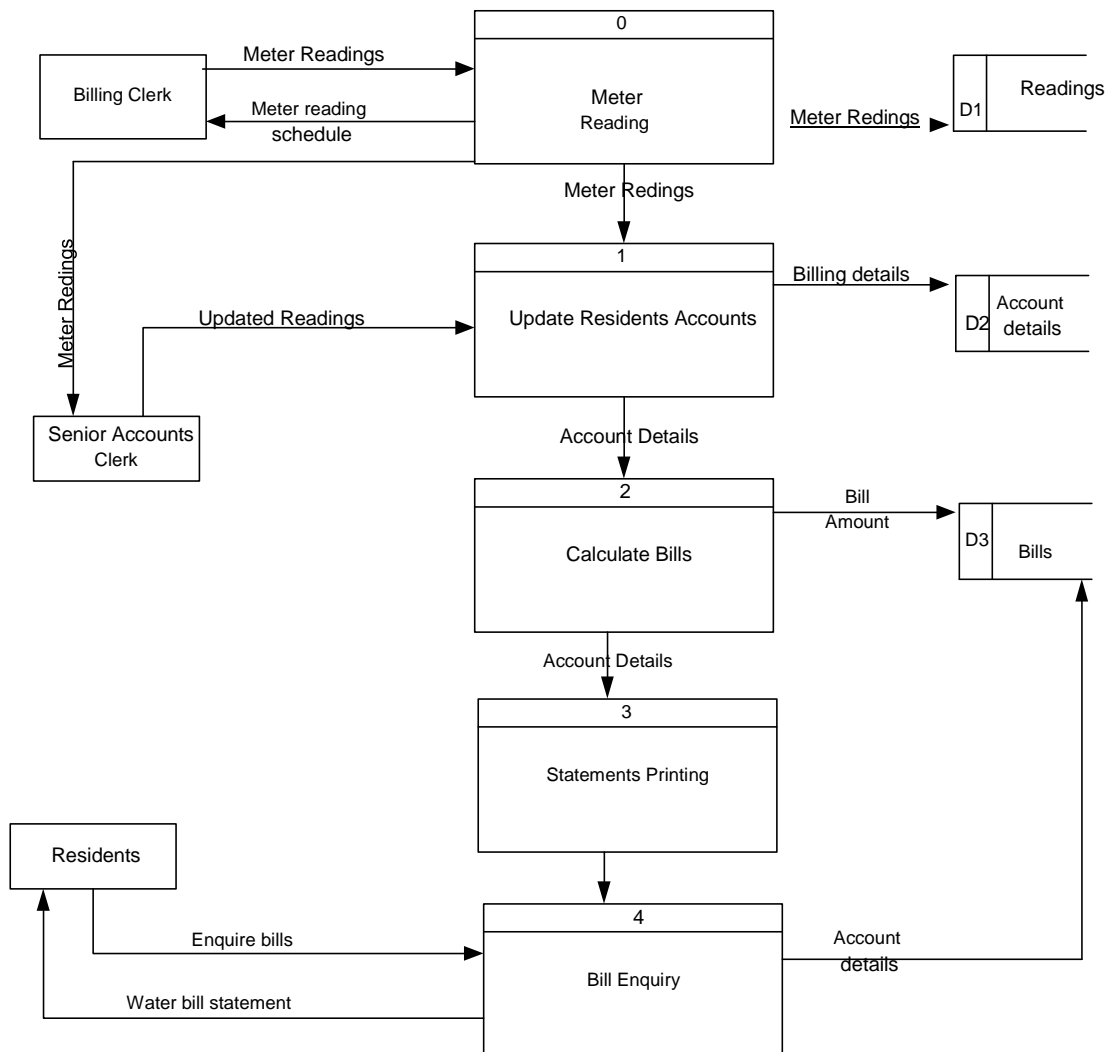


Fig 3.3 Data Flow Diagram of the existing system.

3.6 Weaknesses of current system

There is repetition of work since data captured manually will need to be entered electronically. In some instance bills are calculated using estimates, this leads to overcharging the residents or undercharging the bills. Updating meter reading is a monotonous process hence the system is prone to mistake caused by processing too much data at once also handwritten data might be eligible. There is always late delivery in some instances water bill statements are not distributed to the residents on time. The system requires too much man power for it to be effective of which this is too expensive for the council. Also the system does not guarantee the residents if the meter readings captured are the correct ones.

3.7 Evaluating Alternatives

When it comes to system development there are many avenues that can be exploited to accomplish a project. Three main alternatives were considered in this category namely outsourcing, improvement and in-house development.

3.7.1 Outsourcing

The term outsourcing means the passing of software development responsibility to vendors (James, 2009). Not every project can be developed internally hence there is need to determine if the organization has the skills set for the projects or personnel who have worked in similar project before if not the project is likely to be outsourced to experienced organizations so as to mitigate the risk of project failure.

3.7.1.1 Advantages of Outsourcing

It reduces costs associated with hiring an experienced personnel for a particular project, it will be costly to hire a developer for project which can last few months. Also it reduces risk of project failure due to lack of required technology since most developing companies work with various clients they are always up-to-date with the new technology (Fong,2006).

3.7.1.2 Reasons against Outsourcing

There is loss of technical knowledge in the organization when a software development is outsourced, since there will be no need to keep up with technology when developments are done outside, the firm can lose its ability of staying up to date with technology break through. Also if the software developer delivers advanced services to the organization, a large amount of the new knowledge required remains in the hands of the developer and cannot be transferred to the organization as they try to maintain their competitive advantage. Furthermore, the

innovation capability of the firm itself can be reduced, since every innovation requires a sufficient availability of technical and economic resources, something that is not precisely favoured by outsourcing. Unclear Cost-Benefit Relationship. Taking into account all the relevant outsourcing factors and trying to translate them into monetary terms is no easy task for instance, how to value the potentially better service delivered by the provider or how to measure the consequences derived from a poor quality service on the part of the provider .

3.7.2 Improvement

This alternative involves studying and analysing the current system and then further work on its weaknesses and cements the strengths. In some cases this entails re-engineering which is the examination and alteration of system to reconstitute it in a new form and the subsequent implementation of the new form (Fong, 2006).

3.7.2.1 Advantages of Improvement

It is quick to implement since there is an existing system in place the current system will be used as a blueprint used in improving the system thus solving the weaknesses of the current system.

3.7.2.2 Reasons against Improvement

More financial and human resources required for system upgrade. Resistance by the staff over the idea due to cumbersomeness of system and compatibility issues due to afore mentioned drawbacks, the alternative of improving or upgrading the current system was not considered in the case of the Bill Enquiry and Notification System.

3.7.3 In-house development

This is the process of developing a new system for the organization after specifying their requirements. This approach is essentially referred to as a service that is provided by dedicated resource directly employed by the organization, where monitoring and control of performance is normally conducted under the terms of the agreements internal-service agreements as regulating mechanisms (Barret and Baldry,2003).

3.7.3.1 Advantages of In-house development

It is cheap to implement as it uses makes use of some internal staff it also give the organization to grow its staff instead of hiring from outside, and so provide career prospects that reduce staff turnover. It does not depend on the external personnel people who are in-house employees usually perform better than outsourced employees who make decisions based on how they will

affect their own employers, not the people for whom they are working by proxy .It is tailored since an effort will be made of covering all user requirements.

3.7.3.2 Disadvantages of In-house development

It takes a lot of time to deploy as there is a great deal of time involvement in this exercise, from investigation to implementation. Also it requires high level of expertise in the development of such a system, if employees and users are not fully involved in the development of the system they may resist a new system.

3.8 Requirements Analysis

The requirements for a system are the description of the services provided by the system and its operational constraints (Sommerville, 2007).At the other extreme, it is a detailed, formal definition of a system function (David, 2003).A requirement analysis is done in order to make sure that the functionality that the system is to support satisfy the original system objectives.

3.8.1 Functional Requirements

Functional requirements define the function of the software or the component. These functional requirements can further be explained as the inputs and the relationship between the results of the system. Functional requirements are directly related to the system objectives, the environment description and functional constraints (Shelly and Rosenblatt, 2012).Functional requirements are statements of service the system should provide, how the system react to particular inputs and how the system should behave in a particular situation.

3.8.1.1 Use Case

A use case diagram provides a view of a use-case model. Many use-case diagrams can be used to view and provide different perspectives on a single use-case (Bittner and Spence 2003). It contain only actors only use cases, or any combination of the two. Below is an overview diagram showing all the use cases and actors.

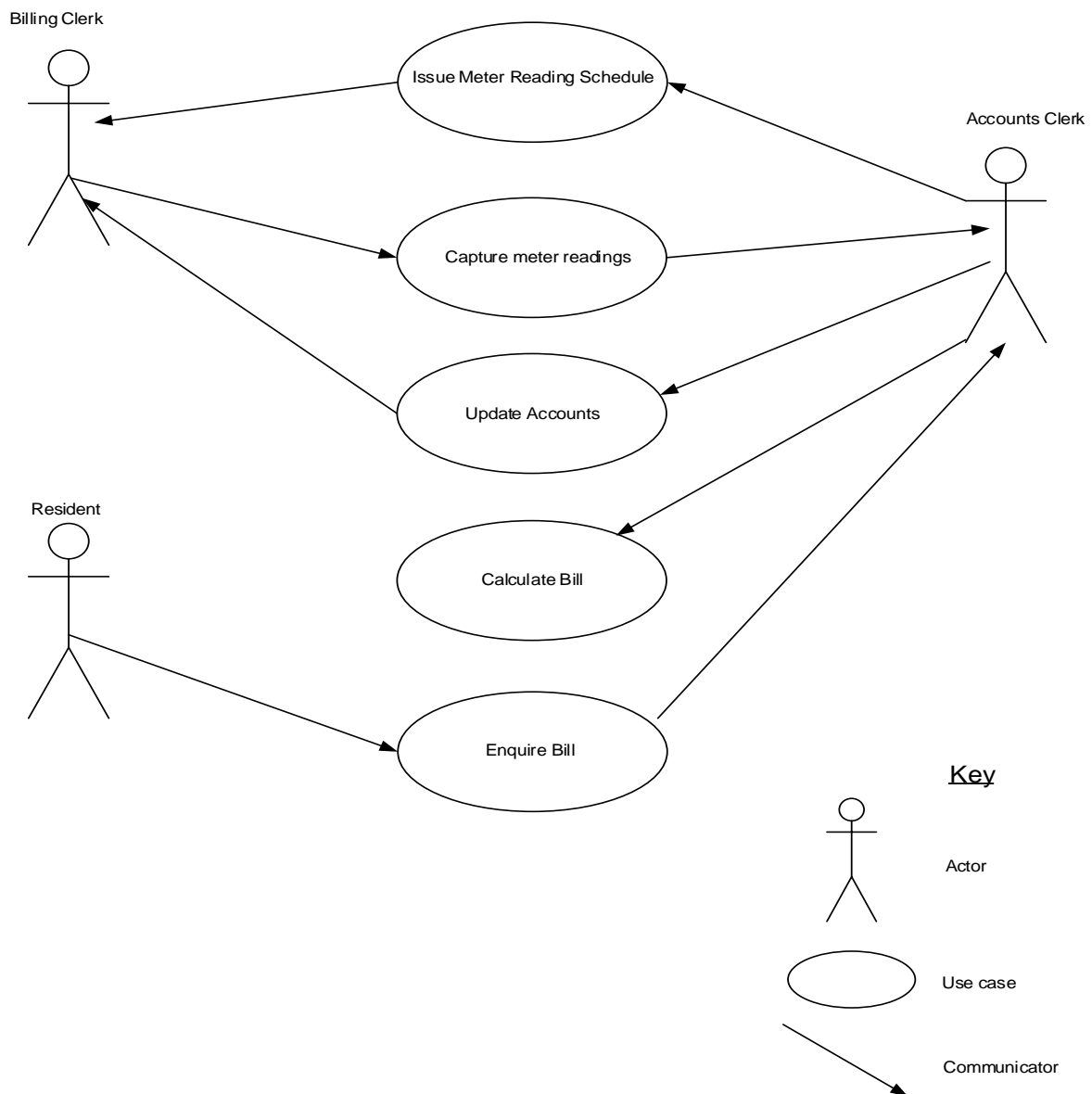


Fig 3.4 Use case diagram

3.8.2 Non-functional requirements

These are constraints on the service or functions offered by the system, they include timing constraints and constraints on the development process and standards. Non-functional requirements are not directly concerned with specific functions delivered by the system. Alternatively they relate to emergent system properties such as reliability, response time and store occupancy.

Usability are the users able to use the system without difficulties that is the user friendliness of the system. This is achieved by using user friendly graphic user interfaces through the use of a simple icon that can be understood and easily interpreted by anyone.

Reliability this is when the system is dependable. When this requirement is met the system should be able to provide its services as per request. With the Mobile Bill Enquiry System, as long as there is internet access the system is assured to be up and running.

Interoperability this is when the system is compatible and operable with other hardware and software. In this ever changing technological environment, the system ensures that the newer technologies both software and hardware are compatible.

Security this is a system for the public and for its accessibility the security must be open.

3.9 Conclusion

Analysis of the current system and assessing all the probable options, it has been considered suitable to develop an application in-house to construct a unique software package which will be the most ideal solution for the problem, as a result all the functional and non-functional requirements have been identified. Therefore the next stage now is to proceed to the actual design of the proposed system.

Chapter 4: Design Phase

4.1 Introduction

This phase focuses on the design of the proposed Mobile Bill Enquiry System so as to meet the user requirements and solve problems in the existing manual system. A system is a set of interconnected components that has an expected behavior observed at the interfaces with its environment (Saltzer, 2009). The design phase is based on the findings of the current system from the previous chapter. Documented requirements from the detailed analysis phase, in defining the physical implementation of the system. Designing entails outlining how the proposed system is going to be developed, configured and deployed. The designing phase is simply a blueprint or a plan for a solution of the system (Wixom, 2012). The design process for a software system often has two levels, at the top level the focus is on deciding which modules are needed for the system, the specifications of these modules, and how the modules should be interconnected. The second level consists of the internal design of the modules upon, these modules include, system design, architectural design, physical design, program design and interface design.

4.2 System Design

The design of a system is correct if the system built is precisely according to the design that satisfies the requirements of the system. Desirable properties of a good software design are, verifiability, completeness, consistency, efficiency, understandability. Verifiability of software design is concerned with how easily the correctness of the design can be argued. Completeness requires that all the different components of a design should be specified, that is all the relevant data structures, modules, external interfaces and module interconnections are specified. Consistency requires that there are no inherent inconsistencies in the design. The efficiency of any system is concerned with the proper use of scarce resources in the system. In computer systems the resources most considered for efficiency are processor time and memory for an efficient system is one that consumes less processor time and requires less memory.

4.2.1 Description of the proposed system

This entails identifying the modules involved and the inputs, processes and outputs to assist in clearly describing how the application works. The application is an android application used by Billing Clerks to capture water meter readings and calculate instantly the current water bill for residents. Also residents can enquire their bills anytime and anywhere using this application, they are able to send complaints to the council via the application. More so the

council can send notices to the public using the application. The application is made up of the following modules.

1) Bill calculation module.

Inputs are

- Meter reading schedule
- Residents Account details
- Meter number
- Meter status

Processes

- Calculating bill amount.
- Updating meter status
- Updating residents accounts.
- Residents verifying meter readings.

