ZRP REAL TIME GEOGRAPHICAL MAPPING SYSTEM

FUNGAI ANDREYA

R123449F

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BY

FUNGAI ANDREYA

Submitted in partial fulfilment of the requirement of the degree of

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Department Of Computer Science and Information Systems in the

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Supervisor: MR T.TSOKOTA

ABSTRACT

The research project was centred on developing the ZRP Real Time geographic mapping System to address the issue of transit management in the organisation. With this understanding, the researcher concentrated on ways to improve transit management for ZRP staff to and from work. The system management to quickly view activities of their buses as well as ZRP staff to request bus locations and Estimated Times of arrival in real time. To have a detailed understanding: interviews were conducted; questionnaires were distributed; observations were also held. After the logical design of entities, classes, menus, the system was developed using VB.Net, SQL server and Android Java. The developer further recommends that the users stick to the basics learnt during the training period for any challenges they should refer to the comprehensive user manual. Security measures were considered through use of user names and passwords thus restricting access to certain privileges to some users. To cater for changes in user requirements system maintenance will be provided when the need arise.

DECLARATION

I, **Andreya Fungai,** hereby declare that I am the sole author of this thesis. I , authorize the **University Of Midlands State** to lend this thesis to other institutions or individuals for the purpose of scholarly research.

Signature..

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

APPROVAL

This dissertation thesis entitled "ZRP REAL TIME GEOGRAPHICAL MAPPING SYSTEM" by "Andreya Fungai" meets the regulations award governing the award of the degree of Information Systems of the Midlands State University, and it's approved for its contribution to knowledge and literal presentation.

Supervisor   MR. T. Tsokota

Date   ....

ACKNOWLEDGEMENTS

Dedication

"I dedicated this research project to my family who have supported me to pull through, all the way since the beginning of my studies. Finally, this work is dedicated to all those who believe in the richness of learning."

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LIST OF ACRONYMS

CID – Criminal Investigation Department

PPA – Payback Period Analysis

ROI – Return on Investment

RTGMS – Real Time Geographical Mapping System

ZRP – Zimbabwe Republic Police

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CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

This chapter presents the background to the research to be undertaken, the background of the Zimbabwe Republic Police (ZRP) as well as the clear statement of the research problem that has led to the undertaking of this study. Also discussed are the objectives, limitations, justification and methodologies and development tools to be used in undertaking this research study and coming up with the new system.

1.2 BACKGROUND

1.2.1 Background of the organisation

Immediately after independence, the Zimbabwe Republic Police [ZRP] was formed in 1980 with members coming from former colonial police that is British Southern African Police [B.S.A.P], the Zimbabwe African National Liberation Army [ZANLA] and the Zimbabwe People's Revolutionary Army [ZIPRA]. The force is organised by province, and comprises uniformed police, the Criminal Investigation Department [CID], and traffic police. To date, there are seventeen known provinces which are headed by a senior assistant Commissioners. It also includes specialist support units including the Police Support Unit, Police Internal Security and Intelligence unit, Police Protection Unit and canine unit etc. Overall command of the force is exercised by the Commissioner General of Police who is responsible for providing a dynamic and stimulating environment to improve operational performance of the organisation, identifying incompatible policies to organisational management; and the provision of alternatives and recommending appropriate technologies for use by the organisation to enhance crime management strategies

The force is also divided into sections that include the administration section, Criminal Investigation department, the technicians section, the sub-aqua section, the police protection unit section, the training unit, the transport section and the ICT section. Each section is led by a senior staff officer who reports to the Commissioner General of Police and all the sections pull in the same direction in formulating policies that enable the force to achieve its objectives.

The Zimbabwe Republic Police ICT section facilitates the development, implementation and maintenance of information systems that work to support core business and also supporting services such as transport and human resources. The ZRP Strategic Plan has been changed due

to the advent of ICT which are used on day to day basis of ZRP operations. This however is in support of ZRP's way of achieving its stated goals.

The ICT section has therefore been working closely together with the Transport section to ensure efficiency in the transit system through the use of IT gadgets and systems that ensure that officers get to work on time and can attend emergencies if called for. To commute to and from work, ZRP officers are transported by organisation buses and each officer has a designated pick up point. The buses have routes in which they go around residential areas picking up officers to work. The Police Protection Unit (PPU) whose task is to guard very special people for example ministers, is highly depended on the transport system to attend to their duties.

1.2.2 Vision

To achieve a crime free society with a stable political and economic environment

1.2.3 Mandate

The constitutional mandate of the ZRP as enshrined in section 93(1) of the Zimbabwe constitution provides that "there shall be a police force which together with such other bodies as may be established by the law for the purpose, shall have the function of preserving the internal security of and maintain law and order in Zimbabwe (ZRP.lnc,2015).
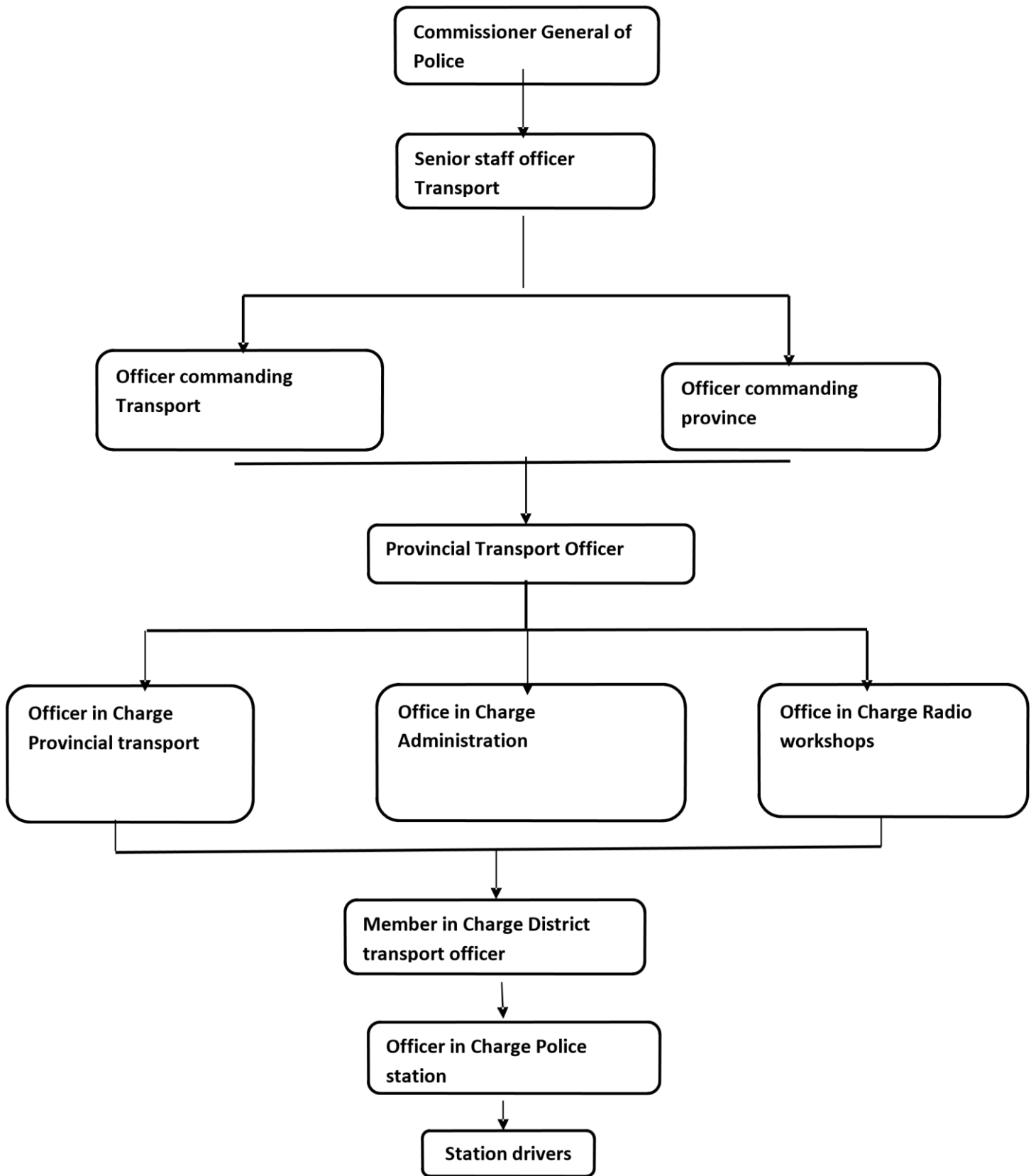
Figure 1.1 Organogram

1.3 PROBLEM DEFINITION

Lack of sufficient staff accommodation for ZRP officers in the Harare Metropolitan province has led to officers looking for accommodation elsewhere, thereby living all around Harare province. As a result, transporting these officers to work on a daily basis had becoming a problem since there has been poor communication between the drivers and the passengers.

The uncertainty inherent to the transit system combined with a lack of communication has led to disruptions on ZRP operations. A majority of ZRP officers, such as the Police Protection Unit (PPU) who must adhere to a strict schedule for buses or depend on them for emergencies.

The current transit system lacks proper and real time tracking of ZRP buses when picking up officers. In addition, the system lacks proper direct communication between bus drivers and the officers waiting at pick up points in times of breakdowns, delays and other deviations of schedules of arrivals at pick up points. The current system cannot update officers about Estimated Time of Arrival (ETA) at pick up points. The current system cannot monitor or detect misuse of the force's buses for personal trips.

Because of lack of proper real time communication between the bus and officers, even if a bus is running exactly on schedule, officers and other staff have no easy way of knowing that information and those that have alternative modes of transportation will be less likely to ride the bus regardless of its actual timeliness.

Therefore, the problem addressed in this research is that ZRP has no real time geographical positioning system to monitor bus activities and communicate with officers at pick up points in real time about bus arrival times

The mentioned problem can therefore be addressed by developing a Real Time Geographical Mapping system for ZRP using modern communication devices, that allows real time tracking and automated communication about estimated times of arrival with officers at Pick up Points

1.4 AIM OF THE RESEARCH

The research's aim is to develop a system that utilizes modern, publically available technologies to provide ZRP bus users with accurate, real-time information about the arrival times of buses nationwide through the use of an android application.

The system will therefore consist of:

> - **An Android app** -The Android app's primary purpose is to facilitate the communication of the device's precise geographical location using the phone's Global Position Systems (GPS).This location is then used in calculations performed by the web server.

> - **A web server** - The web server is in charge of keeping track of the bus GPS information, performing the calculations to estimate arrival times, and hosting the website that displays this information to the user.

1.5 OBJECTIVES OF THE STUDY

The objectives of this research include:

> - To develop a GPS tracking system that uses the bus's positional data and allows monitoring of bus movements by management using maps.

> - To develop a system that allows officers at pick up points to pin point the bus' location in real time.

> - To develop a system that uses routing information to calculate estimated arrival times (ETA) at each pick up point for officers.

> - To develop a system that calculates the speed of the bus and triggers an alarm to the web server if maximum speed of 80km/hr. speed allowed is surpassed.

> - To design and implement a system that allow frequent bus user to monthly rate bus schedule timeliness and speed conformance

> - To develop a system that allows the bus driver to raise an alarm in cases of emergency, accident or breakdown management and frequent bus users.

1.6 METHODOLOGY

Different fact finding techniques will be implemented to gather information about the weaknesses and opportunities of the current system for the system designers to consider them in the proposed system. To obtain consistent, complete, feasible, accurate, traceable and verifiable facts the company investigation team (panel) embarks on the following fact finding techniques Kendall and Kendall (2005).

1.6.1 Instruments

- ➤ **Interviews** - Face-to-face interviewing will be carried out at the work place and some of the pickup points, by so that all weaknesses of the existing system will be catered for in the proposed system.