Output

- Water bill statement.
- Meter status report
- Reports.

2) Bill enquiry module

Inputs

- Account number
- Password
- Complaint details.

Processes

- Retrieving bill
- Sending complaint.

Output

- Current bill amount
- Notifications

3) Notification module.

Inputs

- Account details
- Notice details.

Processes

- Sending notifications.
- Responding to complaints.

Output

- Public notices.

4.2.2 Context Diagram

The context flow diagram of the proposed system is a lot different from that of the current system as process flows are no longer manual and new entities and other entities are replaced by system processes. New entities are also incorporated to make the system work more efficiently. The context diagram below helps explain data flows between entities in the new system.

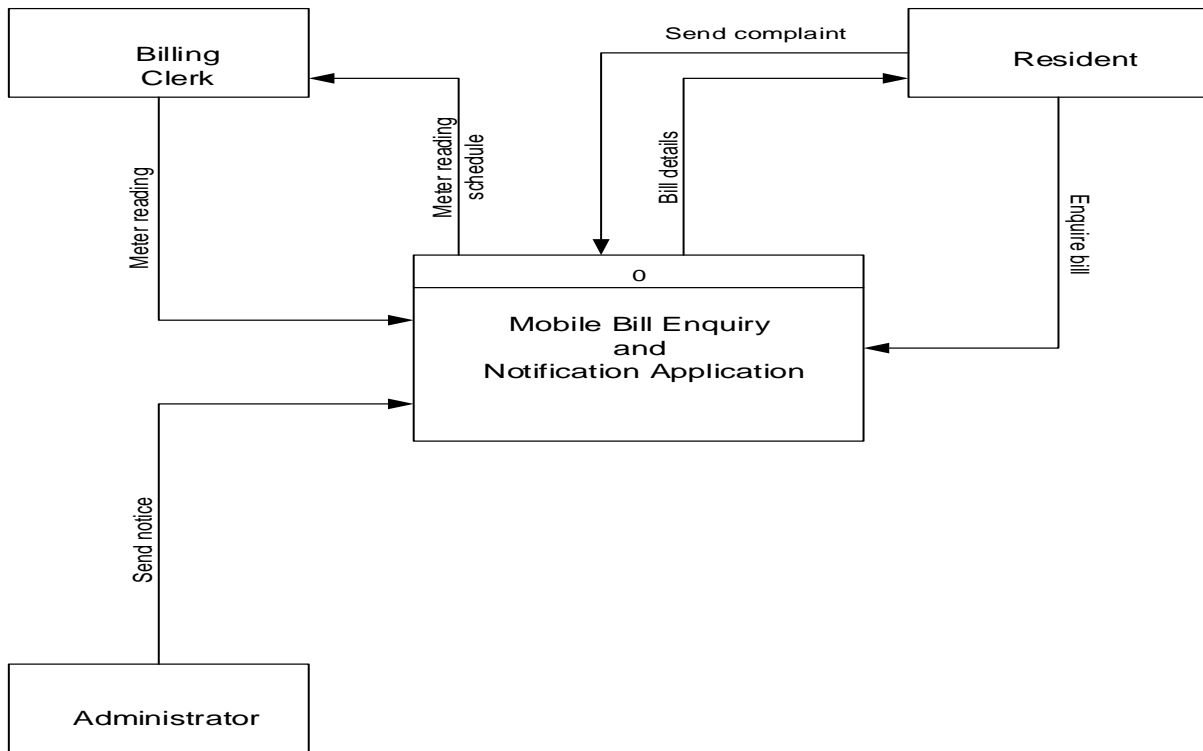


Fig 4.1 Context diagram for the proposed system.

4.2.3 Data flow Diagram of the proposed System

The data flows in the proposed system are less complex than those in the current system as there are different data stores to hold different type of data so as to maintain the integrity of the data. This new architecture significantly improves system efficiency and also reduces data redundancy. The data flow diagram below fully highlights how the data is going to flow in the proposed system.

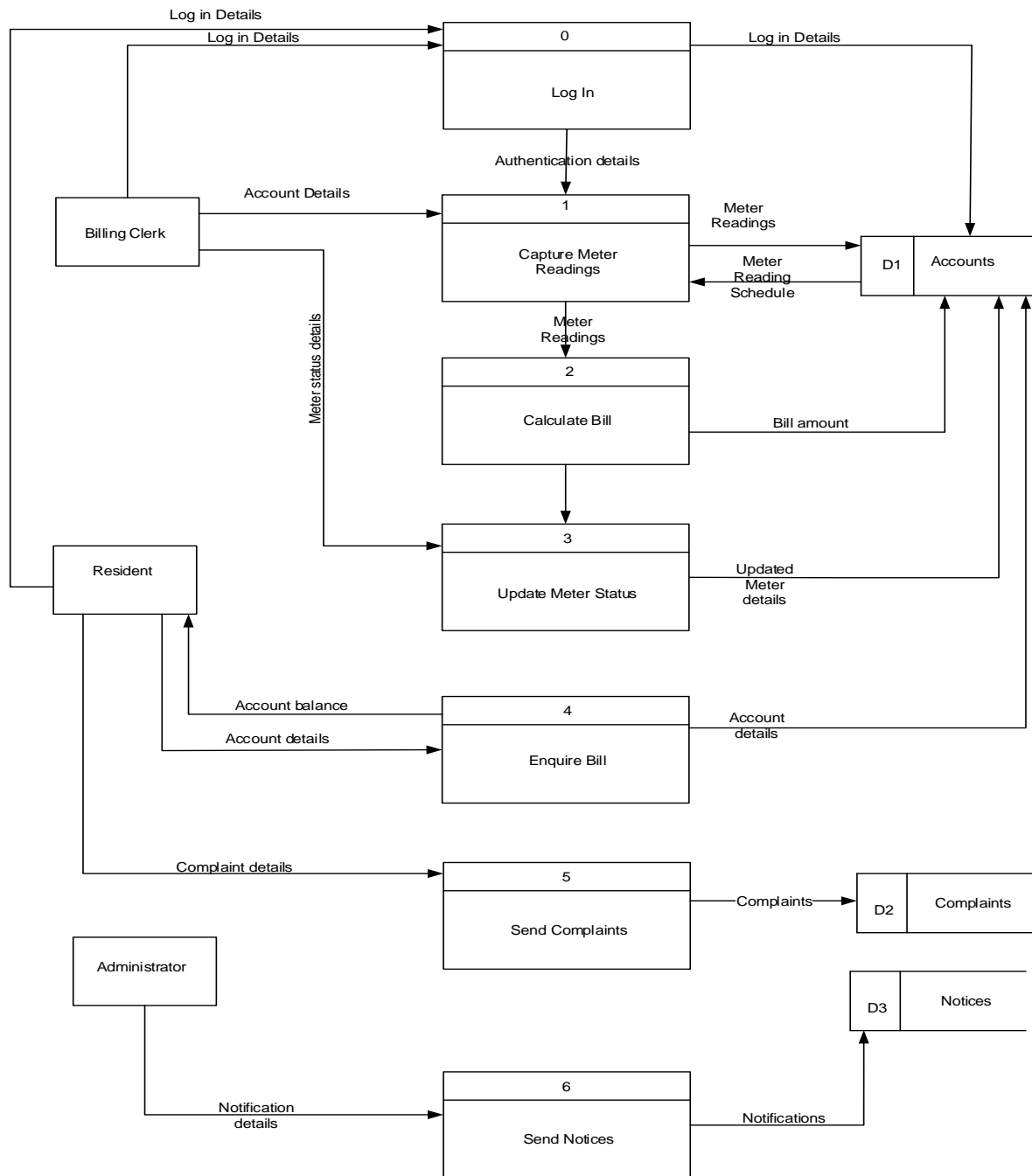


Fig 4.2 Data flow diagram for the proposed system.

4.3 Architectural design

Software architecture constitutes the primary design of a software system. Consequently architectural design involves decisions involved in architecture design that have a key impact on the system in such aspects as future maintenance costs, resulting quality and timeliness. Software architecture evaluates and translates Software requirements both functional and non-functional into a collection of design elements that specify structural and behavioral aspects of the major components of the system together with their provided quality and interrelationships required to support the detailed design and construction of software systems and the products resulting from such activity (Otero, 2012). Architectural design identifies the necessary elements and attributes of those elements that support detailed design and construction efforts. It represents the structure of data and program components that are required to build a computer-based system. It considers the architectural style that the system will take the structure and properties of the components that constitute the system, and the interrelationships that occur among all architectural components of a system (Agarwal, 2009). The risks exposed by poor architecture include software that is unstable, software that is unable to support existing or future business requirements, or software that is difficult to deploy or manage in a production environment.

4.3.1 Client Server Architectural Style

This architecture describes a system which comprises of a client, server and a network to link the two. In its simplest form it involves a 2-tier architectural style which involves a server application used by many people concurrently. The application will be developed based on this style because it provides a centralized data access it becomes easier to administer the data since it will be in a central repository. Also there is higher security than in storing data in a client computer.



Fig 4.3 Client server architecture.

4.4 Physical design

The physical design is a blue print for the actual system deployment and development (Keyes, 2002). In this case the system is mobile application which will be deployed via Google play platform. It is from this platform or via a link to Google Play users will be able to download the app which runs on all android operating system on the market. Users will use the application on any android device.

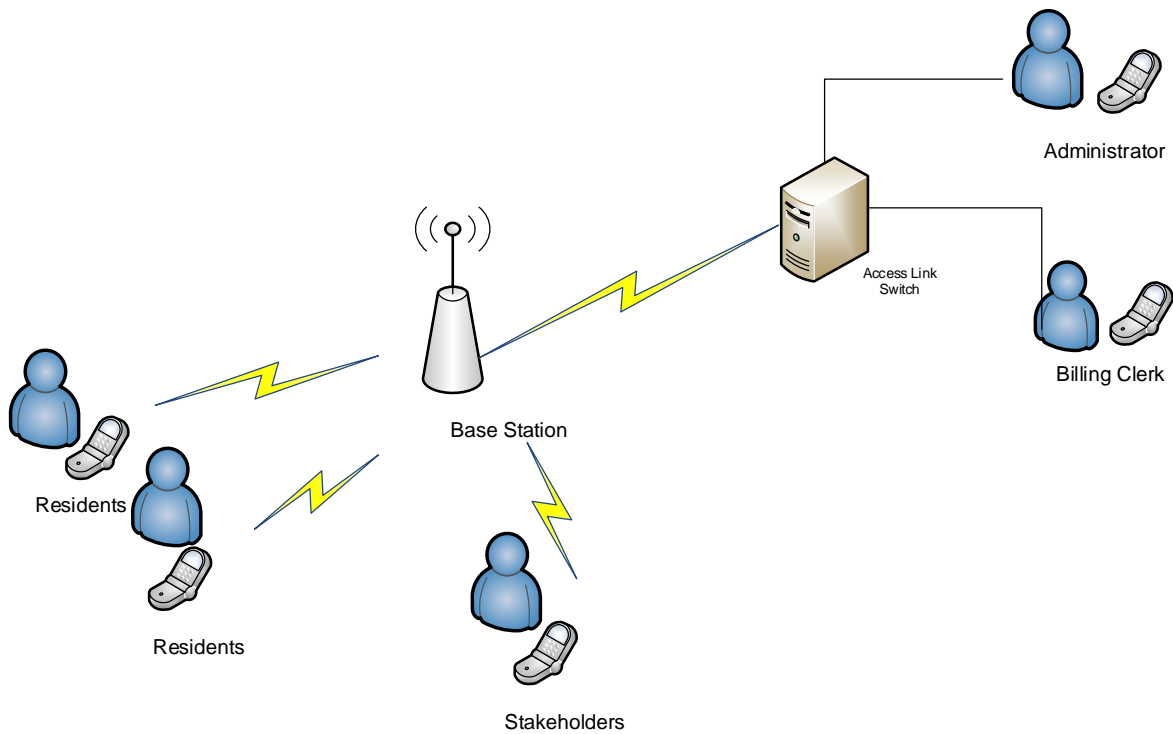


Fig 4.4 Physical design.

4.5 Database design

A database is an organized collection of data used for the purpose of modeling some type of organization processes (Hernandez, 2013). A database model describes an organized and ordered set of information stored on a computer. This ordered set of data is often structured using a data modeling solution in such a way as to make the retrieval of and changes to that data more efficient (Powell, 2006). The structure of a database can be modified to allow efficient changes to that data.

4.5.1 Tables

Residents Table

Name	Data Type	Attribute Remarks
Account Number	Varchar	Primary key
Name	String	Not Null
Surname	String	Not Null
Address	Varchar	Not Null

Table 4.1 Resident details.

Administrator Details

Name	Data Type	Attribute Remarks
Employee Id	Varchar	Primary Key
Name	String	Not Null
Surname	String	Not Null
Department	String	Not Null
Gender	String	Not Null

Table 4.2 Administrator details.

Bills Table

Name	Data Type	Attribute Remarks
Invoice Number	Varchar	Primary key
Account Number	String	Not Null
Address	String	Not Null
Date	Date	Not Null
Amount	Double	Not Null

Table 4.3 Bills

Billing Clerk

Name	Data Type	Attribute Remarks
Employee Id	Varchar	Not Null
Name	String	Not Null
Surname	String	Not Null
Address	String	Not Null
Department	String	Not Null

Table 4.4 Billing Clerk details.

4.5.2 Enhanced Entity Relationship Diagram.

It represents entities and their relationships to each other, it is an analyst's tool to diagram the data to be stored in a database system (Bagui and Earp 2012). The model is a representation of the structure and constraints of a database that is independent of the database management system. It provides important semantics about the relationship that exist between the entities involved in an enterprise model such as specialization, generalization and categorization (Dietrich.et, 2011).

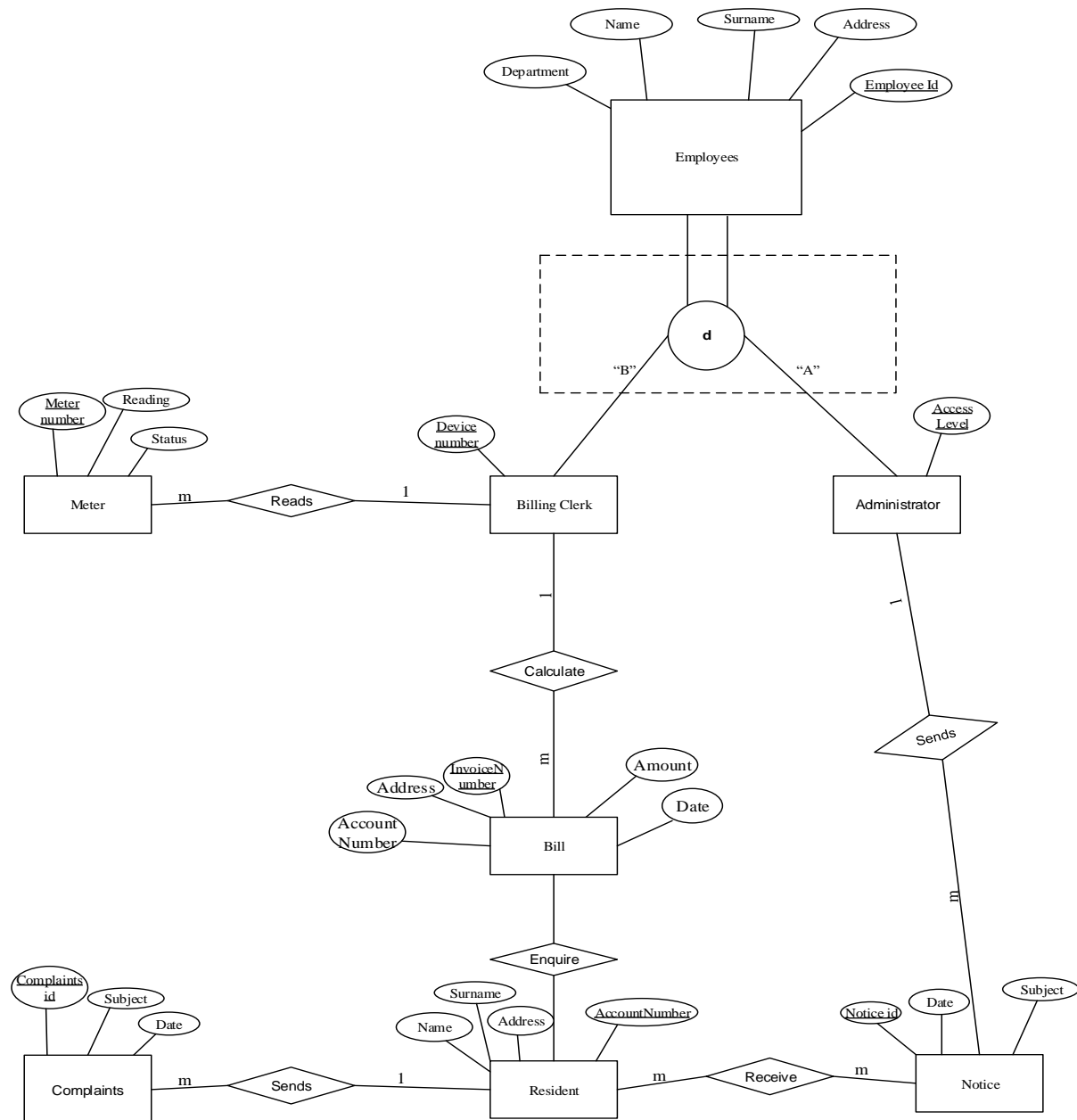


Fig 4.5 Enhanced Entity Relationship Diagram

4.6 Program design

It is an activity of progressing from a specification of some required program to a description of the program itself (Otero, 2012). The input to this phase is a specification of what the program is required to do. During the phase the design decisions are made as to how the program will meet these requirements, and the output of the phase is a description of the program in some form that provides a suitable basis for subsequent implementation.

4.6.1 Package diagram

A package diagram or package model represents how a system is split up into logical units. In this diagram the dependencies among logical units are clearly shown. A package is generally referred to as a directory, hence package diagrams provide a logical hierarchical decomposition of a system (Delligatti, 2013).

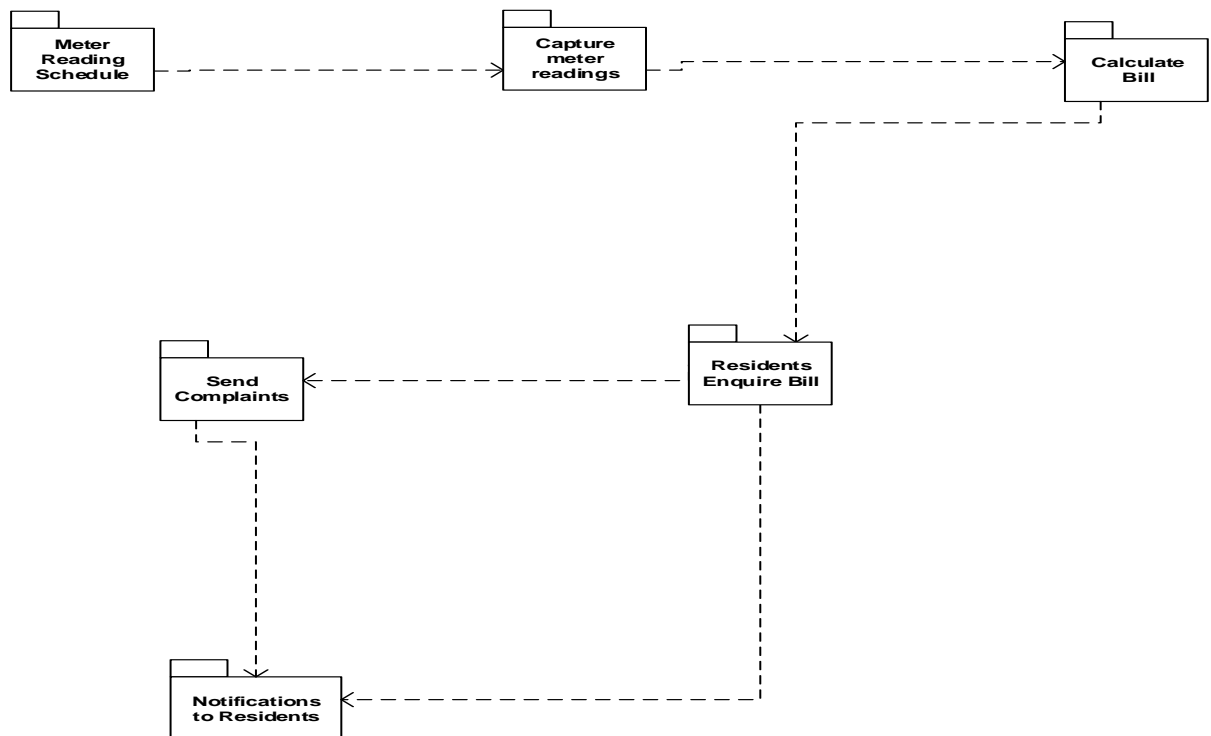


Fig 4.6 Package diagram for proposed application.

4.6.2 Class diagram

A class is a descriptor for a set of objects with similar structures, behavior and relationship, they have data structure and behaviors and relationship to other element (Favre, 2003).It describes the type of objects in the system and various kinds of static relationships that exist among them (Fowler, 2003).It also shows the properties and operation of a class and the constraints that apply to the way objects are connected.

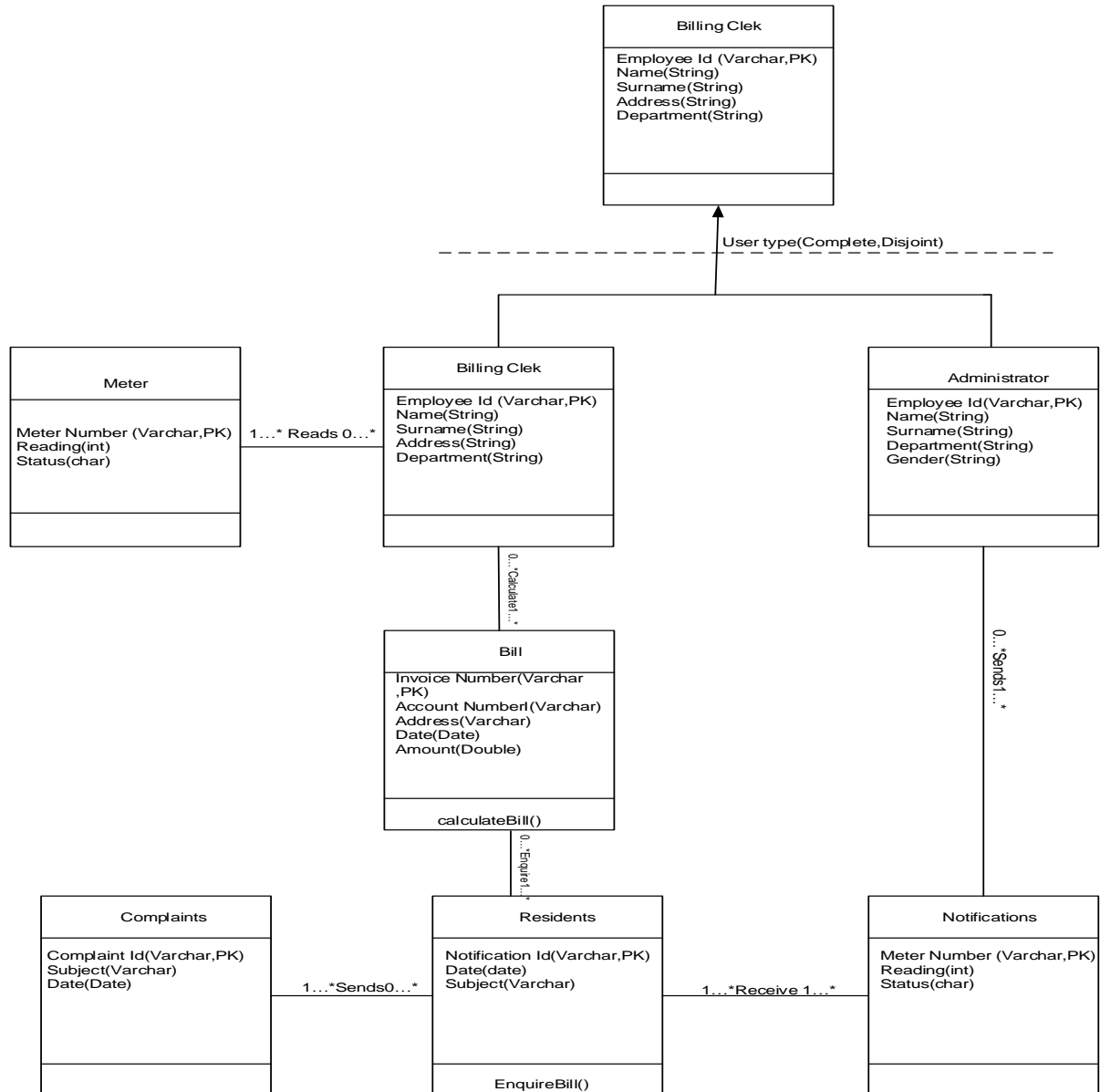


Fig 4.7 Class diagram.

4.6.3 Sequence Diagram

Sequence diagram model interactions by focusing on the ordering of messages as they occur over time, it contain objects and links (B'Far, 2005). It demonstrates the behavior of objects in a use case by describing the objects and the messages they pass. For the application under study there are three sequence diagrams as depicted below.

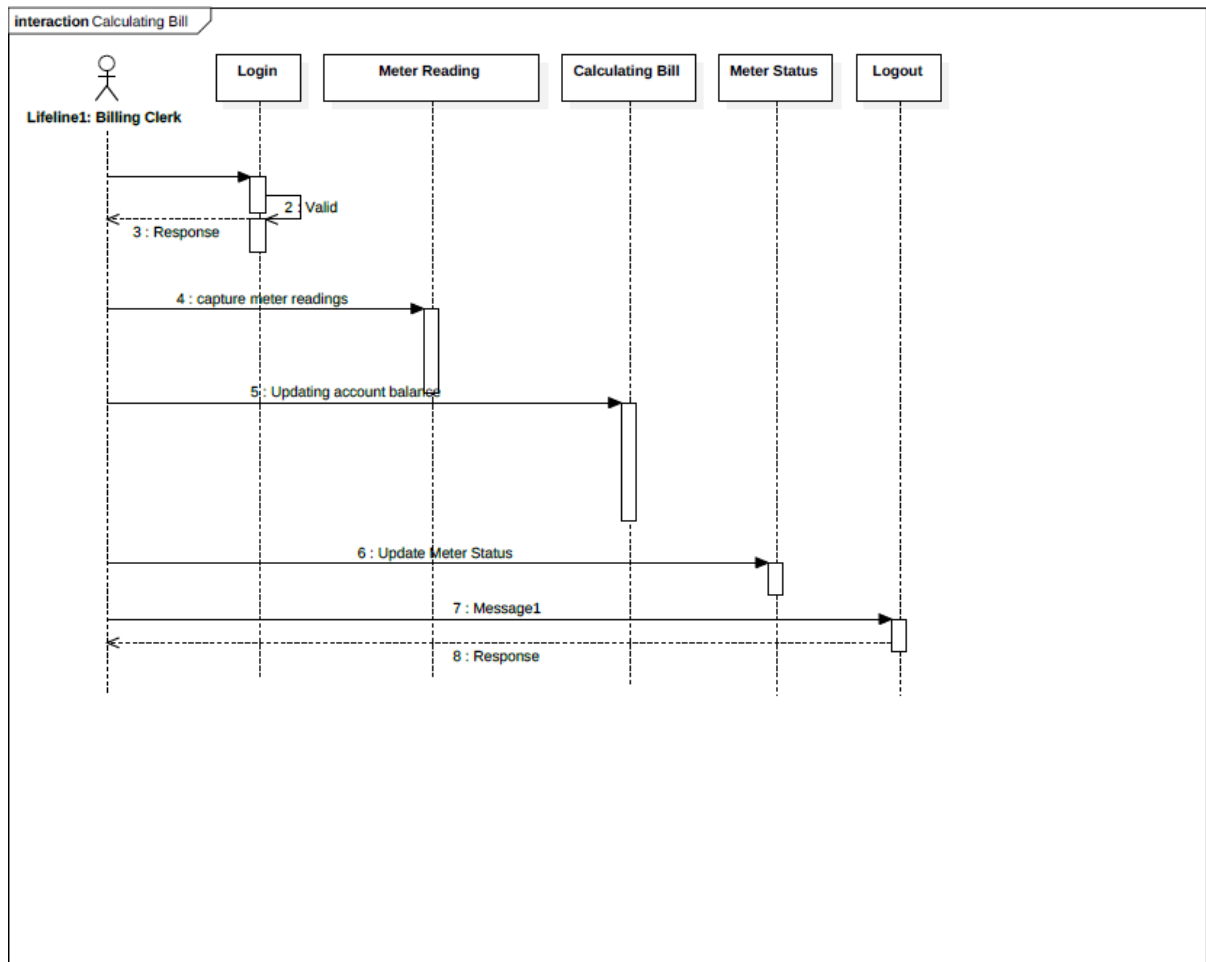


Fig 4.8 Sequence diagram for calculating bill.