- ➤ **Questionnaires** - A special purpose document called questionnaire will be used by the Analyst as a guide in the collection of the required information. Various stakeholders who are directly and indirectly involved in consultations processing will be requested to fill in the questionnaire forms, which will be designed in a brief and user-friendly manner which will ensure anonymity and no evaluation of the source of reference.

- ➤ **Observations** –visits will be made to pick up points to investigate on the adherence of the bus to the schedule. The information collected through observations will be enough that the system designers will manage to simulate the data collected for better presentation. Abstract models will be designed to guide the designers on how to work on the system, which will meet the requirements expected.

1.6.2 Hypothesis

- ➤ **Android SDK / Java-**Android is an open source operating system for mobile devices developed by Google. One of the key features of Android is its ability to extend the functionality of devices through new applications (or apps).
- ➤ **Java -** the developer chose to write this code in Java, which I needed to use for the Android components of the system
- ➤ **MySQL-** MySQL is an open-source database management system that is licensed for free under the terms of the GNU General Public License. Because of its open license,

MySQL is one of the most popular database management systems for both commercial and personal use.

➤ **Google Maps API -** According to its website, the Google Maps API is "a free service that lets you embed Google Maps in your freely accessible web pages or mobile apps". The Application Programming Interface [API] allows developers to quickly access information provided by Google without having to manually go to the site and deal with the user interface.

1.7 LIMITATIONS OF THE STUDY

➤ As a student, I have no access to a hosting site due to lack of funds, therefore to overcome this constraint, the developer used a local offline database server that is hosted on a laptop and uploads the coordinates through a local area connection using Wi-Fi Hotspot Tethering.

➤ The project also requires a considerable amount of money for data collection, purchase of the needed devices and the expenses such as printing and postage for it to succeed well and this may pose a problem. In addition, the other constraint foreseen is the time it will take to plan, find instruments to collect data, analysing the data and all the other processes necessary to make and implement the whole project so that it becomes a success

1.8 JUSTIFICATION AND RATIONALE FOR THE STUDY

Having an efficient bus monitoring and management system enables ZRP transport section to have greater control over their buses. They can use the system to monitor the activities and timeliness of their drivers and to determine which driver or vehicle should respond to a service call, provide a delivery service and more. This ultimately can help the Force to function more efficiently.

A real time geographical mapping and monitoring system can also promote better organization within ZRP. The system can help the transport management section to control work schedules and hours and balance workloads between drivers.

An effective GPS tracking system can also be used to decrease fuel costs by finding the most efficient route that minimises costs and making sure that drivers to adhere to that route always.

Through the system, ZRP fleet supervisors can also monitor the behaviour of their drivers. They can use the system to learn how quickly they speed from one location to the next or if they tend to take their time and move more slowly than they should.

1.9 CONCLUSION

Having discussed the background of the ZRP, the problem definition, objectives and aim as well as justification for undertaking the research in this chapter, the methodologies, instruments to be used as well as the hypothesis have been discussed. The next phase chapter 2: Planning Phase explores planning, research and feasibility study of the proposed system will be analysed.

CHAPTER TWO PLANNING PHASE

2.1 INTRODUCTION

Planning Phase involves feasibility analysis, risk analysis, business value of the system and work plan. Planning is mapping the way forward (Kendall and Kendall, 2005).Planning spells out how practical the system is. This is achieved by carrying out a feasibility study. Feasibility analysis focuses on viability of the project through studying the economic, social and technical viabilities. It is at this phase that justification of developing ZRP Real Time Geographical Mapping System [RTGMS] is reviewed.

2.2 BUSINESS VALUE

It is the sum total of elements that determine the health and wellbeing of an organisation in the long run (Sliger and Stacie, 2008).All the gains realised from development of RTGMS make up the business value.

➢ Risk Analysis

It is the identification of condition, events, or situations that may affect the system negatively. In other words risk analysis constitutes identification of elements that may led to system flaw (Bentley, 2004).

➢ Feasibility Study

Is an activity targeted at analysing the viability of an idea. The question that feasibility study thrives to answer is should we proceed with the project or not (Sliger and Stacie, 2008).In order to simplifier feasibility study; it is divided into four categories namely:

- Economic feasibility
- Technical feasibility
- Operational feasibility and
- Social feasibility

Feasibility study also includes ascertation of benefits from the system. If benefits out way the cost incurred in development of the system then the system is viable otherwise it's not.

➢ **Work Plan**

A comprehensive schedule of the activities to be carried out in the system development process given that the system has been given the green light to proceed

2.2.1 Identification of Business Value

The system is expected to help the organization in providing an organised, secure and reliable transit system for ZRP officers. Efficiency in the use of the Force's buses will be improved as well as reducing uncertainty to officers. Fuel costs are expected to be kept at a minimum due to an organised way of picking up officers to work. We also appraise the worthiness of the whole project on the overall business objective by trying to answer the question; what business value will be added by implementing the system.

2.3 FEASIBILITY STUDY

Feasibility studies refers to the initial investigations into the benefits potentially associated with undertaking a project (Kendall and Kendall, 2002). Feasibility study is done to consider all factors associated with the project, and critically analyse if the project is worth an investment of time and other resources and whether it will yield a desirable result. One of the most vital aspects of the study is to make sure that the total investment needed to successfully bring the project to completion is considered and usually, this include addressing components such as cash reserves, labour availability and cost, outsourcing, and the cost of raw materials. The success of the feasibility study results in the project progressing to the next level.

2.3.1 Technical Feasibility

According to Kendall and Kendall (2002), technical feasibility takes into consideration the following issues:

- The availability of the required technology to carry out the research
- The availability of the required resources -

- Manpower- programmers, testers & debuggers
- Software and hardware

2.3.2 Operational Feasibility

According to Kendall (2005) operational feasibility can be defined as the study that assesses the reality about the various stakeholders of the research regarding their support for the proposed system. The management team of ZRP fully support the idea of having a Bus Management System in place to improve the efficiency of the transit System. In addition all the ZRP staff approached seem to be supporting the research too since it will enable better communication, however, it has been identified that some of the end users have a sense of fear of the unknown and are therefore sceptical about the system and therefore the developer took time to explain and make the users understand the need for the new system. At this stage of feasibility, end user and management support has proved to be very important

Taking into consideration the above mentioned situation at Zimbabwe Republic Police in relation to the proposed situation, a conclusion that the system is operationally feasible can be therefore drawn since a majority of the system stakeholders completely support its development.

2.3.3 Economic Feasibility

According to Lucey (2002), economic feasibility can be defined as study that is carried out so as to determine whether the proposed research can be carried out up to its completion given the available finances taking into account the anticipated benefits to be accrued from the suggested system against the estimated costs of maintenance and development of the proposed system. The whole process of economic feasibility is therefore summarised by the comparison of benefits versus costs taking into account opportunity cost. A project is therefore said to be feasible economically or worth undertaking if the benefits expected, financially are greater than the costs estimated.

2.3.3.1 Cost-Benefit Analysis

Cost-Benefit analysis is the comparison between costs anticipated and the benefits to be expected. The benefits involved under this development include:

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- ➢ Cost Savings
- ➢ Cost Avoidance
- ➢ Improved Information

This analysis is mainly done to assess the worthiness of undertaking a project and therefore give a enable comparison with other proposals so as for management to make informed decisions about projects and they are estimated in monetary terms either considering or not considering the time value of money.

Cost Saving Benefits – refers to all the benefits that actually lead to the reduction of administration and operational costs.

Cost Avoidance Benefits – refers to those benefits that ultimately lead to the suppression of prospect costs of administration and all operations.

Improved Information Benefits – these are the benefits which are accrued from the proposed system. Generally, taking an example of the adhoc reports which are well summarized and having diagrams and graphs enable better decision making for. The costs and benefits are generally categorized in the following manner:
- ✓ Tangible or Intangible
- ✓ Fixed or Variable
- ✓ Direct or Indirect

Tangible

Tangible costs or benefits are those costs or benefits that can be touched physically, seen, or felt. A tangible costs example can be the money paid for labour and a benefit can be the profits and cost cuts in fuel. Such benefits and costs can be easily calculated and approximated using known formulas.

Intangible

These refer to those costs or benefits that cannot be felt, touched or seen. Their value can be very difficult to calculate or approximate and a good example would be Goodwill or Negative Goodwill.

Direct

These are costs or benefits that can be directly attributed to the project (Lucey, 2002). A good example of such are costs such as working hours for developers.

Indirect

The Indirect costs or benefits have cannot be directly attributed to the project research in question. These costs are not incurred directly, such as heating, lighting and rent for offices.

Variable and Fixed

Fixed costs are costs that do not vary directly with production, they remain constant or fixed. A good example would be that of rent for offices, or employees' salaries

Variable costs are such costs that vary with level of production. As production numbers go high, they also go high and vice versa. For example costs for purchasing computers and networking material.

Table 1: Development Costs.

Development Cost	Year 1	Year 2	Year 3	Year 4
Computers	1750	0	0	0
Printer	150	0	0	0
Ethernet Cables and RJ 45 Connectors	250	0	0	0
Servers	2100	0	0	0
Total	**3750**	**0**	**0**	**0**

Table 2: Operating Costs

Operating Cost	Year 1	Year 2	Year 3	Year 4
Hardware Maintenances	0	300	300	250
Software Maintenances	0	150	150	200
Training Costs	450	0	0	0
Total	**450**	**450**	**450**	**450**

Table 3 Cost / Benefit Analysis. Tangible

Cost / Benefits	Year 1	Year 2	Year 3	Year 4
Tangible Benefits				
Reduced Paper Work	400	430	445	490
Reduced Operating Costs	415	456	470	470
Reduced Clerical Staff	3600	3600	3600	3600
Computation Accuracy	400	500	700	765

Table 4 Cost / Benefit Analysis. Intangible

Cost / Benefits	Year 1	Year 2	Year 3	Year 4
Intangible Benefits				
Increase in staff morale	300	305	340	350
Improved service level	200	243	260	260
Improved report generation	180	210	242	250
Security Enhancement	120	200	250	300
Goodwill	100	130	170	340
Total Benefits	**5715**	**5831**	**6477**	**6825**

Table 5 Cost / Benefit Analysis. Net

Costs	Year 1	Year 2	Year 3	Year 4
Operational	450	450	450	450
Development	0	150	150	0
Total	4200	450	450	450
Net Benefit or Cost	1515	5381	6027	6375

2.3.3.2 Net Present Value (NPV)

According to Randall (2001), Net Present Value is the actual value of money relative to today's value. Net Present Value considers the changing value of money over time. This is estimated using discount rates, interest rate and targeted rate of return The formula to calculate NPV is as below:

Net Present Value = Value in year n where n=number of years and r=discount rate

Value in year t / (1+r) ^n

Using a 10% discount rate

$$= (1515/(1+0.1)^0 + 5381/(1+0.1)^1 + 6027/(1+0.1)^2 + 6375/(1+0.1)^3$$
$$=1515+4892+4981+4790$$
=16178

The positive NPV clearly shows that the project is economically feasible and should be undertaken.

2.3.3.3 Return on Investment (ROI)

Branson (2009), define the return on investment as the financial benefit expected to be returned after investing or committing financial resources to a project. It is calculated through the division of the net profit by the total investment. A project that returns a high percentage of ROI is worth undertaking as it shows a high probability of success.

The formula to calculate the Return on Investment is as below:

Return On Investment = Average Annual Profit/Total Investment) * 100

$$= \frac{4824.5}{5550} \times 100\%$$

$$=\underline{\mathbf{86.928\%}}$$

In this case the ROI is favourable meaning that the project is worth undertaking. The advantage of using Return on Investment is that it is easy to calculate and doesn't take much time when calculating. However, ROI doesn't take into account the time value of money and hence does not take inflation into account thereby it may be misleading sometimes.