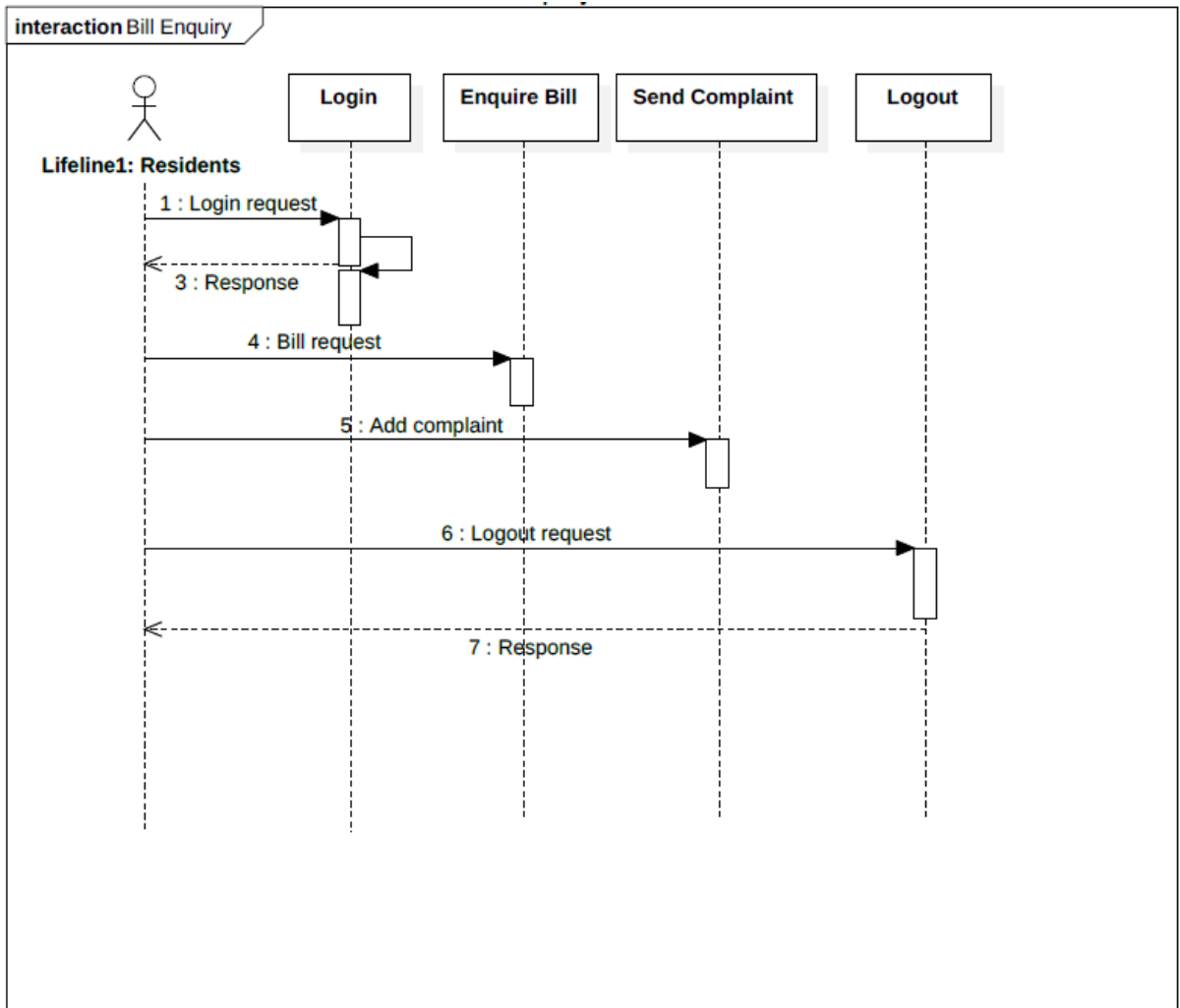


Fig 4.9 Sequence diagram for bill enquiry.

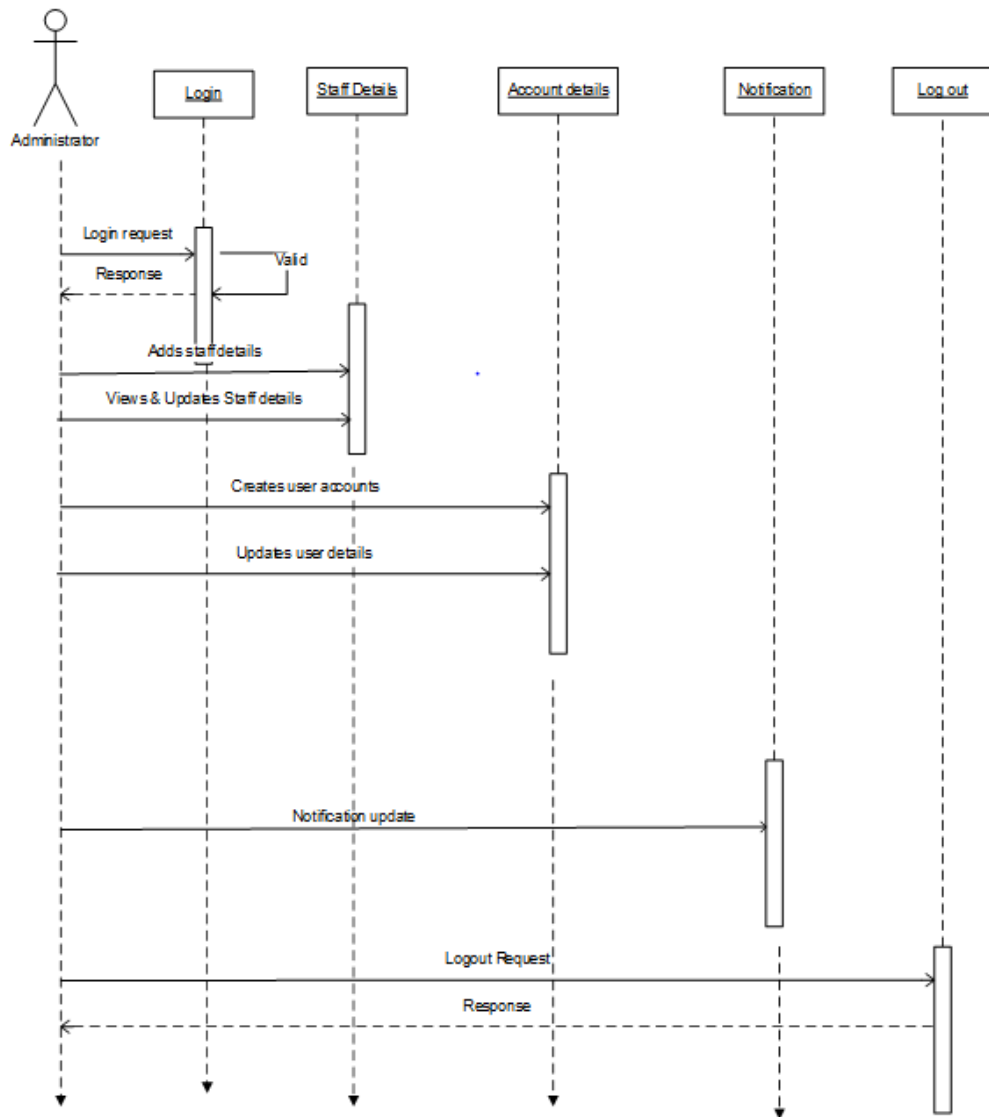


Fig 4.10 Sequence diagram for the Administrator.

4.7 Interface design

User interface design is a subset of a field of a field of study called Human computer interaction is the study, planning and design of how people and computers work together so as to satisfy human needs (Galitz,2007).The user interface has two components input which describe how a user communicate his or her needs to the application and output is how the application convey the results of its computations and requirements to users. Without an interface it becomes difficult for user to use the system in this case will using graphical user interfaces in the application which is a combination of windows, icons, images and buttons.

4.7.1 Application Launcher icon

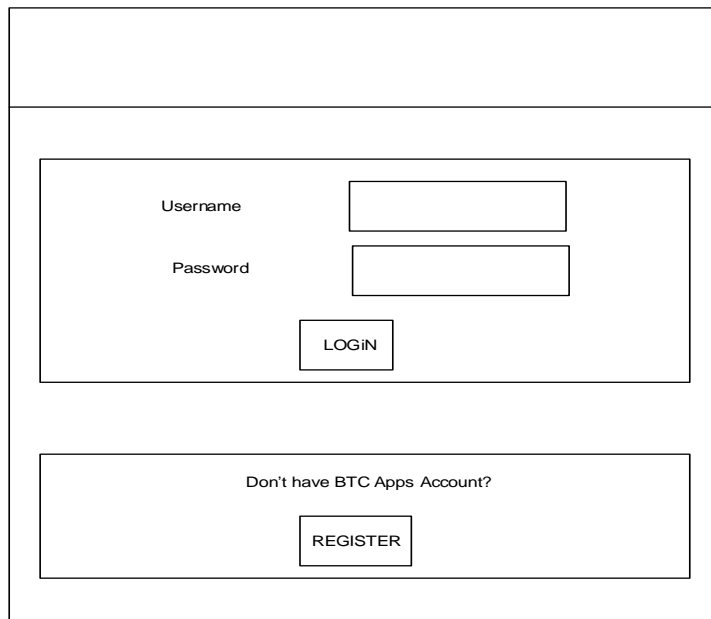
The application will be launched by pressing and tapping on the icon, it is the entry point into the system. Beitbridge Town Council logo was used so as to make it easy for users to identify the application in play store and in their android devices.



Fig 4.11 Application launcher

4.7.2 Log in menu for proposed application.

The login screen will be used to validate user credentials in order to use the application.



The diagram shows a login page layout. At the top, there is a header area. Below it, a main content area contains a login form. The form has two input fields: one for 'Username' and one for 'Password'. Below these fields is a 'LOG IN' button. At the bottom of the form area, there is a link that says 'Don't have BTC Apps Account?' with a 'REGISTER' button below it.

Fig 4.12 Login page.

4.7.3 Meter reading and bill calculation page.

The Billing Clerk will select the account type from four options high, medium, low density and commercial stands and capture the meter readings and calculate the current meter bill statement.

The screenshot shows a web form for calculating a meter bill. At the top, there is a dropdown menu labeled "Select the type of account". Below this, there are two input fields: "Account number" and "Meter reading". At the bottom of the form, there is a button labeled "Calculate Bill".

Fig 4.13 Meter reading and bill calculation.

4.7.4 Bill enquiry page.

The user will enter an account number in the text field labeled account number and enquire current account balance.

The screenshot shows a web form for bill enquiry. It features an input field for "Account number" and a button labeled "Bill Enquiry". Below the input field and button is a shaded area labeled "Bill Details". At the bottom of the page, there is a button labeled "Pay Bill".

4.14 Bill Enquiry

4.7.5 Registration page.

The user will register in order to login into the application.

The registration form is titled "Registration" and contains the following elements:

- Name:
- AccountNumber:
- Email:
- Password:
- Confirm password:
- Register button:
- Cancel button:

Fig 4.15 Registration page

4.7.6 Notices.

Notices will be displayed in a grid view.

The notice display is titled "Notices" and shows a grid of four placeholder boxes, each labeled "Notice".

Notice	Notice
Notice	Notice

Fig 4.16 Notice display

4.7.7 Complaints

Residents will use this page to send complaints to the council.

Complaints	
AccountNumber	<input type="text"/>
Email	<input type="text"/>
Name	<input type="text"/>
Subject	<input type="text"/>
Details	<input type="text"/>
<input type="button" value="Submit"/> <input type="button" value="Cancel"/>	

Fig 4.17 Complaint input

4.7.8 Notice Update

This page will be used by the administrator to send notices.

Notice	
NoticeId	<input type="text"/>
Date	<input type="text"/>
Subject	<input type="text"/>
Details	<input type="text"/>
<input type="button" value="Submit"/> <input type="button" value="CANCEL"/>	

Fig 4.18 Notice update

4.8 Conclusion

The design phase defined how the system would work in the actual environment. It exploited the various tools that have been used in designing the system. It further broke down the components of the system before detailing the tools to design the system. Since the required design deliverables were made clear, the application development will progress to the next stage which is system implementation phase.

Chapter 5: Implementation phase

5.1 Introduction

The final phase of system development is the implementation phase, it is the installation and delivery of the entire system into production during which the system is actually built at the end the system will be put into operation and supported and maintained (Whitten, 2007). The system will undergo variety of tests that will verify that the system performs as expected. According to Rixom (2012) the implementation phase consists of developing and testing the system's software, documentation and new operating procedures. Aspects such as installation of the new system, selection of the most suitable conversion approach, preparing the organization and the users to adapt to the new system and ensuring that the system is supported after it is put into use are looked at.

5.2 Coding

One of the ways that data can be entered more accurately and efficiently is through the knowledgeable employment of various codes. The process of putting ambiguous or cumbersome data into short, easily entered digits or letters is called coding (Kendal and Kendal 2011). Coding can help users in keeping track of events, classifying information, concealing information.

5.2.1 Pseudo code

Pseudo code is a conversion of a programming statement into structured English by adding input and output statements as well as control statements such if else statements(Gilberg, 2005).

User login code

Start

Enter username and password

If (username and password) valid

Log in

Else

Wrong credentials try again.

End.

Add Resident Form

Start

If (add user)

Enter user details and add user

Check Resident account existence

Start

If (add user)

Enter user details and add user

Else

User already exist

Calculate Bill

Start

If (low density)

Enter account details

Else

Wrong account details

5.3 Testing

It is an investigation on anomaly or error in a program code that can remain undetected indefinitely (Yaetes, 2004). To prevent this from happening the code is tested at each stage. Testing is done in order to make sure that all components of the system such as error handling capabilities, timeliness, and ease of use are functioning as required. It is also aimed at ascertaining whether the system is able to meet the initial objectives of the project and thus answer the question of whether the problems currently being faced by Beitbridge Town Council have been addressed. Before the system is fully implemented all programs must be desk checked, checked with test data whether the modules work together with one another as planned.

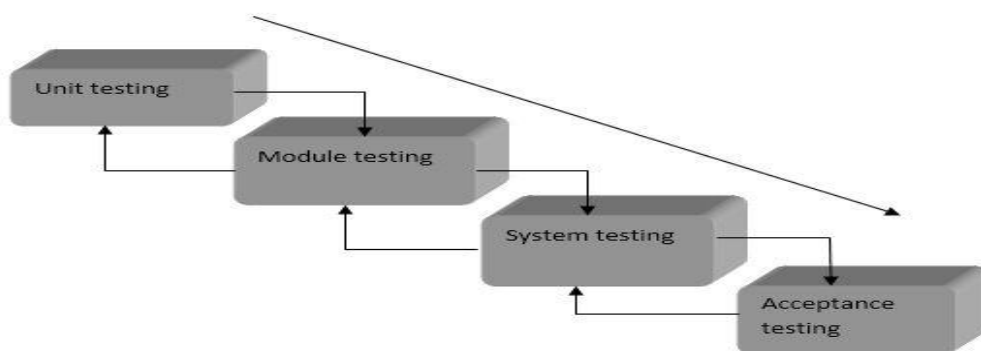


Fig 5.1 Software testing process.

5.3.1 Unit Testing

During unit testing, individual components were tested to ensure that they are operating correctly, the programmer examines each module separately, actually trying to make it fail (Edwards, 2007). Each component was tested independently, without other system components. The objective is to check whether each unit performs its task as specified. For instance the system verifies if the logging details entered by the user are valid in order to enter into the system.

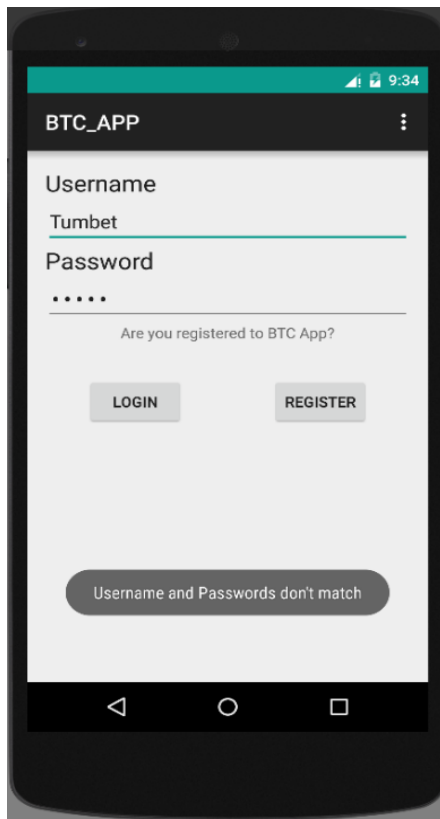


Fig 5.2 Screenshot for validation of user passwords.

5.3.1.1 Black Box Testing

Functional testing this focuses on inputs and output of the software system unit without bothering about internal knowledge of the software program. In this case the test plan is developed directly from the program specifications (Rixom, 2007). Each item in the program specification becomes a test and several test cases are developed for it.

5.3.1.1.1 Advantages

- Test is unbiased because the tester and the designer are independent of each other.
- The test is done from the point of view of user not the designer.
- The tester does not need knowledge of any specific programming language.

5.3.1.1.2 Disadvantages

- Testing every possible input stream is unrealistic.
- Test cases are difficult to design.

5.3.1.2 White Box Testing

Logical testing focuses primarily on the inner working detail of a system unit and helps in strengthening security, the flow of inputs and outputs through the application, and improving design and usability. It is reserved for special circumstances in which the tester wants to review the actual program code, usually when complexity is high (Rixom, 2007).

5.3.1.2.1 Advantages

- The test is able to inspect the internal state of the box after the test has been run. This can be useful to ensure that internal information is in the correct state regardless of whether the output was correct or not.
- All the features and functionality within the application can be tested.
- Testing can be started at the very initial stage. Tester does not need to wait for interface or GUI to be ready for testing.
- Can reduce to number of test cases to be executed during black box testing.
- Helps in checking coding standards and optimizing code.
- Extra code resulting in hidden defects can be removed.
- Reason of failure can be known.
- Identifying test data is easy because coding knowledge will be a pre-requisite.

5.3.1.2.2 Disadvantages

- As knowledge of code and internal structure is a prerequisite, a skilled tester is needed to carry out the test which makes the test expensive.
- Tester should be highly skilled because should have the knowledge of coding, implementation.
- White Box testing is very complex.

Test cases maintenance can be tough if the implementation changes very frequently

5.3.2 Module Testing

According to Myers (2012) module testing is defined as an integrated testing which assesses the possibility of a set of modules of the system can work together without error Related components are tested as standalone modules without other system modules. For each module, code in each of the forms in the system was tested to see if it was performing to the desired function. Execution paths, error-handling paths, normal, abnormal and extreme data were thoroughly tested.

5.3.3 Integration Testing

Also known as link, subsystem or level 1 testing (Yeates, 2004). This step is in-between isolation and testing the whole system. The purpose of integration testing is to test the interfaces between programs in the same functional area. Each program is linked to all the other programs with which it interacts, the test is not limited only to if data entered is correct and in correct format, but that it happens in the specified sequence and within the specified response time.

5.3.4 System Testing

Desikan (2006) stressed that system testing is performed on the basis of written test cases according to information collected from detailed architecture and design document, module specification and system requirements specification ensures that the entire application modules work together without errors. It examines how well the system meets business requirements and its security, usability and performance its performance under heavy workload. This test ensures that changes made as a result of integration testing did not create new errors, this is the developers last.

5.3.4.1 Objective Vs. System solution

Objective 1: To develop a system that instantly calculate water bills for each household.

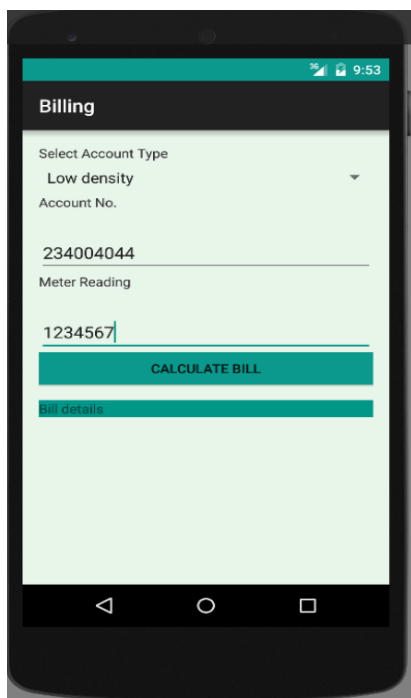


Fig 5.3 Solution for objective 1

The screenshot shows the billing page where the Billing clerk will capture meter reading and calculate bill amount for residents.

Objective 2: To develop a system that allows residents to enquire bills.

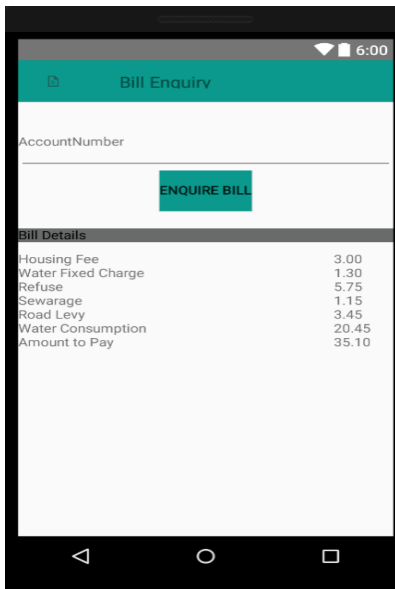


Fig.5.4 Solution to objective 2

This screenshot shows the bill enquiry page in which residents will check their account balances.

Objective 3: To develop a system that allow residents to send complaint to the council.

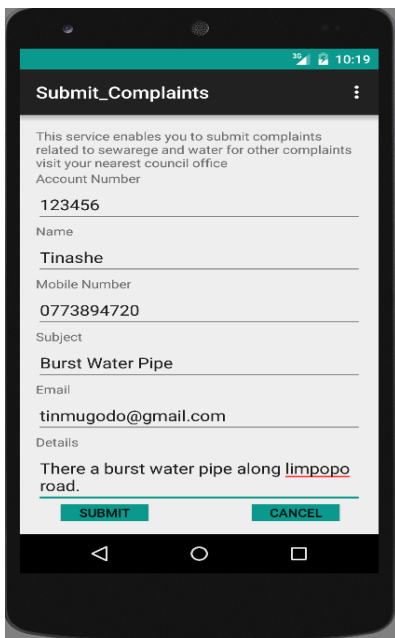


Fig 5.5 Solution to objective

This screenshot shows the complaints page which allows residents to send complaints related to water and sewerage to the council.

5.3.5 Acceptance Testing

Acceptance testing is conducted to examine if the developed software is ready for use in the user environment(Desikan,2006).This testing is done by real users of the software application ,the users identifies a set of test cases that will be performed to qualify and accept the software product.

5.3.5.1 Alpha Testing

Alpha test is conducted by the users of the system. Some of the previous tests carried out by the programmers and system analysts are now repeated by the users. As users have insatiable desires, their specifications relating to appearance or functionality of the system can be changed after the alpha testing. Alpha test is usually carried out within the developers' environment.

5.3.5.2 Beta Testing

This testing phase occurs immediately after the correction of the system when the alpha test is carried out (Craig, 2002). It is also carried out by the system users but this time in the users working environment or work stations. Developers will have finally released the system into the operational environment.

5.3.5.3 Defect Testing

According to Limaye (2009) the goal of defect testing is to disclose all the defects the program might have. A defect test is considered to be successful if it prompts the system to anomalously behave. The following diagram represents the steps carried out during the defect test phase.

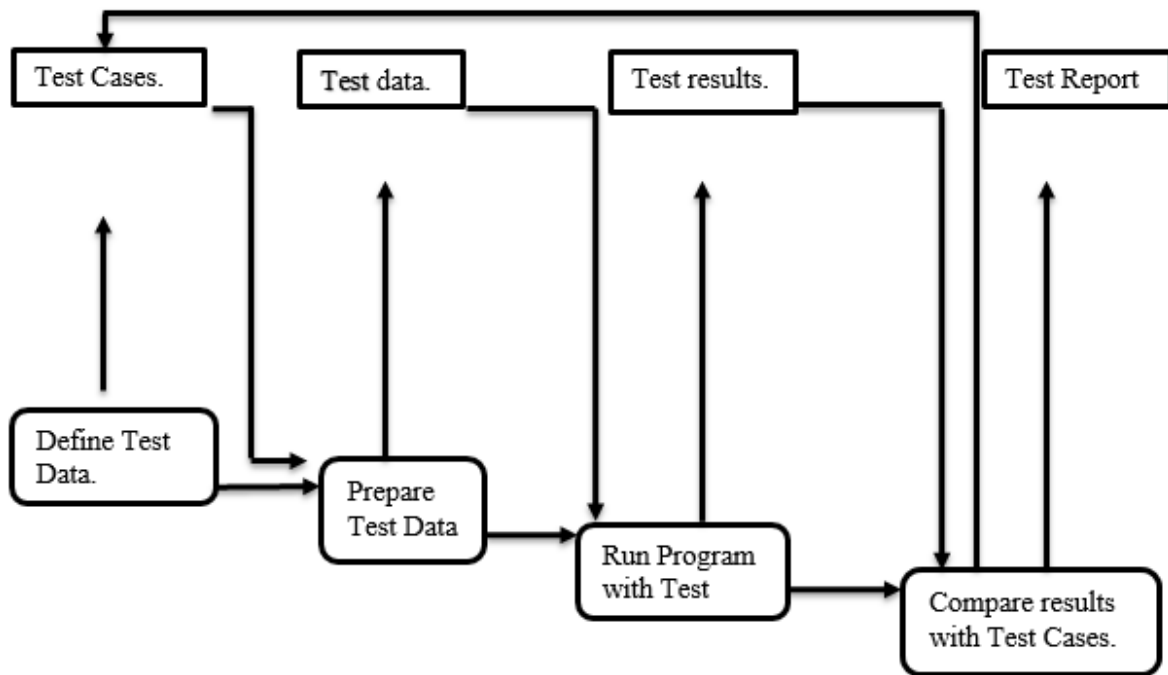


Fig 5.6 Defect testing process

5.3.5.4 Validation

Sommerville (2011) says software validation is the process of checking that the system conforms to its specification and that it meets the real needs of the users of the system. The objective of this phase is to check that the software developed is solving the specified problem. The new system is compared against the user requirements to ensure that it meets the requirements. Validation is achieved through the comparison of data entered and the output. This was to ensure that the data is captured as required and the output is as required. Validation mainly checks values entered in the textboxes if they correspond to specified field type.

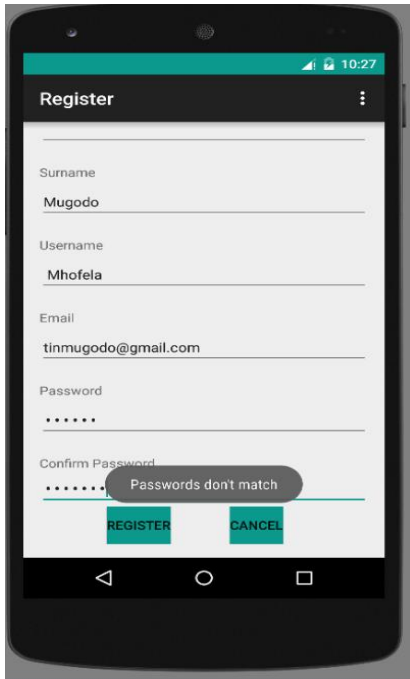


Fig 5.7 Screenshot for password validation

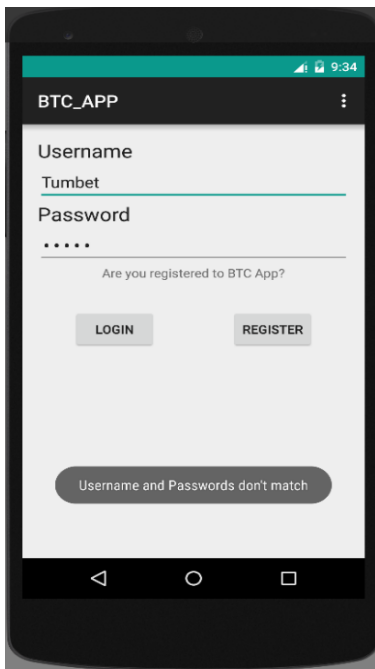


Fig.5.8 Screen shot username and password don't match.

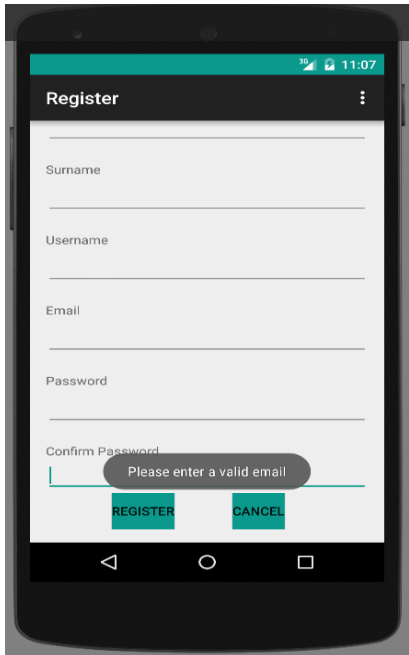


Fig.5.9 Screen shot wrong email address.

5.3.4.5 Verification

Sommerville (2011) propounds that system verification is the process of checking that a system meets its specification. It seeks to ensure that the implemented program meets the expectations of the application's users. Structured walkthroughs and code reviews were used to verify the system. These techniques were used to detect and correct logic and syntax errors in the program. The system exhibited consistencies and correctness in its execution thus meeting its objectives.

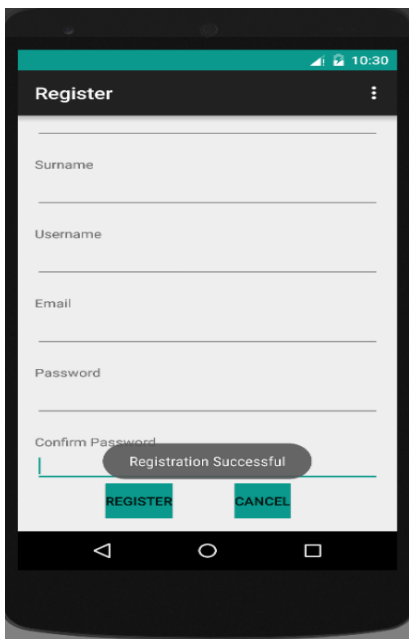


Fig 5.10 Registration successful.

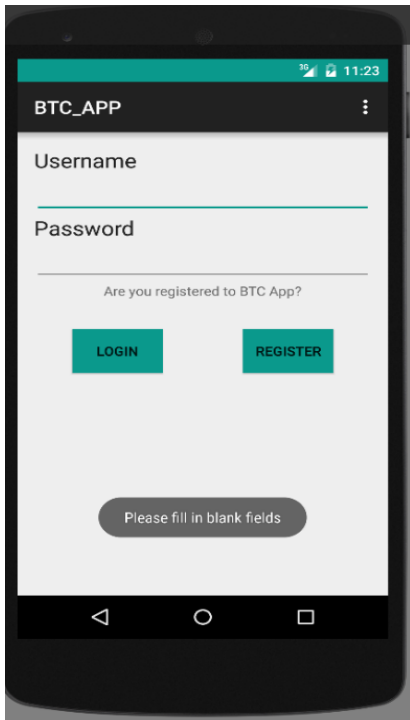


Fig 5.11 Blank field's verification.