Now in conclusion, considering the above situations and results from calculations pertaining development and implementation of the Vehicle fleet Management System, and having ventured into economic, technical and operational feasibility studies, it gives a clear picture that it is wise to undertake the system development since it is wholly financially profitable and considering the fact that some or even most to be precise, of the technical resources are currently present and mostly, the end users are in full support of the system implementation as well as the management hence making the system a viable one.

2.4 RISK ANALYSIS

Risk analysis refers to the critical analysis of all the possible risks or constraints associated with undertaking a project. It is done so as to enhance decision making on which project to undertake and which one to dump as well as helping in developing of contingency and containment plans in case the worst happens. Risk analysis is an ongoing process, new risks are identified and

assessed continually results in the continuous assessment of contingency and containment plans (Pressman, 2005). In order to manage risks, the researcher should follow the following steps:

✓ Identify all the potential risks
✓ Risk analysis and classification
✓ Development of a risk alleviation plan
✓ Risk control and tracking

2.4.1 Economic Risks

✓ The Zimbabwean economy is highly unpredictable and therefore no one knows what may happen tomorrow, this therefore makes all the estimated returns, benefits or costs unpredictable.

2.4.2 Technical Risks

✓ User requirements are ever changing, today's requirements may be different from tomorrows. This therefore makes it difficult for the researcher as one has to continually ask and research, updating user requirements and making necessary changes
✓ Not all ZRP staff have android phones, nor the data required to connect, therefore the system may fail to address their problems resulting in resistance to implementation

2.4.3 General Risks

✓ The risk of virus or malware on computers, servers and phones is in-eradicable. Even though the computers will have antivirus software installed, guarding against viruses is difficult and it is almost impossible to be 100% safe from computer malware.

2.5 PROJECT WORK PLAN AND TIMING

Table 6 Project Work Plan

ACTIVITY	START DATE	COMPLETION DATE	DURATION (Weeks)
Project Proposal	24.12.2014	15.01.2014	3

Planning and Phase	16.01.2014	30.01.2014	2
Analysis Phase	31.01.2014	14.02.2015	2
Design Phase	15.02.2015	05.03.2015	3
Implementation	06.03.2015	20.03.2015	2
Maintenance	21.03.2015	15.04.2015	2
Documentation	24.12.2015	15.04.2015	15

GANTT CHART

Table 7 Gantt chart

ACTIVITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROPOSAL	█	█	█												
PLANNING				█	█										
ANALYSIS						█	█								
DESIGN								█	█	█					
MPLEMENTATION											█	█			
MAINTENANCE													█	█	
DOCUMENTATION	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█

Analysis of Work Plan

The results of time frames shown on the Gantt chart and work plan table are estimates. It is important to note that development of the system may take more or less time that the expected and shown above due to changes in user requirements changes, availability of resources and other factors affecting project progress that may be or may not be in the control of the developer.

2.6 CONCLUSION

Having discussed the feasibility, risk and work plan of the research, to conclude, evidence from the figures and facts outlined show that the project is highly feasible and worth undertaking. Having positive Net Present Value and a high return on investment shows how the project is expected to perform. Focus is now on the analysis of the existing system used by ZRP which will be discussed in the next chapter: the analysis phase.

CHAPTER THREE ANALYSIS PHASE

3.1 INTRODUCTION

The purpose of this chapter is to obtain a thorough and detailed understanding of ZRP need as defined in the first chapter and captured in the second chapter, and to break it down into distinct requirements and finally clearly defining them. In this chapter that involves the system requirements analysis process, where the framework for the proposed system is developed and clearly outlined, thus building foundation for development and design efforts and also creating a detailed functional specification document that defines all the system capabilities to be implemented, as well as the accompanying data and process models that illustrate the processes to be supported and the information to be managed by the proposed system. Data and process analysis will be done shown by Data Flow diagrams and Context Diagrams

According to Kendall and Kendall (2005), analysis is a problem solving technique that involves breaking down a system into its pieces to study and analyse the performance of the modules and sub modules in accomplishing the system goals
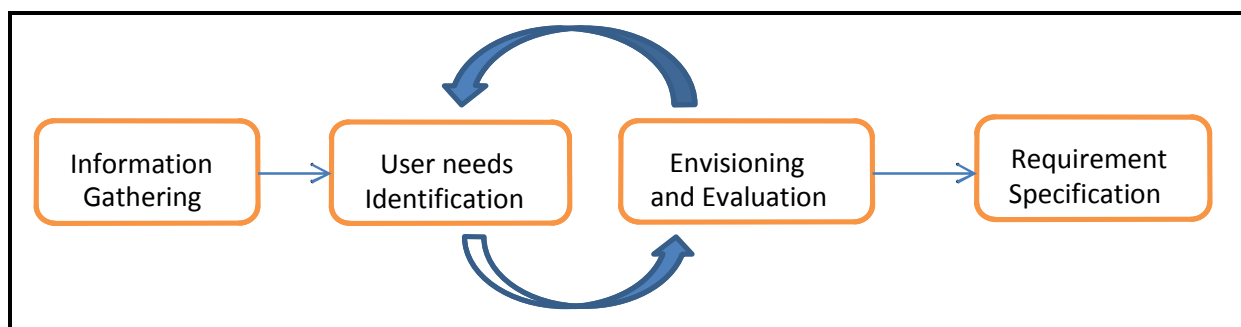
Figure 3.1 General Process

3.2 INFORMATION GATHERING METHODOLOGIES

Information gathering methodologies can be defined as procedures that are followed in gathering and collecting all relevant data to the research so as to obtain data to be used in developing the system (Edwards, 1993).

Kendall and Kendall (2005) asserts for a project to be called a success, the Information system developed should be able to satisfy the requirements that gave rise to its advent, otherwise the whole project would be a failure. Therefore this shows how critical user data and requirements are to the success of the project. Therefore there is need to set up effective methods and procedures to collect relevant data that is credible and reflect the true view and need of the end users. The main purpose information gathering is to determine all the information requirements of users so as to satisfy them. In most cases information requirements about a system are not stated by management. It is the analyst's responsibility to prepare a precise system requirements specifications (SRS), which is easily understood by users, since it is a vital document before starting a project and also it will be used throughout the project up to completion.

Figure 3.2 Information Gathering Process.

The following methodologies were used for data collection which was used for the design and development of ZRP Fleet Manager:

- ➢ Observations
- ➢ Questionnaires

> ➢ Interviews

3.2.1 Observation

Sommervile (2007) defines an observation as a method that qualitative provides descriptive sets of information about what happens in an activity or event, including the environment or context, activities, processes, and discussions. Critical observ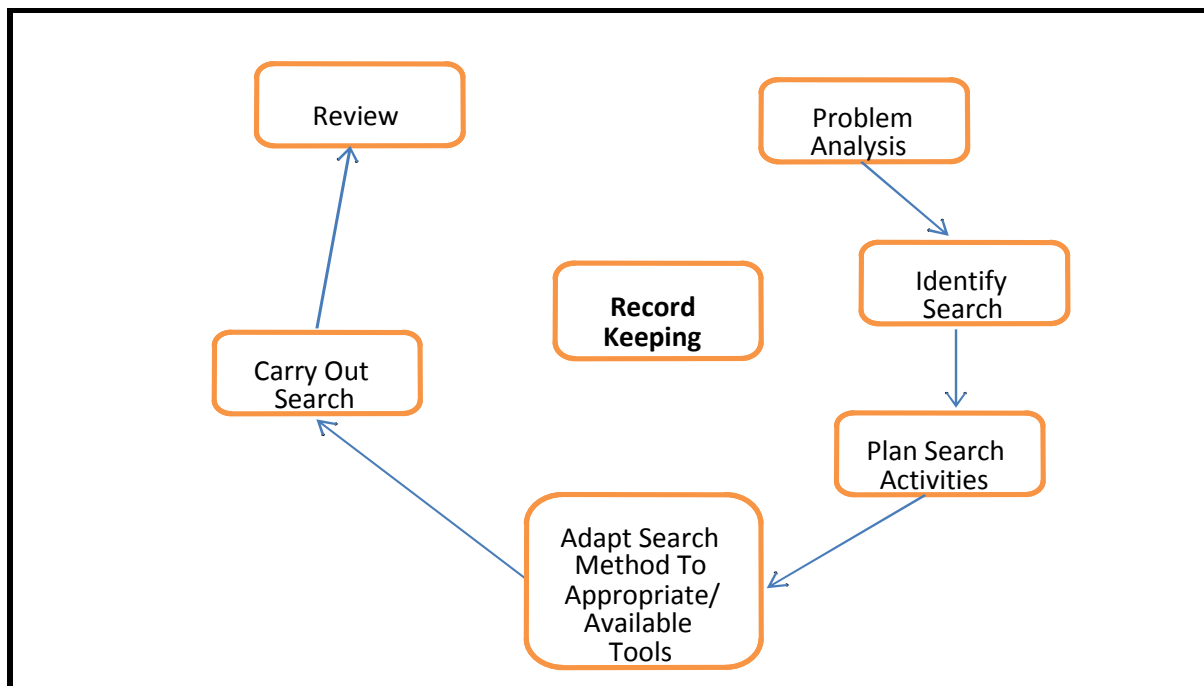ing and listening are the two most important keys to observation. Observation involves documenting activities, behaviours and physical aspects as they happen in the actual working environment without having to depend upon people's willingness to respond to questions. Observation takes the developer or research to as close to the system as possible. After watching, following and recording activities as they are performed, the researcher is therefore expected to then interpret those observations and draw conclusions regarding them. It is the best way to obtain actual system behaviour. Observations can be classified as participant and non-participant.

Participant observation involves the developer being involved and participating actively for an extended period of time. Because of their nature, participant observations may require the observer to live or work in that area and also may require the observer to make himself or herself party of the group. Observations were done through the developer visiting some of the pick-up points for the bus, taking not of time of arrival of the bus as well as travelling speed and staff complains and recording data after the activities.

On the other hand, non-participant observation assumes that the observer is an eavesdropper; that is the observer attempts to observe people without interacting with them and also without their knowledge that they are being observed. The researcher would sometimes visit pick up points and watch from a distance recording data

3.2.1.1 Advantages

> ➢ Allows the observer to view what users actually do in context and may discover unnoticed processes as it involves observing the processes without interfering with the users operations such as interviewing the users which may at times call for the user to stop working as the user tries to explain the processes.

> Observations allow for data collection in real time, that is, activities are observed and recorded as they happen. This is so because first- hand information is collected from the site of operations. Observation is characterized by collecting data observed during actual operation.

> Observation removed the bias and reliance on the observant's willingness to provide information as the technique involves collection of data without interfering with the users, only observed data is collected whether the users are willing or not willing. Users provide information unknowingly as information is collected by observing the users work.

> Observation enables insight to the researcher to view things from a different angle than that of program participants and staff as interviews and questionnaires are biased towards what the responded wants to be believed observation provides for information on what actually transpires on the ground.

3.2.1.2 Disadvantages

> Relatively time consuming to perform as it involves observing and learning which require time to achieve since learning is a process which on its own takes some time.

> Susceptible to observer bias. The observer concludes according to personal judgement of what is observed hence the result is biased towards observer's way of thinking.

> Hawthorne effect – the tendency that makes people perform better when they know they are being watched or observed. Normally people tend to stage performance when they are under surveillance such that the way the users would perform during observation is different from the way they would perform without being observed.

> There is need for further interviews or questionnaires to help explain and Understand why people behave the way they do. Otherwise, observations alone may be misleading

- With participant observation, a skilled facilitator is needed to help participants present a critical evaluation and this may prove to be costly to implement.

3.2.1.3 Findings

Participant observation was mostly used by the researcher since the researcher is one of the officers of the ZRP that also requires ZRP provided transport to get to work, to make sure that quality information was obtained, the researcher moved from one pick up point to the other, observing arrival times and consistence on the bus schedule as well as reaction of officers to bus schedules.