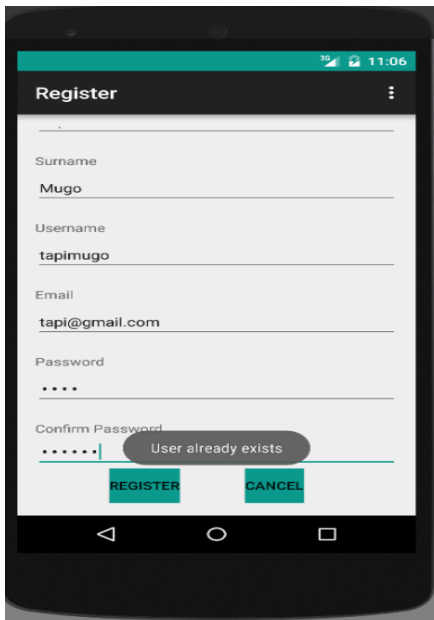


Fig 5.12 User account verification.

5.4 Installation

Installation is whereby the developed application is deployed into the device where it will operate within. In this case the application will be deployed on any android compatible device. Specifications of what will be performed by the users were made and it included technical aspects such as installing and configuring of hardware and software and converting data from the current system to the proposed system. The major steps in the process were:

- Hardware installation.
- Software installation.
- User training.
- File conversion.

5.4.1 Hardware Installation

This included setting up of necessary hardware for the proposed system, that is, installation of the user computers, the mobile phones and all the network installations.

5.4.2. Software Installations

System installation involves downloading the application from Play Store alternatively the application can be shared via Bluetooth .The application will be launched by ruuning the the downloaded apk file.

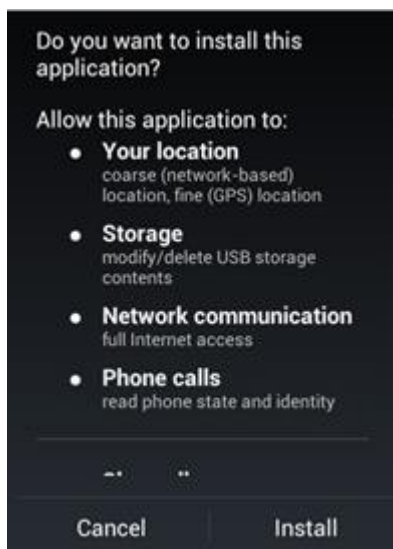


Fig 5.13 Application install permission.

5.4.3 User Training

This is the process by which all the prospective users of the system were introduced to the system and made to be fully acquainted with the system (Shelly, 2012). The training was divided into two thus staff training and residents training. On staff training the emphasis was on equipping the personnel with the technical know-how of installing the application and how to capture and update meter readings whilst resident training was done to teach residents on how to download the application and install it as well as how to enquire bills and send complaints using the application. Training workshops were held in all wards.

5.4.4 File conversion

File conversion had to be undertaken to ensure the old data is converted to digital data which was going to be used. This was important so that the new system was tried in the real operational environment and performing the functions in real time instead of using test data.

5.4.5 System Changeover Strategy

Once a successful system test has been completed we can begin preparations to place the new system into operation. Using the design specification for the new system a detailed conversion plan is developed (Whitten and Bentley 2007). System changeover strategy can be parallel, direct, pilot and phased changeover strategy.

5.4.5.1 Direct Changeover Strategy.

In simple words direct cutover approach is a direct approach where old system is cut and over write by new system (Edward,2007). The direct cutover approach causes the changeover from the old system to the new system to occur immediately when the new system becomes operational. This is a least expensive method among all four but involves high risk of data loss. With the direct cutover method, company cannot revert to the old system as a backup option. Direct cutover involves more risks of total system failure and if there is a system failure in health centre then it will be difficult to store information this will result in improper storage of data. But as there is lack of funds, this approach will be a possible option because of its low cost application among all four approaches.

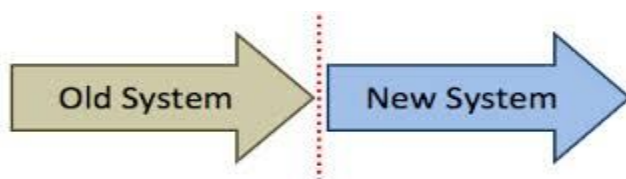


Fig 5.14 Direct change over

5.4.5.2 Parallel changeover

According to Desikan (2006) the parallel operation changeover method requires that both the old and the new information systems operate fully for a specified period. When users, management, and the IT group are satisfied that the new system operates correctly, the old system is terminate. Parallel operation is having very low amount of risk as if the new system does not work correctly, the company can use the old system as a backup. But it is the most costly changeover method. Data have to be input in both systems. Users must work in both system and result in increased workload and processing delays. Because of its high cost it would not be a suitable approach for the council even though it's the safest approach as it is having back up.

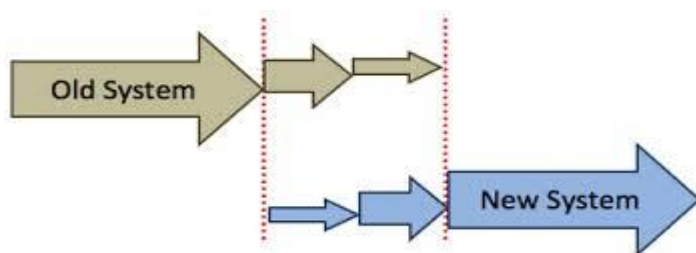


Figure 5.15 Parallel Conversion

5.4.5.3 Phased changeover

Phased operation works in different phases or stages. Implementation of new system in modules or stages is phased operation. This is also a combination of direct cutover and parallel similar to pilot operation. But in this approach the entire system is provided to some users instead a part of system to all users. In phase operation the risk of errors or failures is limited to the implemented module only and also phased operation is less expensive than the full parallel operation. But in some cases, phased operation can cost more than a pilot approach where the system involves a large number of separate phases. Because of the involvement of so many phases it would be difficult and costly to apply phased operation approach.



Fig 5.16 Phased operation

5.4.5.4 Pilot changeover

The pilot operation changeover method involves implementing the complete new system at a selected location of the company. The group that uses the new system first is called the pilot site. The old system continues to operate for the entire organization including the pilot site. After the system proves successful at the pilot site, it is implemented in the rest of the organization, usually using direct cutover method. Pilot operation is combination of parallel operation and direct cutover methods. Pilot site assure the working of new system and reduces the risk of system failure. This is also less expensive than the parallel operation as only at one section both system works for limited period. This is less expensive and safer approach as its combination of both direct cutover and parallel operation. It will save money for the council and also keep their data safe with smooth working.



Fig 5.17 Pilot operation

5.5 Maintenance

Software development efforts result in the delivery of a software that satisfies user requirements accordingly the software product must change or evolve .Maintenance is the process whereby a software product undergoes modification to code and associated documentation due to a problem or a need for improvement (Edwards, 2007). An important process to be given good attention if the system is to live longer while delivering its intended purpose. It is important for my system because the system will continue to change and evolve as it is being used .The operating environment will change, implying that the system must be adapted to those changes .The changes will be arising from change request due to problems encountered. Bugs identified in the system that must be fixed. Changes will be arising from users and as such maintenance will be very vital for the successful long run of the system. It involves modifying, improving and upgrading a system to make it perform better and cater for new requirements that might emerge after some time.

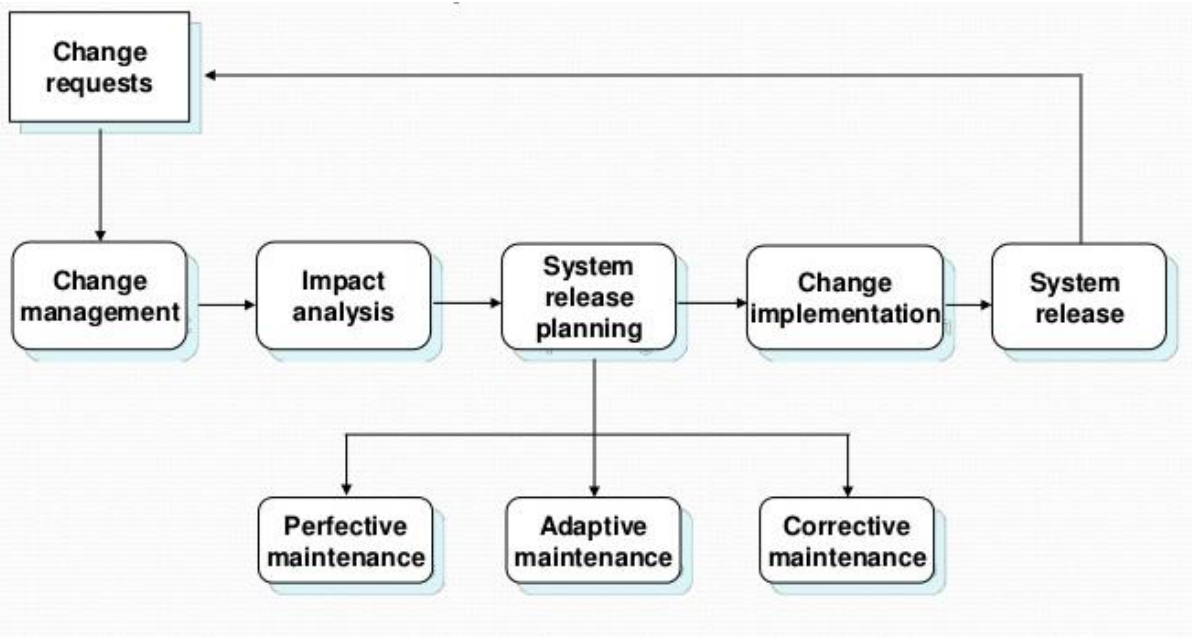


Fig 5.18 Maintenance Process

5.5.1 Corrective Maintenance

This is a reactive modification done in the software product after delivery (Hambling, 2007). Its main goal is to correct or fix discovered and user reported problems in the newly installed system these defects can be due to logical or run time errors in the application.

5.5.2 Adaptive Maintenance

This shall be undertaken to cater for changes that might arise to the working environment of the user (Hambling, 2007). It is done to upgrade the system or add enhancements so as to adapt it to the environment changes, for example the introduction of new mobile phones in the market will affect some of the libraries used by the application on run time due to environment inconsistencies all the alterations done during adaptive maintenance must be documented for future reference.

5.5.3 Perfective Maintenance

This will be carried out to make sure that the Bill Enquiry Application is constantly satisfying user requirements, thus constant communication with user is established to open room for improvements and new add-ons. The system is refined so that it operates more efficiently and the system is made more stable.

5.6 Conclusion

The maintenance phase outlined how the system is maintained as well as the different methods of maintenance that can be employed. The system has been designed in such a way that it can easily change or adapt to the new environment.

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Appendix A: User manual

Introduction

Every user of the application should register in order to create an account with the system.

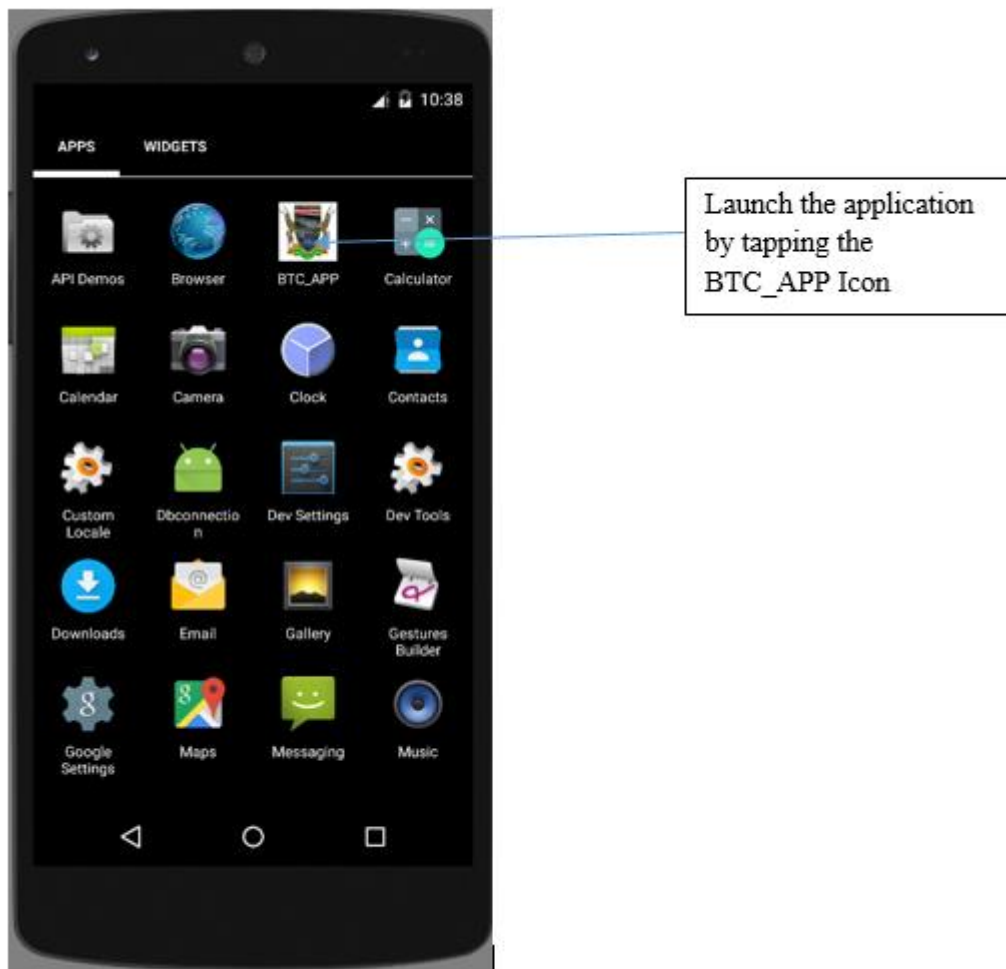


Fig A1 Application Launcher

The application will be launched by tapping the icon BTC_App .