The following conclusions were then drawn from observation

- The time schedule for the bus arrival is not consistent, sometimes it is early than expected, sometimes it is very late and no communication is done with officers at pick up points about bus delays

- Some of the officers end up using alternative transport to go to work when the bus is late

- Some officers no longer use the bus anymore, due to its unreliability

3.2.2 Questionnaires

As a data gathering technique, analysts use questionnaires to study what people were made to believe as truth about a system (beliefs), what people do and how they do it (behaviour), what users want in a system (attitudes) as well as properties of targeted people (characteristics) of the people who may be affected by the current or proposed system (Kendall and Kendall, 2005). Questionnaires are often used to quantify and complement the data obtained from interviews and observations.

The responses from the ZRP staff from the questionnaires distributed were analysed and sample of this is attached to the Appendix Section.

3.2.2.1 Advantages

- Questionnaires give ZRP officers time to evaluate responses before writing them down and submitting, an officer may choose to respond to the questionnaire when they are less busy, thus helping improve the quality of information obtained.

- Questionnaires guarantee confidentiality and anonymity of officers, therefore an officer feels free to express his or her views about the current system Bus Transit system.

- Using questionnaires proved to be a fast and cheap way of obtaining relevant system data since questionnaires were printed and distributed to many officers and regular bus users at a low cost.

3.2.2.2 Disadvantages

- Some of the respondents did not answer questions well and mentioned that they needed clarification on some of the questions thus therefore reducing the quality of data obtain from the sample survey

- Some of the ZRP officers allocated questionnaires did not return them, some returned with poorly answered questions, hence making it hard for the researcher to come up with concrete conclusions.

- Last but not least, questionnaires can hardly express respondents feelings, attitude and behaviours, therefore using them alone may be misleading, as the need support of interviews and observation

3.2.2.3 Findings from questionnaires

After distribution, the questionnaires that were returned by ZRP officers and management were collected, analysed and assessed and conclusions were drawn. The sample of the questionnaire is attached to the Appendix Section.

The following conclusions were drawn from the questionnaires returned:

- About a quarter of the sample had stopped using the bus for coming to work due to its inconsistent schedule as well as lack of proper communication.
- At least once a week, officers that use the bus reported late for work due to delays by the bus

3.2.3 Interviews

Somerville (2007) defines it as "a purposeful conversation in which one person asks prepared questions (interviewer) and another answers them (respondent)" Interviews can be either structured or unstructured. Open-ended or unstructured interviews are informal in nature as the interviewer doesn't need to ask the questions in their order, thereby making sure that the interviewee remains comfortable and free.

Structured interviews follow a defined order and often are answered by "Yes" or "Answers", they are prepare along with the possible answers expected, the interviewee can only chose the best answer from the ones given. There is limited room for flexibility for the interviewee, due to the fixed question order. Each person is given the same questions therefore being uniform in nature.

A number of ZRP staff were interviewed, using both the structured way and the unstructured way. Selection of interviewees was carefully done, taking into consideration those that still use the bus, those that have abandoned the system, the bus drivers, work supervisors and the management

3.2.3.1 Advantages of interviews

- Unstructured interviews enable the interviewer to obtain rich details and new insights in areas not previously considered.

- Interviews enable the interviewer to ask for clarification on an answer, in the same way they allow the interviewee to ask for clarification on a question.

- They are useful to obtain from users detailed information regarding personal feelings, perceptions and opinions about the current system as well as needs and requirements

3.2.3.2 Disadvantages of interviews

➢ Open-ended interviews may require an outside evaluator for assistance with methods and analysis.

➢ Interviews may prove to be very time-consuming in setting them up, interviewing, and analysing as well as feedback and reporting

➢ Some interviewees could just answer some questions without much thought, so that they get done with it.

➢ Feelings, emotions and perceptions are important but in some cases they proved to be excessive and some of the interviewees had anger management issues.

3.2.3.3 Findings from interviews

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The following conclusions were drawn from interviews

➢ Supervisors confirmed that their subordinates sometimes report late for work putting the blame on the bus delay

➢ The drivers disclosed that they had no formalized way of communicating with officers at pick up points about delays caused by congestions and breakdown

➢ The management disclosed that there lacked a way to remotely monitor bus and driver activities

➢ The officers confirmed on bus delays and lack of communication leading to late for work

3.3 ANALYSIS OF THE EXISTING SYSTEM

ZRP is currently using a log book system to manage and keep record of its bus activities. Each and every bus owns its copy of the book in which every driver enters his or her name, journey details like route, time of departure, time of arrival, initial mileage, and the total number of mileage after each trip This document is completed by the driver every day in the morning before he or she leaves the premises to pick up officers and after he or she has completed the route, and in the evening before leaving for dropping officers and after dropping them

All the officers to be picked up are given time schedules of the approximate time the bus is expected to arrive at each pick up point and the route information of how the bus will travel. However the time schedules are fixed and are not updated in cases of delays and breakdowns

The fleet officer combines all registered pick up points and drafts a route for the bus. When given a pick up point, he or checks on whether the point has already been registered or not in the system.

At the end of every month the log book is compiled by the transport department to analyse the use and possible condition of that bus and again that log book can be used also to launch investigations concerning probable vehicle misuse such as personal use of the buses and fuel. Experience has proved that most drivers may use company buses for personal gain and business like public transportation and stealing fuel from the company pumps in the name of a vehicle only to later on divert the resource.

However the success of this logging system sorely depends on the integrity the drivers to take care of the log book. Mostly the log books of several buses went missing and others were recorded wrong or incomplete information thus giving the management a hard time in assessing reports. This would results in loss of years of valuable data which can hardly be recovered and this encourage fraudulent activities by drivers

3.4 PROCESS ANALYSIS

Process analysis can be defined as the breakdown of the phases of a process, used to show the inputs, outputs, and processes that take place during each phase (Kendall and Kendall, 2002). This approach of process analysis can be useful in improving the detailed understanding of how the process connect with entities and data stores, and to determine potential targets for process improvement through removing waste and increasing efficiency.

Process analysis can also be used by management at ZRP in improving the performance business activities. It can be a milestone in continuous improvement. The process boundaries

are defined by the entry and exit points of inputs and outputs of the process. The inputs, outputs and process activities of the old system are shown in the table below:

Table 8 Input, output and process activities of the old system.

INPUTS	PROCESSES	OUTPUTS
➢ Route details e.g. pick up points and total distance. ➢ Fuel details i.e. amount of fuel needed for each trip. ➢ Driver's details e.g. Names and signature. ➢ Bus details	➢ Entering data ➢ Analysing data for investigation purposes ➢ Offline monitoring	➢ Reports

3.5 DATA ANALYSIS

"Data analysis is a body of methods that help to describe facts, detect patterns, develop explanations, and test hypotheses."- Somerville (2007)

3.5.1 Context diagram

The Context Diagram is the diagrammatic representation of the system under consideration as a high-level process and then shows the relationship that the system has with other external entities (log book, drivers and officer, managers).
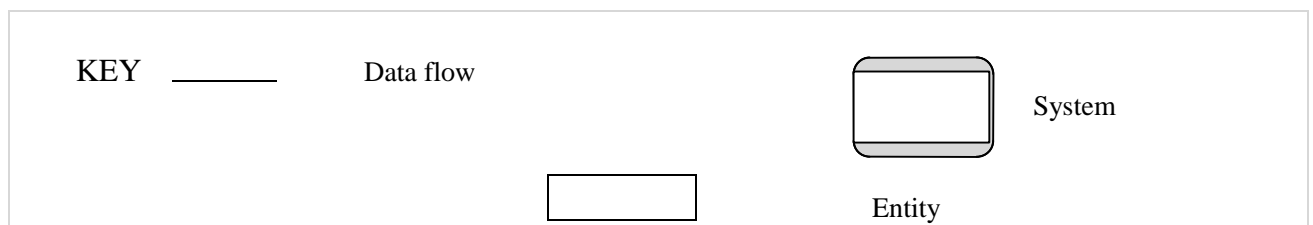
KEY ───── Data flow

System

Entity

Figure 3.1 Key for Context diagram of existing system
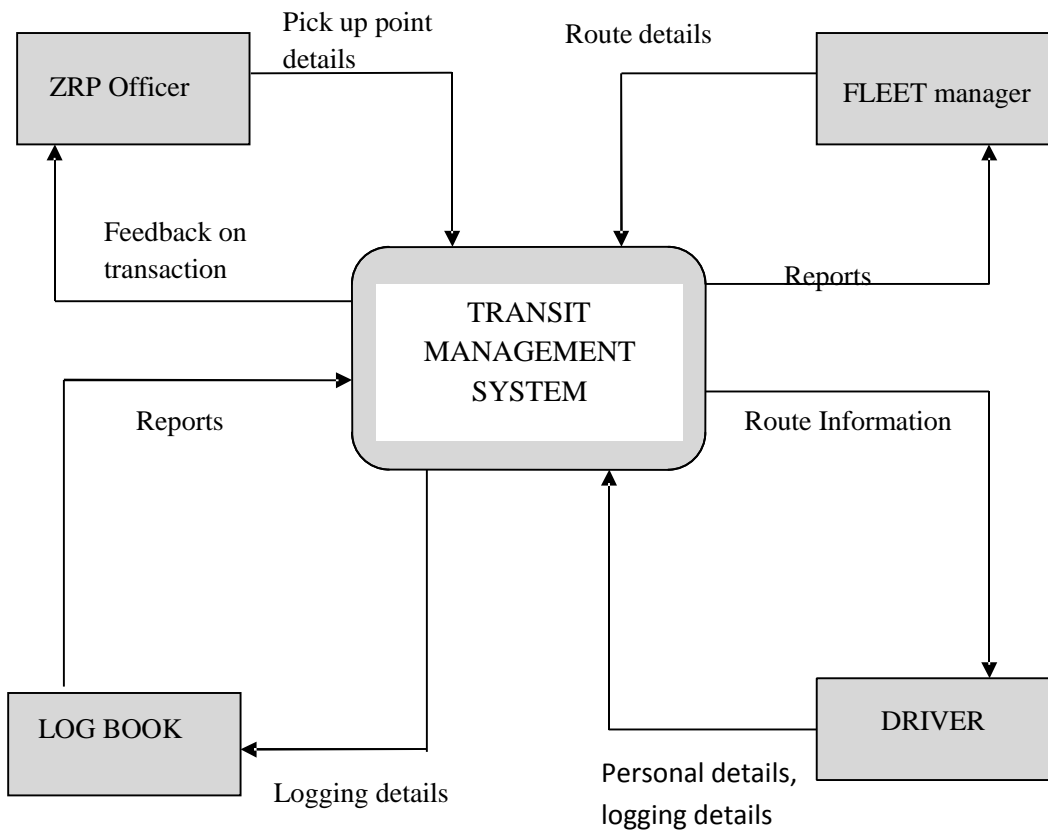
Figure 3.2 Context diagram existing system

3.5.2 Data flow diagram for the old system

A data flow diagram (DFD) is a functional analysis tool that shows the flow of information throughout the system (Kendall and Kendall, 2002). Data Flow Diagrams reveal relationships between the various components in a system. They are an important technique for modelling a system's high-level detail by showing how input data is transformed to output results through a sequence of functional transformations. Below is the DFD for the current system:

Figure 3.3 Data Flow Diagram Key

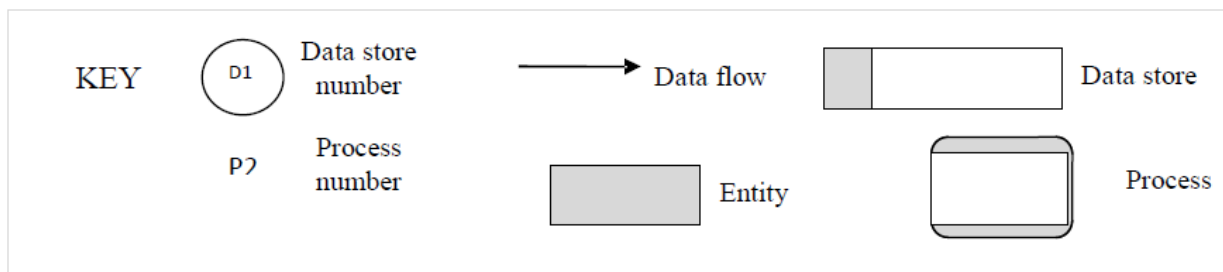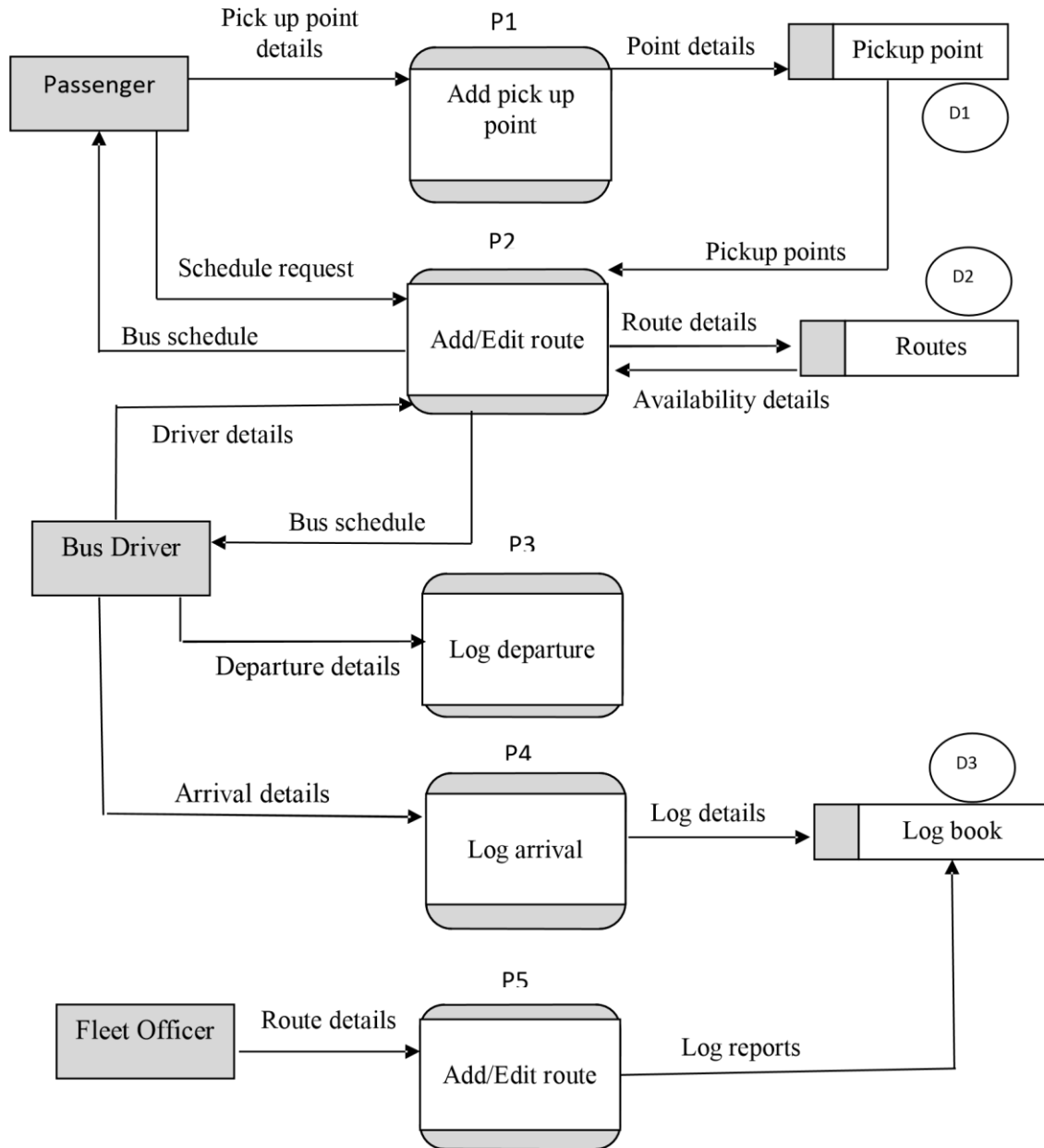Figure 3.4 Data Flow Diagram of the Existing System

3.6 WEAKNESSES OF CURRENT SYSTEM

The current Bus Transit management system has the following drawbacks

➢ The existing system has proved to be time consuming due to it being manual in its aspects such as logging.

- Evaluations and analysis of the bus activities and log reports is difficult and almost impossible because there is no central data repository. Also fraudulent activities like losing log books make records almost untraceable.
- The current system lacks proper communication needed between the bus and officers at pick up points about delays and changes in arrival times
- High stationery cost in purchasing log books and pens for drivers
- The current system lacks real time tracking of buses
- Facilitates corruptive practices due to the intensity of loopholes.

3.7 EVALUATION OF ALTERNATIVES

Despite the availability of considerable choices among the solutions to a specific problem, only a single choice should be put in place as a permanent panacea. In order to reduce the chances of high risks of losses, one needs to consider the feasibility of all available solutions.

The three options available were as follows:

- In house development
- Outsourcing
- Upgrading the existing system

3.7.1 In House Development of Software Packages

The process of in house development is similar to custom information system development where an organization comes up with its own unique system designed to solve all problems that it is currently facing based on its own identified requirements.

Advantages of In House Software Development

- Chances of resistance to change are reduced since employees will be included in the change process.

- Maintenance is easier because the software developed will be fully documented. There are less development costs since the organisational staff will be part of the development team

- Employee morale is increased when officers and superiors are involved in system development as they feel their concerns are being addressed and this also reduces resistance to change on their side.

- Improves the quality of organisation developers

Disadvantages of In House Software Development

- If system fails, a huge loss may be incurred.
- Time taken in developing the system may affect the organization's overall production time and result in reduction in levels of production.

3.7.2 Outsourcing

This is the act of sub-contracting out the project to an external firm. In the present case, it is not very advisable to outsource since the process can be very expensive considering the amount of funding available towards the fulfilment of the project through outsourcing and understanding the fact that the organisation is ready to carry out the project itself since it has the resources and capability to build the system.

Advantages of Outsourcing

- Users will be in a position to request further perfection of the system since the organization will be paying license fees and maintenance fees (Krugman, 2009).
- Reduced development costs.
- Resources belonging to the organization are saved and made available to other areas in need of such resources.
- There is close communication between the users of the system and the system developers.
- Production time is not affected.

Disadvantages of Outsourcing

- If the firm sub-contracted to do the project faces liquidation challenges, the project will then undergo little or no future development.

- It is more costly to use outsource software than to use in-house development procedures.
- It is expensive to implement off shelf packaged software.
- Outsourced software systems may be generic thus may be difficult to connect to already existing custom-made databases.
- There is a high chance that the outsourced software may fail to address the issue at hand.
- There is increased training cost as there will be continual reference to the developers of the software, (Krugman 2009).

3.7.3 Upgrading the Existing System

This involves a simple change process of moving from a lower level system to an upper level more efficient system with regards to service delivery and performance. Although upgrading an existing system eventually leaves out some manual aspects in the new system, this method is relatively a cheaper way of system development.

Advantages of Upgrading Existing System

- Ghezzi (2004) says that the time and costs expended in upgrading a system (development) is less than that of building a system from scratch.
- Employees are more likely not to resist change since they will be involved in the decision making process regarding the implementation of the system.
- There are less training costs since there will likely be some sense of familiarity with the system.

Disadvantages of Upgrading Existing System

- The probability of current system problem perpetuation is very high when using system upgrading.
- More time may be spend cooperating with system users rather than concentrating on activities that keep the organisation up and running.
- It maybe complex and costly to redesign software than to develop a new one.
- If the system to be upgraded is too complex, the overall process become complex and slow down the development process.

3.7.4 Decision

Based on the above analysis, it is highly advisable to use in house development method in building the system. The greatest key factor to regard in order to achieve system success is user involvement. When using in house development method, system users will be highly involved thus all requirements are made clear and hence fulfilled. Considering all of the above mentioned development approaches, in-house development method increases user motivation and morale since they will be deeply involved in the development process thus a sense of belonging is created among employees. Organisational reliance on system developers is greatly reduced since the system will be developed by organisational employees. To follow is a summary of estimated project cost in relation with the development method used:

Alternative	Cost ($)
Outsourcing	7300
Upgrading the existing system	6400
In house development	6200

Despite the fact that upgrading the existing system is slightly more expensive than in house development, it is still not recommended because it does not solve the whole problem in question but rather may carry over the current system weaknesses and vulnerabilities to the new system.

Although outsourcing is a reliable professional way of system development, it is an expensive method that may result in denial to submit system documentation with the aim of monopolizing the system so as to charge high maintenance costs.

In the chosen method of system development, the system users are highly involved thus training cost are greatly reduced. Above all, proper system documentation is readily available thus resulting in low maintenance costs. The following reasons clearly outline why in house development is the best to use in this situation.

➢ Reduced maintenance costs

- ➢ Full utilization of resources
- ➢ It is easy to advance the system whenever there is technological advancement.
- ➢ The system can be customized to perform other tasks apart from its main purpose by incorporating other components into it hence reducing work load
- ➢ Additions or subtractions on system can be done without the need to consult any external organization.

In a nutshell, in-house development is the most appropriate system development method since it safeguards future interests of the organisation as compared to the other development methodologies.

3.8 REQUIREMENTS ANALYSIS

Requirements analysis is considered to be very important in systems development since it defines the resources needed to come up with the system under consideration as well as finding the solutions to the specified requirements (Somerville, 2004). How the users want the system to look and to function is defined at this stage. The two types of requirements taken note of are functional and non-functional requirements.

3.8.1 Functional Requirements

Butt (1994) propounded that functional requirements define the tasks that the system should do and that which is not expected from it. In simple terms, functional requirements outline how individual system features interact with system users so as to help them achieve their objective. Following is a list of functional requirements for the system under study.

Printing Reports

- ➢ The system should be able to print reports in relation to user access and accessed information as and when needed.

Functionality regarding to data should be as follows

> ➢ There should be automated time stamping when data enters into the system.

> ➢ Proper verification and validation of entered data.

> ➢ System should be able to add, update or delete specific data

3.8.2 Non-Functional Requirements

Besides the distinctive system functions, there should be non-functional requirements which focus on the whole system and define the limitations of the services provided by the system (Butt, 1994).

Security

> ➢ In the business community, it is a concern for stakeholders. How the system can be accessed. Security best practices should be enforced to make sure that unauthorized entry into the system is restricted and brute force attacks on the system are contained.

System Backup

> ➢ The system storage facility should be periodically backed up or have a live backup of the data and the system settings so as to be able to recover when there is a system failure or a compromise.

Interface

> ➢ In addition to the highly required system functions, the system interface should be user friendly to the users.

Effectiveness and Efficiency

> ➢ The system should be able to process requests from users quickly and accurately.

Not only the system itself should be able to perform its functions but also the system users should take note of the system backup period and as well access information regarding traffic when the need so arises.

3.8.3 Overview

The system functional requirements define what the system should be able to do as a way of fulfilling user requirements specified by users and the non-functional requirements focus on those functions not included in the functional requirements but as well expected to be on the system.

3.9 CONCLUSION

This marks the end of the analysis phase of the old ZRP transit management system and the beginning of the designing of the new Real time bus monitoring system. All the data needed to move on to the next stage of development has been collected using the various methodologies discussed. Analysis of the existing system using DFDs and Context diagrams has been. As a result the problems being faced in the old system were put to light and the highlight for the need of the proposed system has been shown. Alternatives have been evaluated and the best method for development was chosen, that is in-house development foregoing outsourcing and upgrading alternatives. The next stage is the design phase whereby the conceptual appearance of the new system is going to be exhibited.

CHAPTER 4 SYSTEM DESIGN PHASE

4.1 INTRODUCTION

According to Heathcotte (1997) the design phase puts its focus on how the proposed system is to look like and how it is expected to function. Special emphasis is put on its design that is database design, interface design, security design, just to mention a few. This phase is concerned with explaining and describing the features and functionality of the proposed system. Another scholar, Kendall and Kendall (2002) then defines the design phase as that stage in the development cycle where design methodologies and principles are put into place in an attempt to fully explain the components of the proposed system. The design phase is therefore responsible for converting all the functional requirements into real life functionalities.

4.2 SYSTEM DESIGN

As defined by the System Engineering Guide (2004), system design refers to the activities of defining mechanism, segments, interfaces as well as information regarding the proposed system, this is done mainly to maximise user requirements. Moreover, Saunders (2007) defines system design as the comprehensive representation of the proposed system's properties, its data structures and how they will be represented and the interfaces to be expected in the proposed system. This therefore means that the system to be designed should meet all user needs and requirements as stated in the objectives.

For a system to be defined as well-constructed and designed, it should be usable, effective, maintainable, secure, purposeful and efficient.

✓ **Effectiveness**

A system is said to be effective and well-designed if it provides the users the ease to work with and at the same time the system should result in some advantage to the organization and should help reduce costs in some way.

✓ **Reliability**

Reliability can be defined as the ability to reliably perform all its expected functions, it should consistently produce results as expected and should minimise faults and errors as well as system downtime should be kept at a minimum.

✓ **Maintainability**

If the ZRP system has a fault or errors, it should be able to reverted back to normal operations in a minimum space of time for it to be commended as maintainable. Documentation of the system is very important in maintaining the system for it enables developers to continuously improve the system and even if a new developer arrives, they will be able to continue from where others had left off with knowledge of what has been done before.

✓ **Usability**

A usable system is user friendly and should give the user view alternatives as well as help options. Users of the ZRP Bus management system and application should not have difficulty in using the application or system. The system should produce required reports when needed as well.

➢ **Security**

Security is one of the most important aspects of the proposed system and therefore should be taken seriously. Making use of authentication through usernames and passwords for the web interface should prevent unauthorized entry into the system. Physical security on the servers and systems equipment should be implemented properly to ensure that all systems assets are safe.

4.2.1 Context Diagram

The Context Diagram is the diagrammatic representation of the system under consideration as a high-level process and then shows the relationship that the system has with other external entities (trackers, drivers and ZRP officer, managers).
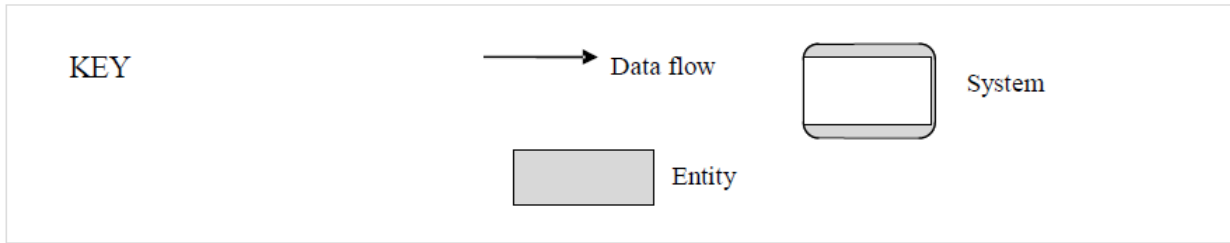
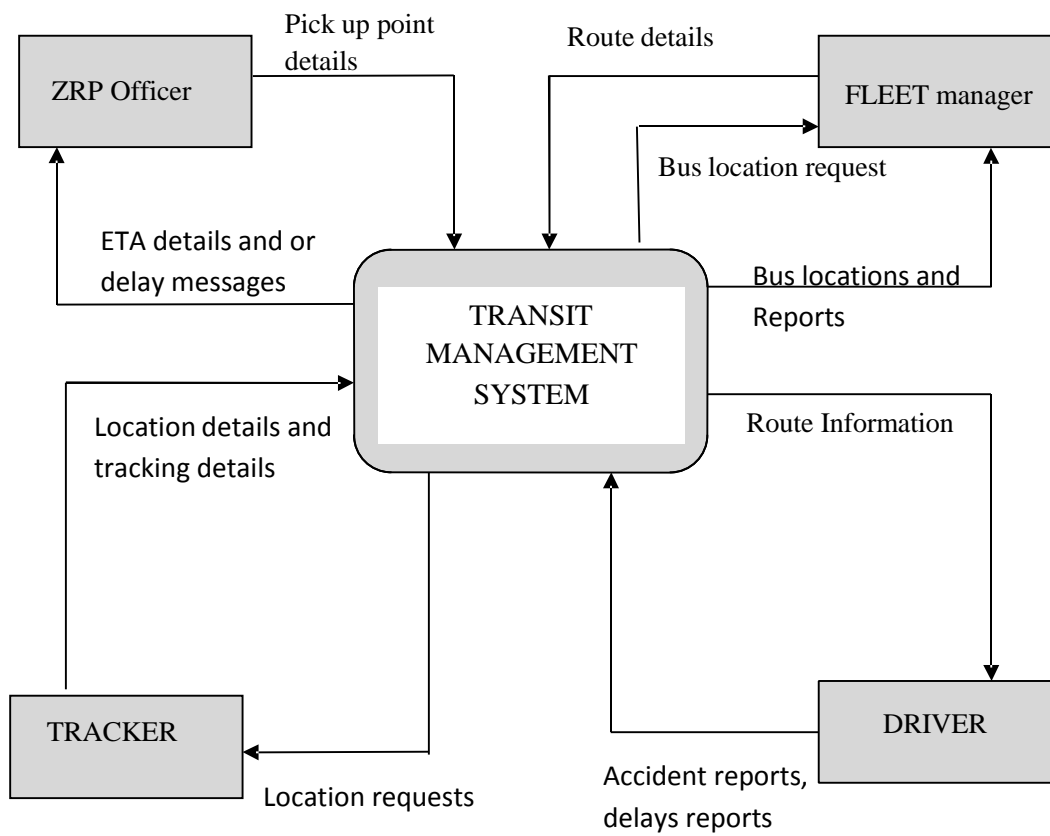Figure 4.1 Context diagram Key

Figure 4.2 Context diagram of Proposed System

4.2.2 Data flow Diagram

Ken, Jane and Rajanish defines a data flow diagram as the principal implement that is used for regulated analysis that graphically explains the components of the system illustrating the processes and also the data flow between entities. Shelly and Rosenblatt also define data flow diagram as the diagrammatical presentation that gives a logical model that explains what the system operations are and how entities link. Preeti (2005) posits that a data flow diagram is a tool that portrays the flow of data through a system. Every data flow should include all the processes, entities, the data flows and the processes in the system.
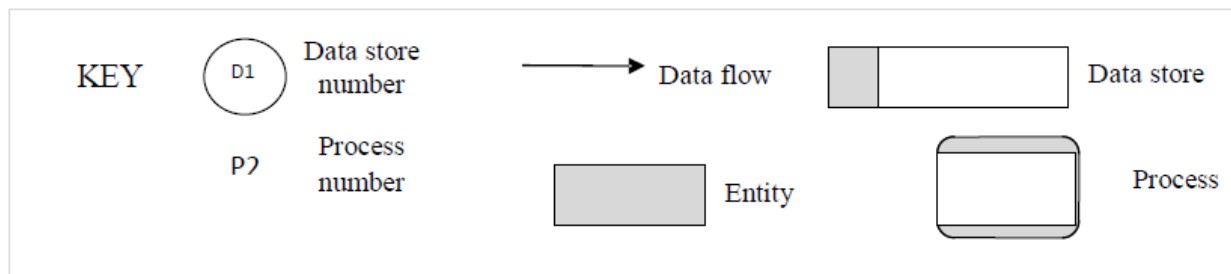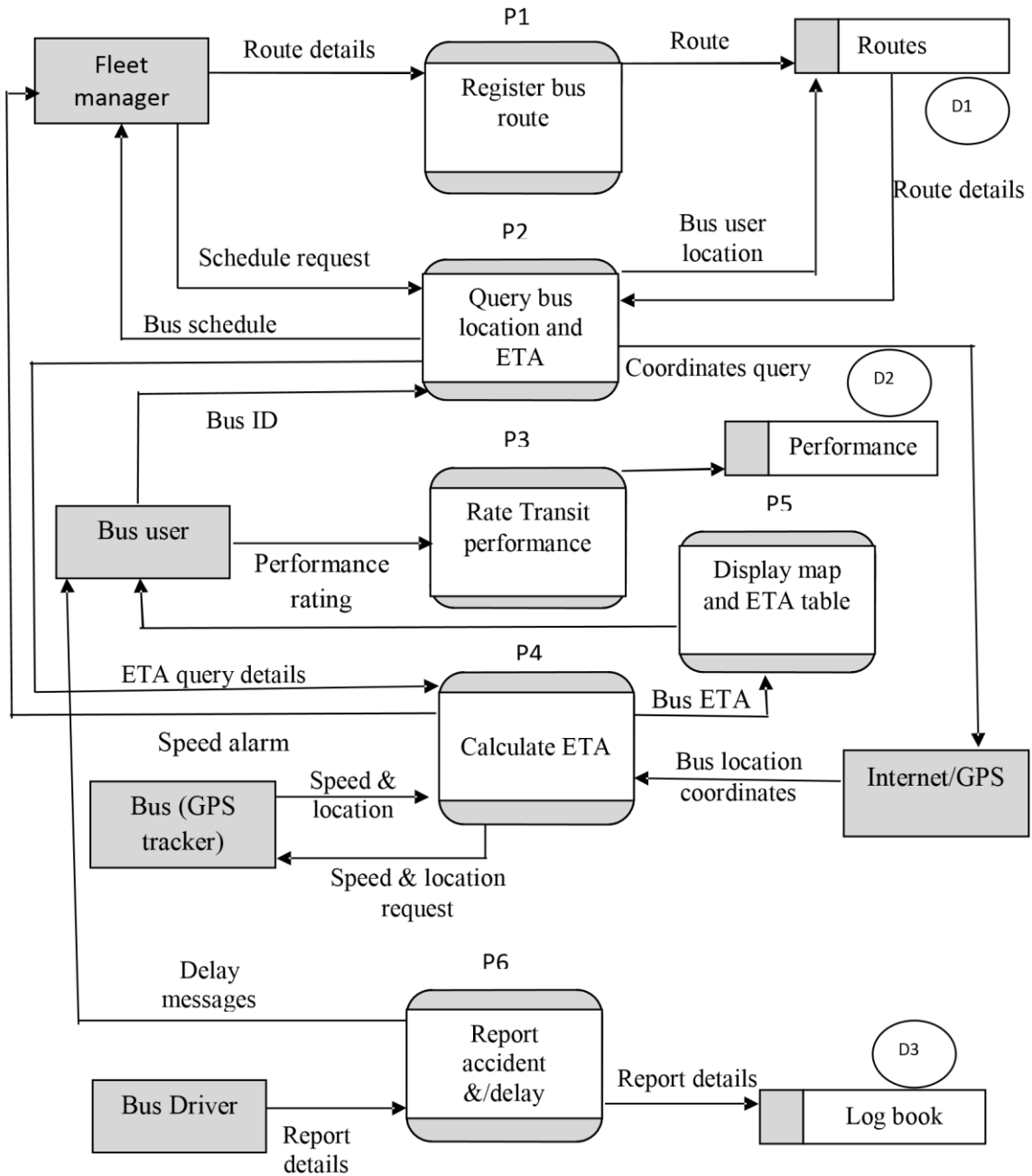

Figure 4.3 Data Flow diagram Key

Figure 4.4 Data flow diagram of Proposed System.