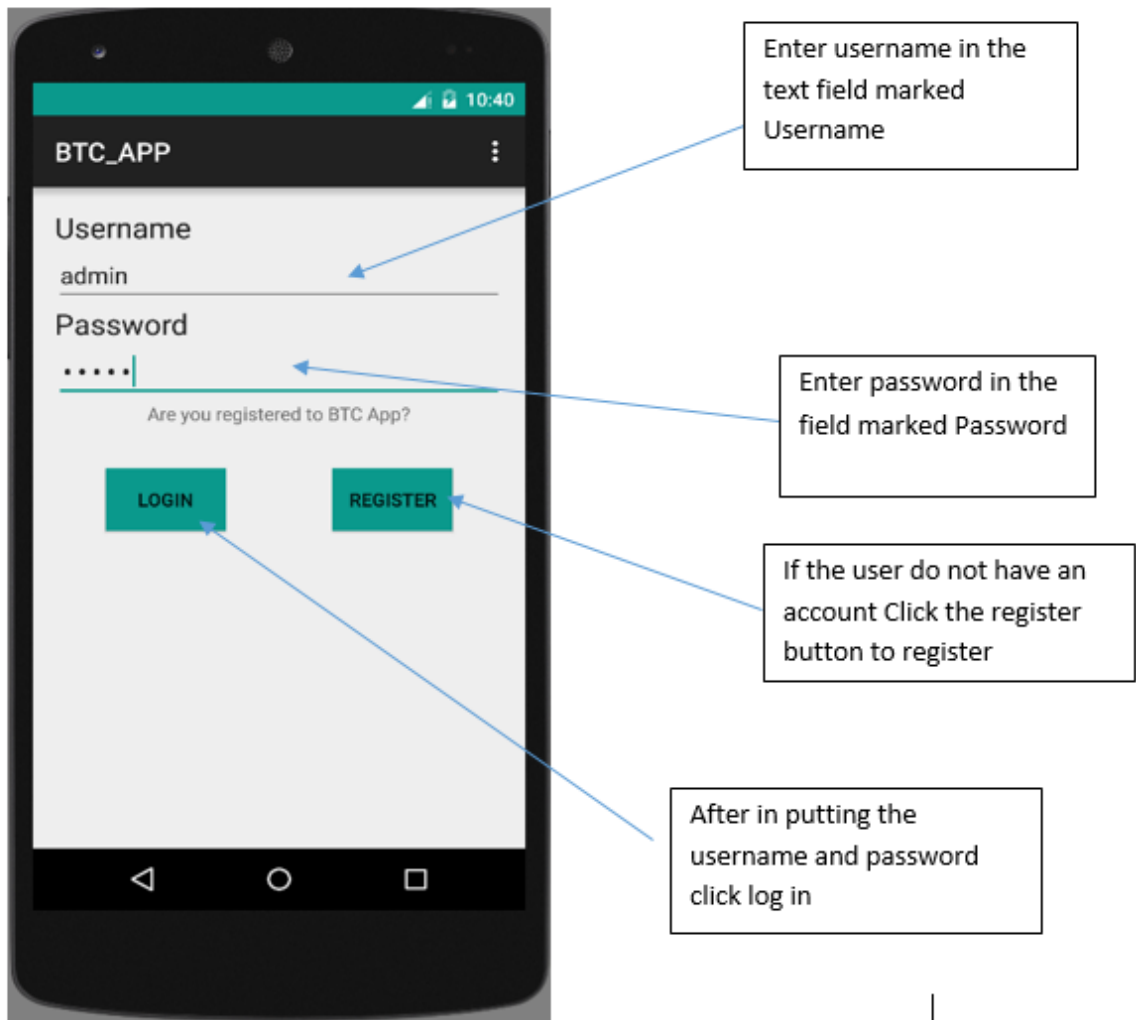


Figure A2 Sign up Screen

The system has 3 access levels. That is the Billing Clerk , Residents and the Administrator. They all log in on the same page which is the log in screen shown below

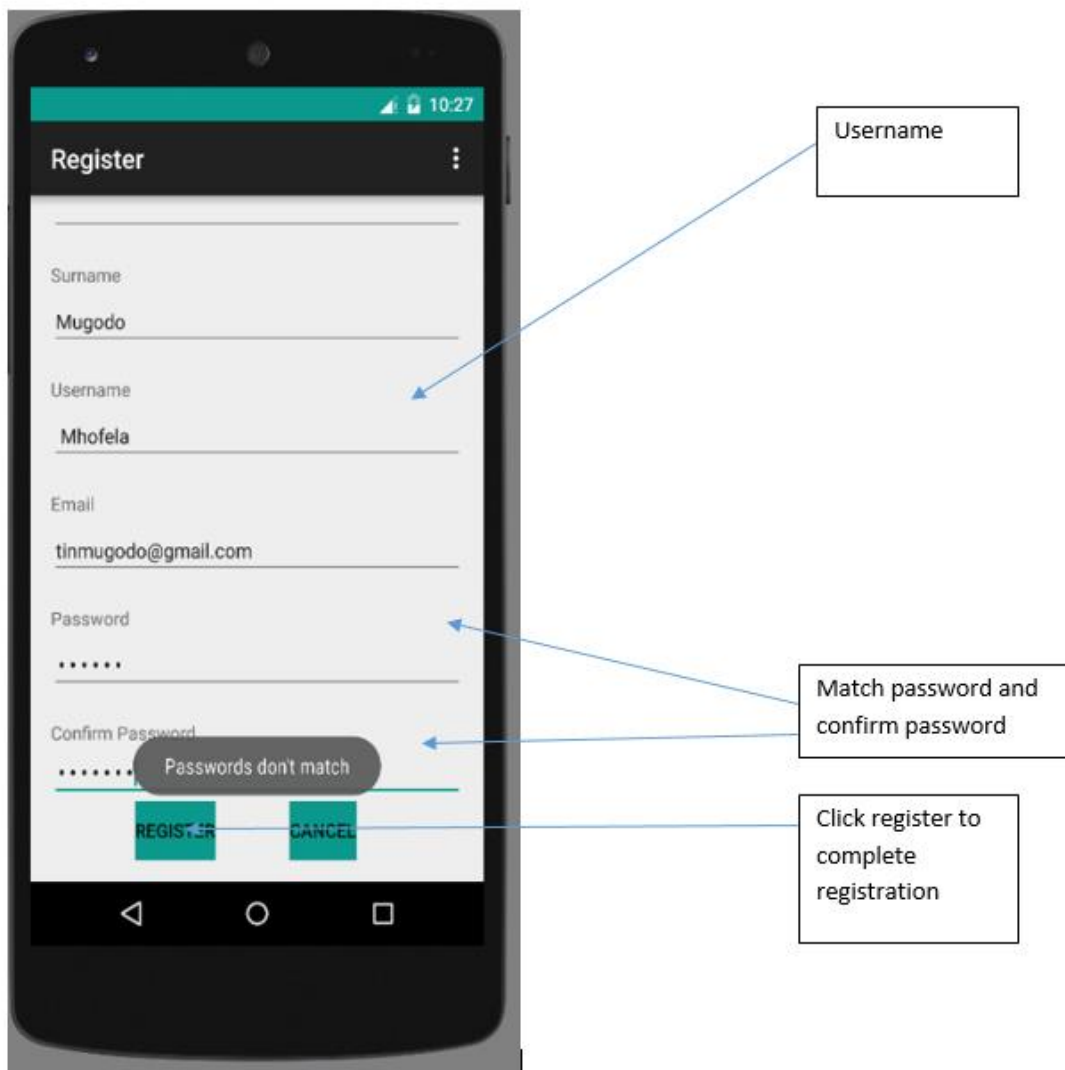


Fig A3 Registration page

In order to use the application all users should have accounts created for the to log in ,the registration will be done in the registration page.

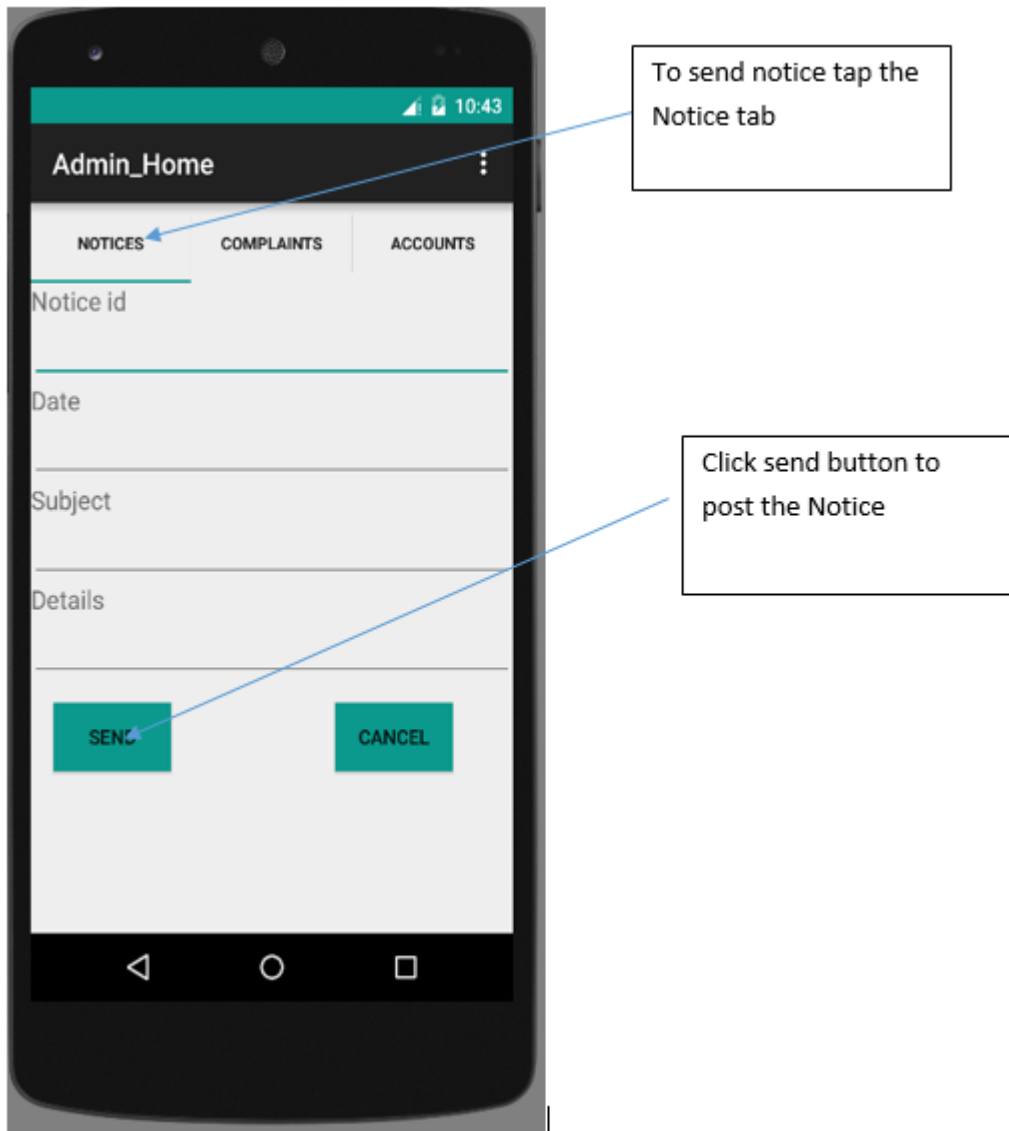


Fig A4 Admin Home

The administrator will be able to send notice using the notice page in the application as shown above.

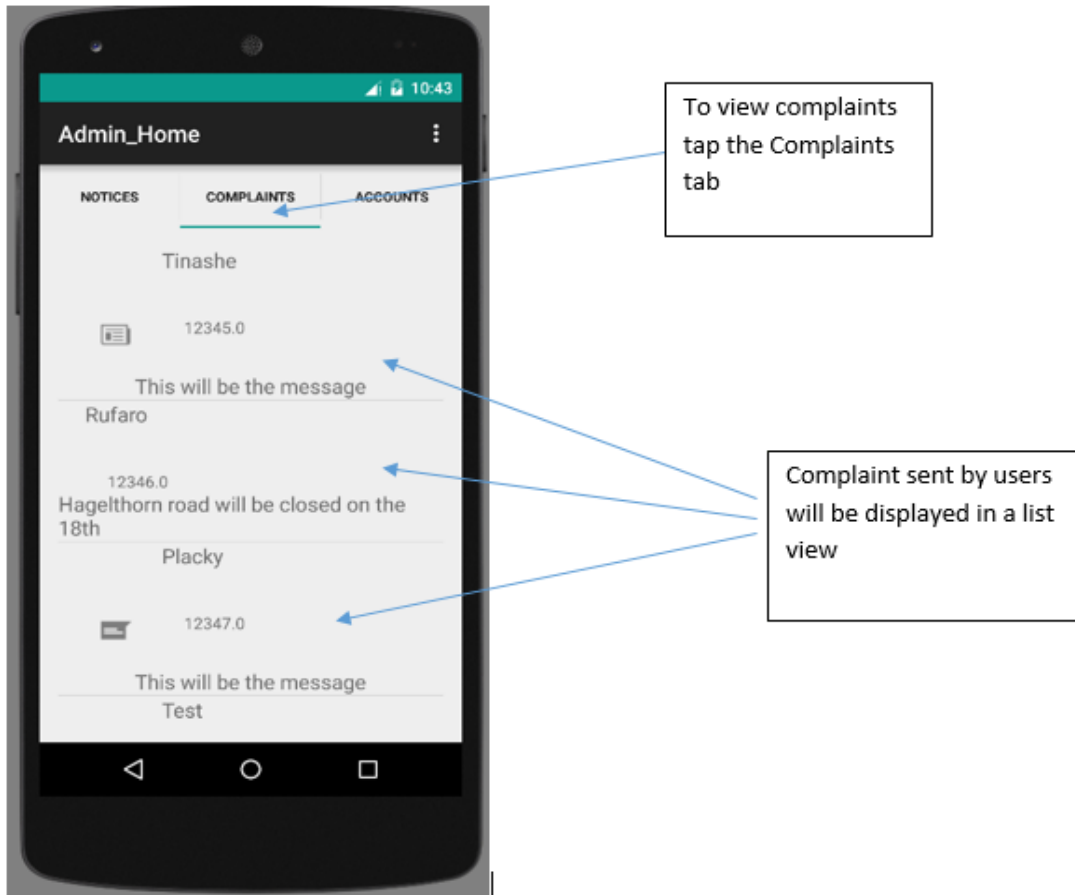


Fig A5 View Complaints

The administrator can view all complaints by tapping the complaints tab.

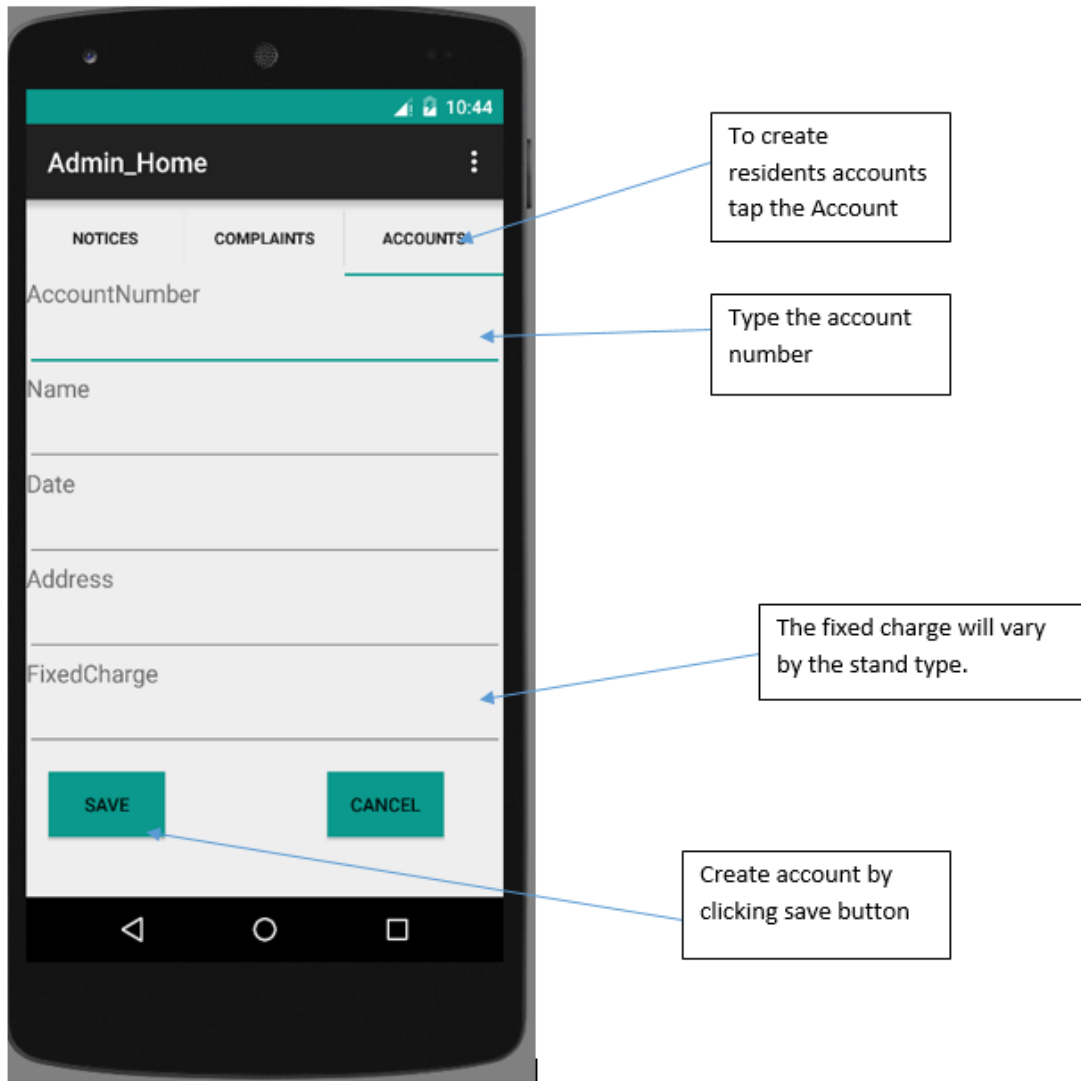


Fig A6 Accounts Creation.