4.3 ARCHITECTURAL DESIGN

Sommerville (2008) asserts that in the architectural design of a system is where is where practical and methodical components of the proposed system are explained and described,

components such as hardware, processes, network structures, software and users of the system proposed. Washmen (2006) goes on to describe the architectural design as a way to demonstrate the program devices as well as the data structures required during the system design process. In this phase, interactions between the mentioned components are designed, illustrated and explained, that is how they will link and communicate to form a complete system desired. The whole system will be implemented on the Local Area Network that is already present at Zimbabwe Republic Police and the android application will be installed on officer's android phones. According to the Bus Transit Management System's requirements, for the system to be successfully implemented, the following resources are needed;

✓ **Android Development Kit and Devises**

These will be used for developing the system and using the system for tracking of the fleet since the system will be running on an android compatible devise only.

✓ **Microsoft SQL Server 2008 R2**

This is the server where all the information about all the users, locations and messages will be stored and reports will be backed up in.

✓ **Client Android cell phones**

This is where the application will be installed and the is need for data bundles to access Google maps

✓ **Management desktop/laptop computers**

This is where the web version of the system will be installed for access by management

✓ **Ethernet Cables**

These are to be used in connecting management computers and the server over the network.

✓ **Uninterruptable Power Supply**

This is a preventive measure just in case there is interruption in electricity supply from ZESA and to ensure safe shutdown of servers.
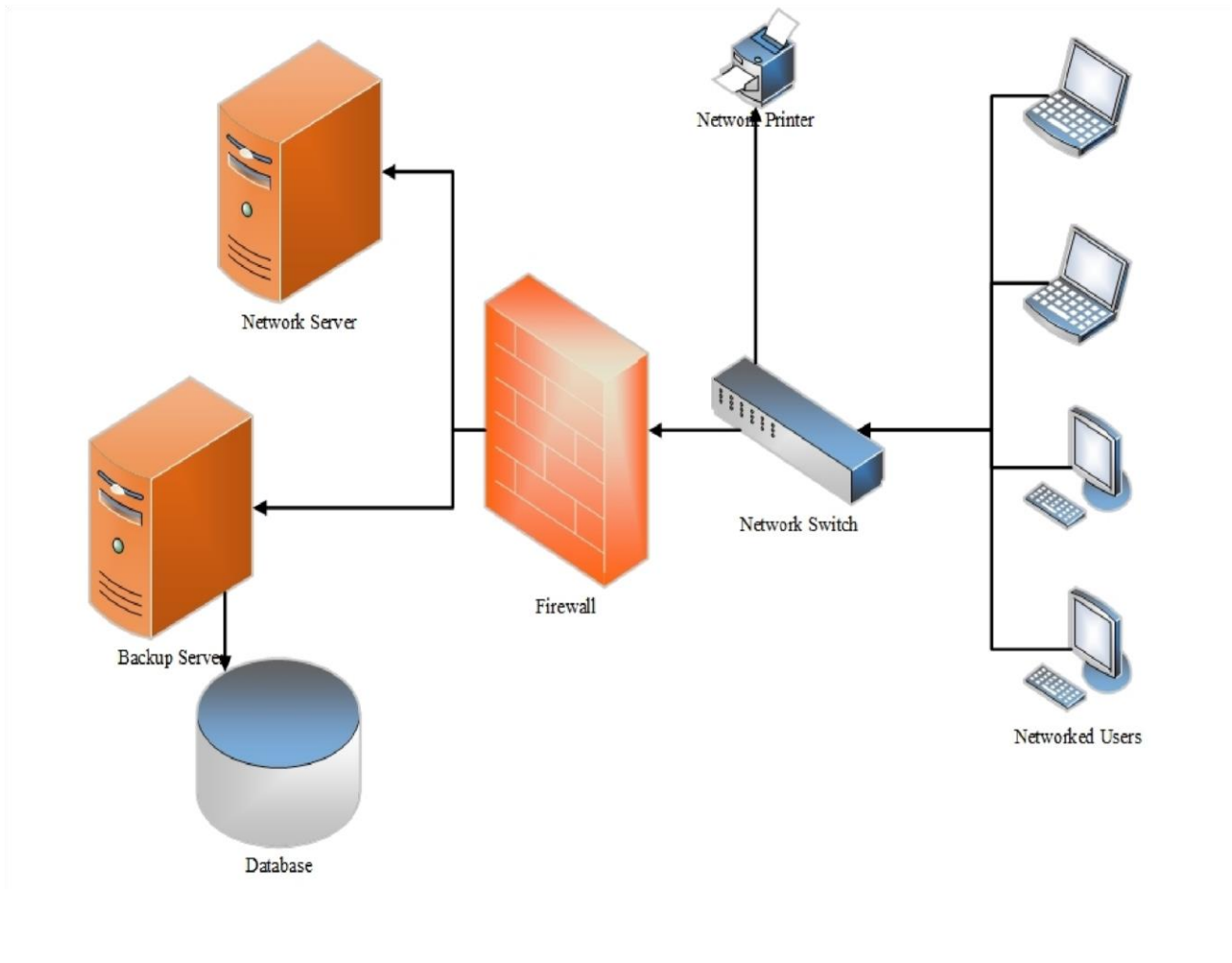
Figure 4.5 System Architectural Design Diagram of the Proposed System

4.4 PHYSICAL DESIGN

As explained by Adams (2010) physical design is the description of how all the system hardware is to be setup in the organisation showing clearly how they are to communicate with each other to ensure effective system functionality and how they are to be linked to the database.

Physical design, therefore is a way to show all interaction that occur in the proposed system between hardware using different hardware and software devices.

4.4.1 The Software Components Required

- ✓ Android Studio
- ✓ Windows 7 or later Operating System
- ✓ Windows Server 2008
- ✓ Microsoft Office 2010 or later
- ✓ Adobe Reader XI or later
- ✓ Sql server R2

4.4.2 The Hardware Components Required

- ✓ AMD Core i3(at least) Laptop
- ✓ Network Printer
- ✓ Cisco switch

4.5 DATABASE DESIGN

According to Coronel and Crocket (2010) database design is the design of how the database is to look like , stating its tables and how all are to link together to form units, modules and subsystems are all linked together to form the whole system that is supported by the database. The proposed system will have one depository of all information to ensure easy access to data and reduce duplication of data. In order to further demonstrate the architecture of the proposed system database, the ANSI SPARC architecture was used and the diagram is shown below:
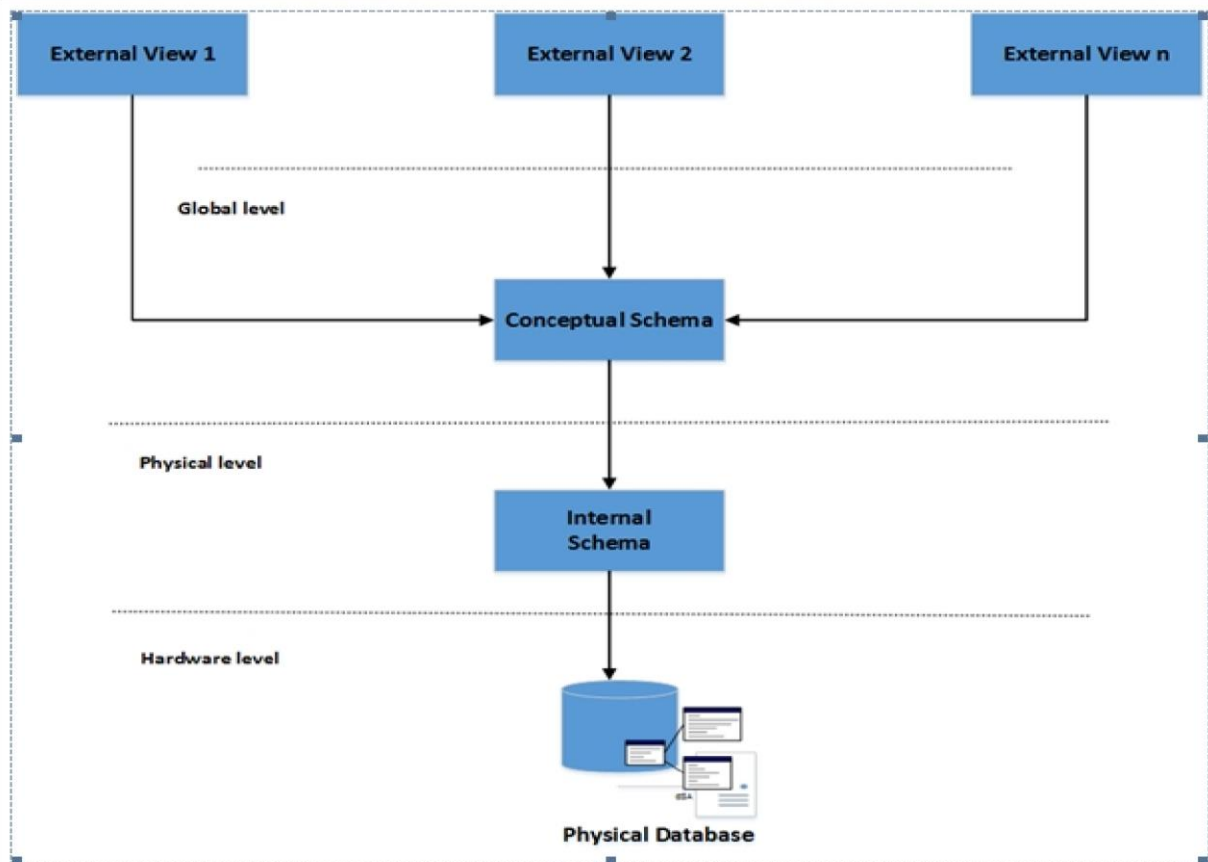
Figure 4.6 Database Architecture Diagram of the Proposed System

(Source: Barry Eaglestone, 2000)

  ✓ **The Global / External Schema**

This level is the view level which only allow users to view personalised or profiled data the manager can only view managerial functions on the desktop application, on the android application, the driver can only see what is relevant for them as well as officers viewing their information needs only.

  ✓ **The Conceptual Schema**

In this schema, which is also called the community view of the database where there relationships between various entities can be seen.

  ✓ **Internal Schema**

This is the bottom level schema that shows the various ways in which the Data is stored in the database.

4.5.2   Enhanced Entity Relationship Diagram (EER)

As defined by Jacob (2006), an Enhanced Entity Relationship diagram is primarily designed to demonstrate how several entities of the system communicate with the database through various relationships. An ERR shows the relationships between entities in the system and therefore, entities that share similar attributes are grouped together thus creating a super type.