Accounts are created by the administrator by tapping the accounts tab. Only users with account with council can enquire bills.

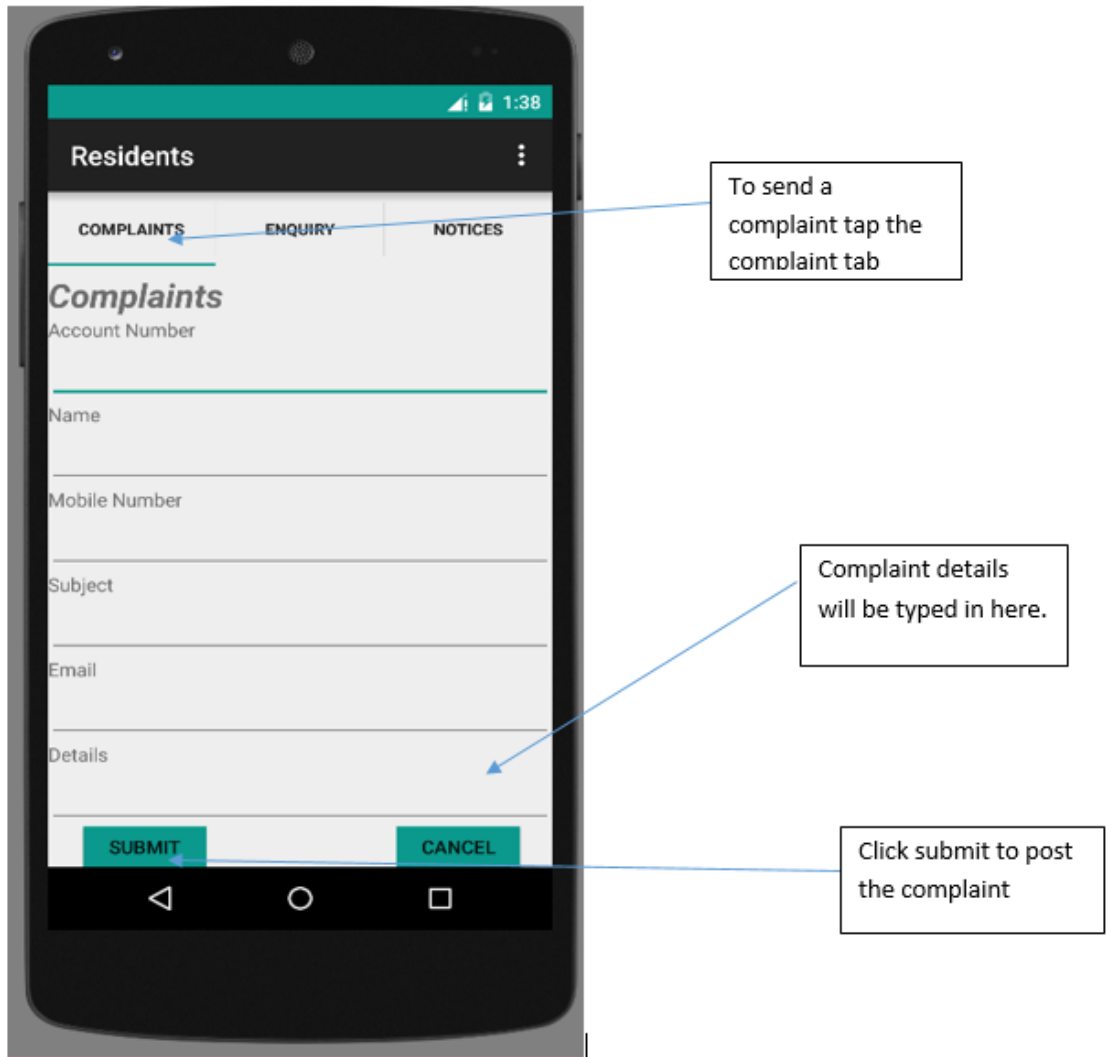


Fig A7 Complaints

Residents will be able to send complaints to the council via the application using the complaints page.

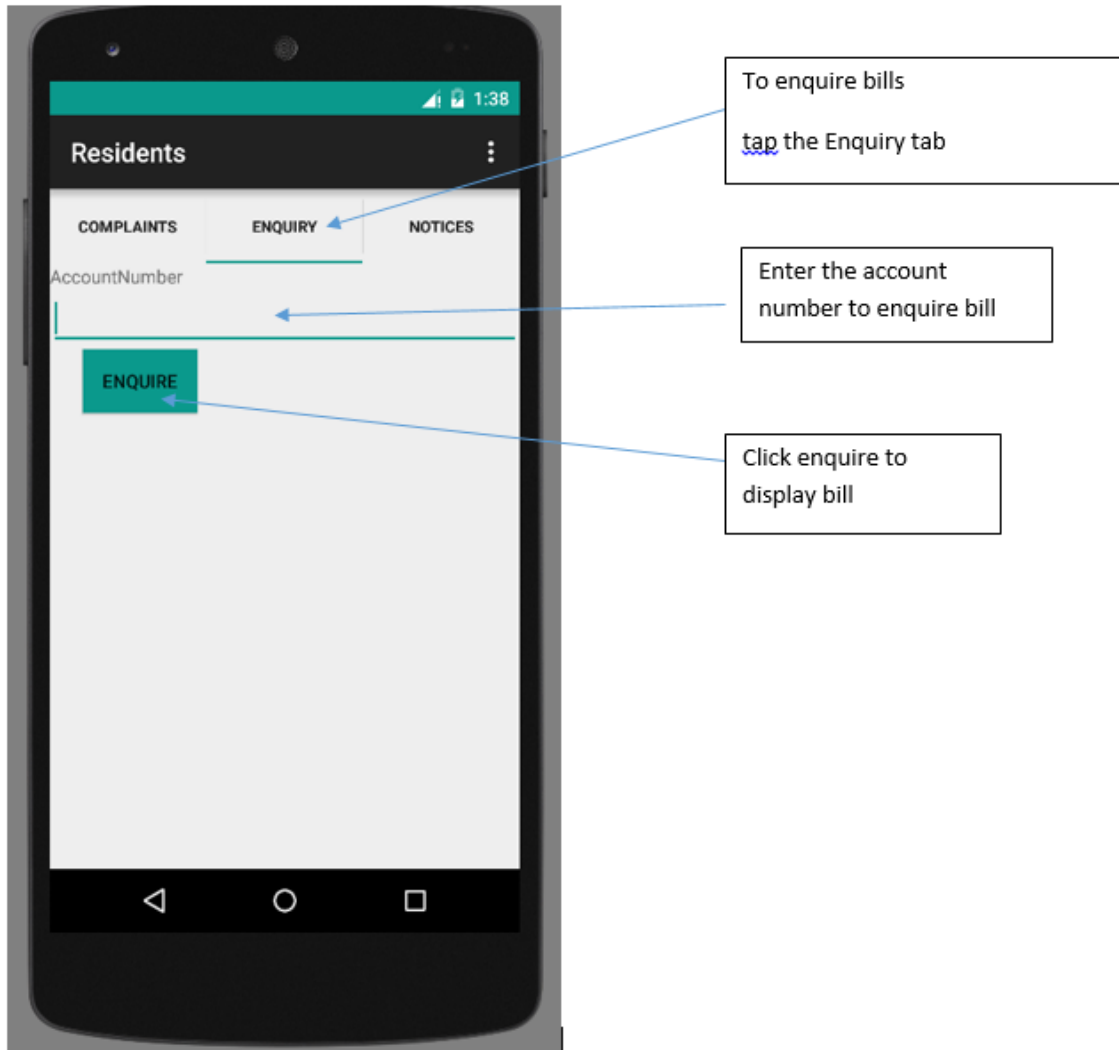


Fig A8 Bill enquiry

Residents can enquire bill by entering their account number the field marked account number.

Appendix B: Questionnaire Checklist

The following are questionnaires to the staff and residents of Beitbridge Town Council compiled by Tinashe Mugodo, fourth year student doing BSc Information Systems at Midlands State University.

Please note: Do not write your name on the questionnaire. Tick where applicable. The information gathered will remain private and confidential and will be used for academic purposes only. If you are a resident please fill in in the Residents Section below

Staff

1. How does the current meter reading system work?

.....
.....

2. Are you satisfied with the current manual meter reading system?

Yes No

3. If you ticked No on question 1 please give a brief explanation on the aspect which you are not satisfied with in the current system.

.....
.....
.....

4. Do you think migrating the manual system to an electronic system will solve problems you cited above?

Yes No

.....
.....
.....

5. What aspects do you think should be implemented in the proposed system?

.....
.....
.....

6. How do you rate the system performance on a scale of 1 – 5? 1 being the lowest score.

1 2 3 4 5

7. Are there any precautions in place to safeguard against unauthorized access to any data and information?

.....
.....

8. Are there any complaints from the residents as a result of the manual system currently available?

Yes No

.....
.....
.....

Appendix C: Interview Questions.

1) Please tell us about your current meter reading system?

.....
.....

2) How effective is your current system?

.....
.....

3) Are there any problems associated with current system which affect the operation of the organization?

.....
.....
.....

4) What other systems are used in-conjunction with the current system?

.....
.....

5) What problems are you facing as a result of the current system?

.....
.....
.....

6) What do you recommend to solve the problems associated with the current system?

.....
.....
.....
.....

Appendix D: Code snippet.

Login code

```
public void onLogin(View view){
    if(view.getId()==R.id.login){
        EditText user =(EditText)findViewById(R.id.userlogin);
        String userstr =user.getText().toString();
        EditText pass =(EditText)findViewById(R.id.loginpass);
        String passstr =pass.getText().toString();
        String password = helper.searchPass(userstr);
        if(passstr.equals(password)){
            Intent a = new Intent(MainActivity.this,Residents.class);
            user.setText("");
            pass.setText("");
            startActivity(a);
        }
        String passwordd = helper.searchPass2(userstr);
        if(passstr.equals(passwordd)){
            Intent b = new Intent(MainActivity.this,Billing.class);
            user.setText("");
            pass.setText("");
            startActivity(b);
        }
        String password3 = helper.searchPass3(userstr);
        if(passstr.equals(password3)){
            Intent c = new Intent(MainActivity.this,Admin_Home.class);
            user.setText("");
            pass.setText("");
            startActivity(c);
        }
    }
}
```

```

    }
    else{
        Toast logerror=Toast.makeText(MainActivity.this,"Wrong username and
password",Toast.LENGTH_SHORT);
        logerror.show();
    }
}}

public void onStop(){
    super.onStop();
}

public void onRegister(View v){
    if(v.getId()==R.id.register){
        Intent b = new Intent(MainActivity.this,Register.class);
        startActivity(b);
    }

}

}

```

Bill enquiry code

```
public void viewAll(){  
    btnenquire.setOnClickListener(  
        new View.OnClickListener() {  
            @Override  
  
            public void onClick(View v){  
                String filter = accountnumber.getText().toString();  
  
                List<Bills> searchBill = helper.getBill(filter);  
  
                ArrayAdapter<Bills> adapter = new ArrayAdapter<Bills>(Residents.this,  
android.R.layout.simple_list_item_1, searchBill);  
  
                myListView.setAdapter(adapter);  
            }  
        }  
    );  
}
```

Calculate Bill code

```
public void onbilling(View v) {  
  
    TextView accnumb = null;  
  
    double readingstr = 0;  
  
    double total = 0;  
  
    double billamnt1 = 0;  
  
    if (v.getId() == R.id.billing) {  
  
        double fixedcharge = 15.50;  
  
        EditText accnum = (EditText) findViewById(R.id.accountnum);  
  
        EditText reading = (EditText) findViewById(R.id.meterreading);  
  
        accnumb = (TextView) findViewById(R.id.textView31);  
  
        TextView billamnt = (TextView) findViewById(R.id.billamnt);  
  
        TextView fxdchrge = (TextView) findViewById(R.id.fixedcharge);  
  
        TextView total = (TextView) findViewById(R.id.total);  
  
  
        String accstr = accnum.getText().toString();  
  
        String readingstr1 = reading.getText().toString();  
  
        readingstr = Double.parseDouble(readingstr1);  
  
        billamnt1 = readingstr * 0.0025;  
  
        total = billamnt1 + fixedcharge;  
  
  
        accnumb.setText(accstr);  
  
    }  
}
```

```

        billamnt.setText(Double.toString(billamnt1));

        fxdchrge.setText("15.50");

        totall.setText(Double.toString(total))

    }

    if( v.getId()==R.id.save) {

        double fixedcharge = 15.50;

        EditText accnum = (EditText) findViewById(R.id.accountnum);

        String accstr = accnum.getText().toString();

        EditText reading = (EditText) findViewById(R.id.meterreading);

        accnumb = (TextView) findViewById(R.id.textView31);

        TextView billamnt = (TextView) findViewById(R.id.billamnt);

        TextView fxdchrge = (TextView) findViewById(R.id.fixedcharge);

        TextView totall = (TextView) findViewById(R.id.total);

        String readingstr1 = reading.getText().toString();

        readingstr = Double.parseDouble(readingstr1);

        billamnt1 = readingstr * 0.0025;

        total = billamnt1 + fixedcharge;

        accnumb.setText(accstr);

        billamnt.setText(Double.toString(billamnt1));

        fxdchrge.setText("15.50");

        totall.setText(Double.toString(total));

        Contact c = new Contact();

```

```
c.setBaccountnumber(accstr);

c.setReading(readingstr1);

c.setBilling_total(total);

helper.insertBill(c);

Intent b = new Intent(Billing.this, Billing.class);

Toast pa = Toast.makeText(Billing.this, "Bill saved sucessfully",
Toast.LENGTH_SHORT);

pa.show();

startActivity(b);
}
}
}
```