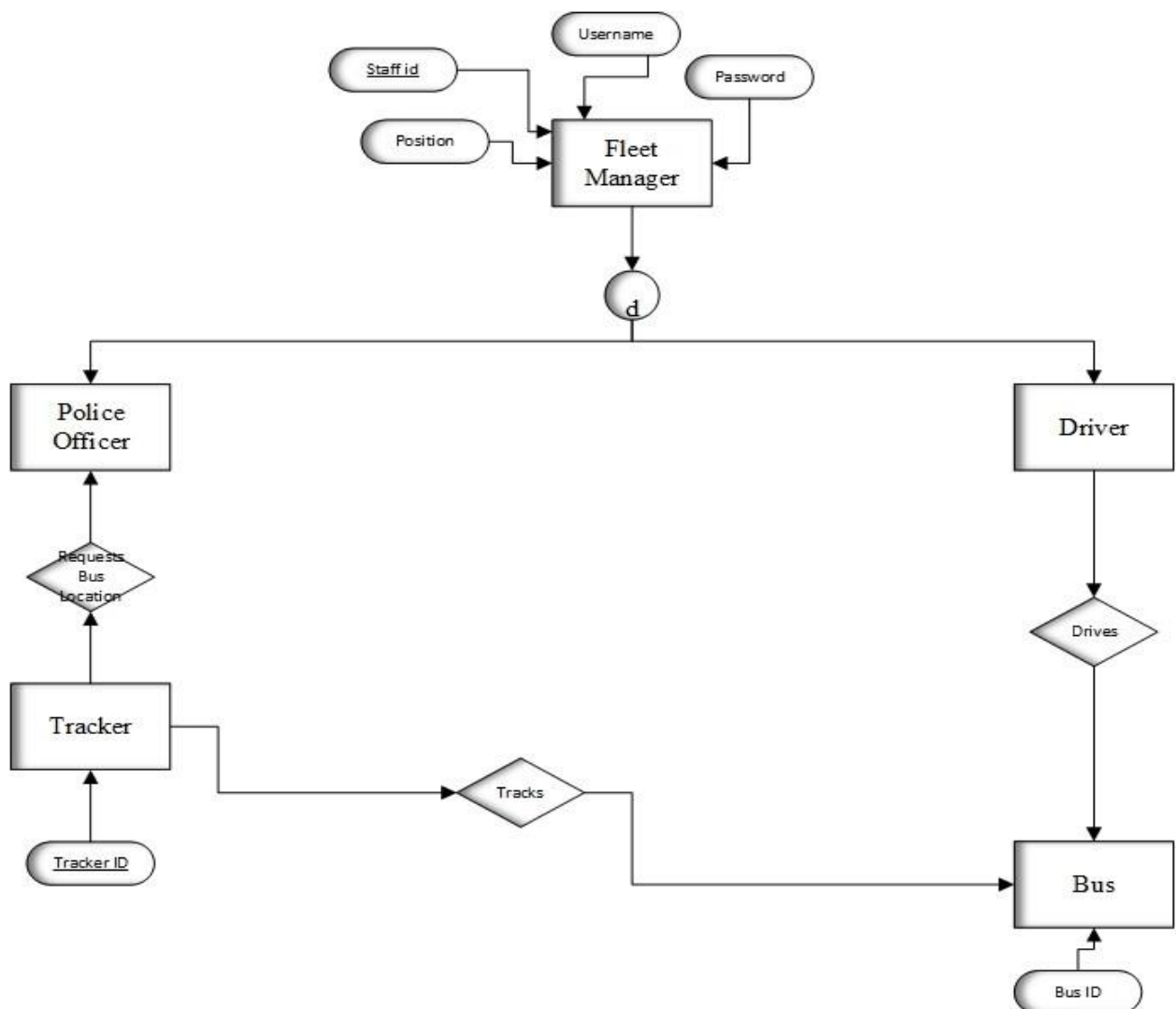The EER for ZRP Bus management system is shown in the diagram below;

Figure 4.7 Enhanced Entity Relationship Diagram (EER)

4.6.2 Package Diagram

According to Silberschatz (2002) a package can be described as a grouping of modelling features under an allocated name. A package diagram, in the Unified Modelling Language is therefore a diagram that shows the dependencies between packages that make up a model. Below is the Package diagram for the proposed system;
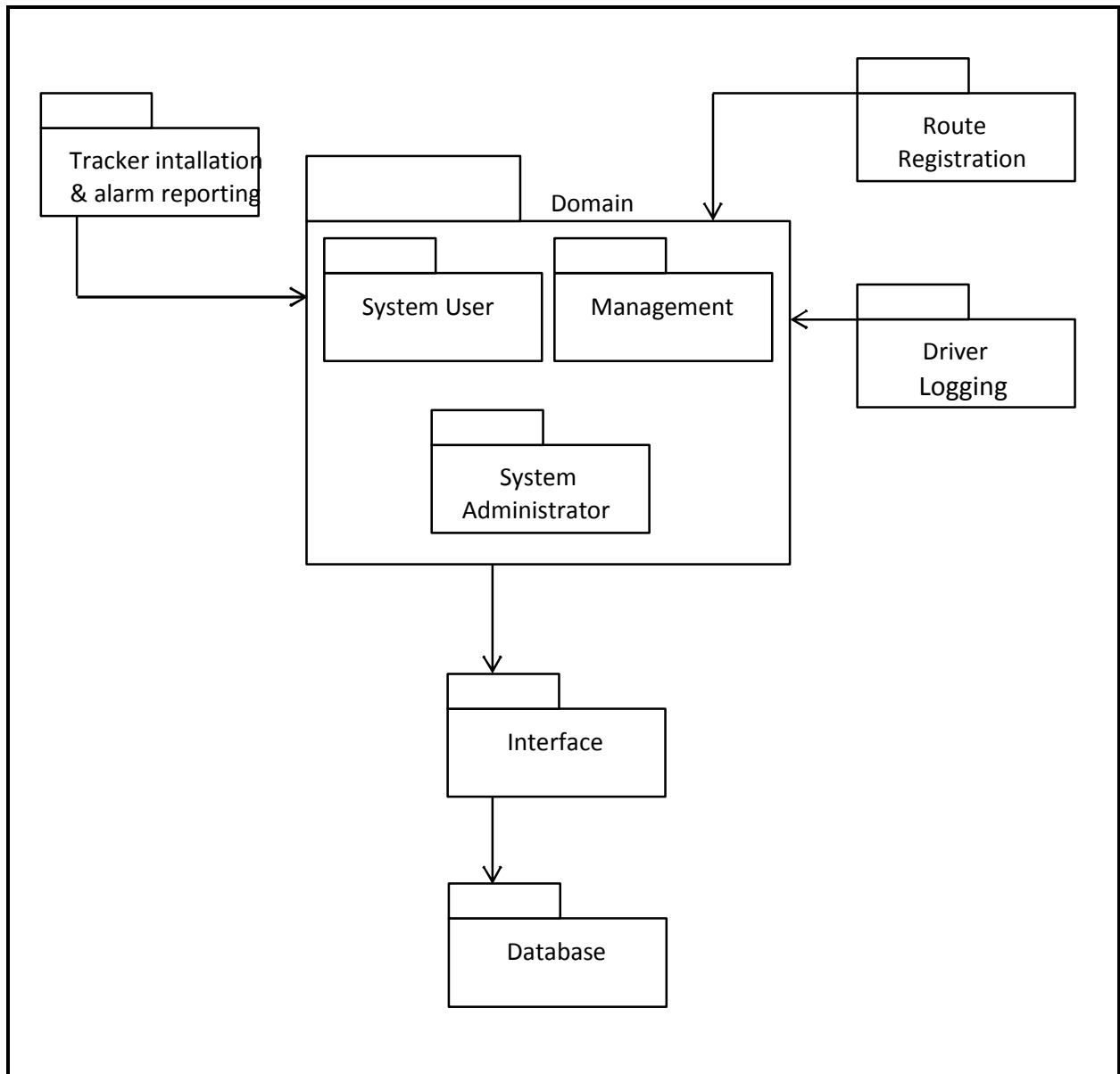

Figure 4.8 Package Diagram of the Proposed System

4.6.3 Sequence Diagram

According to Manning (2004), a sequence diagram can be described or defined as a graphic illustration of all the existing system classes and how they exchange information in a given period of time. Below is the sequence diagram for the proposed system,
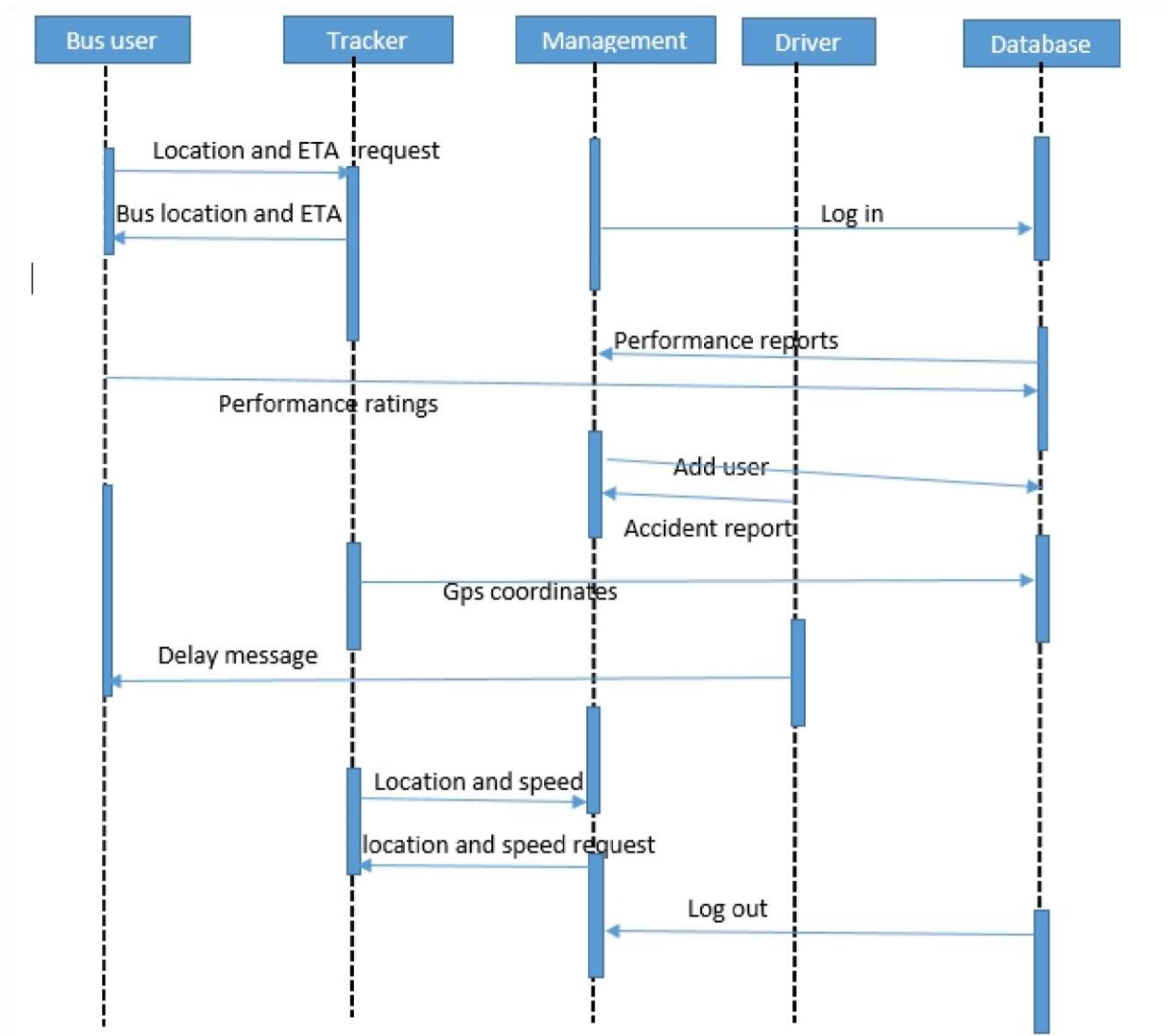

Figure 4.9 Sequence Diagram

4.7 INTERFACE DESIGN

 "Interface is the means through which two subsystem (the computer and the human) communicate with one another" Mayhew(2009) . Basically the human is flexible or adaptable and most computer systems are not, inputs must be made in a particular format and outputs are predefined thus for a computer system a human can learn and adapt while the computer cannot. This puts the burden of successful interaction totally on the user hence then need for a computer-human interface.

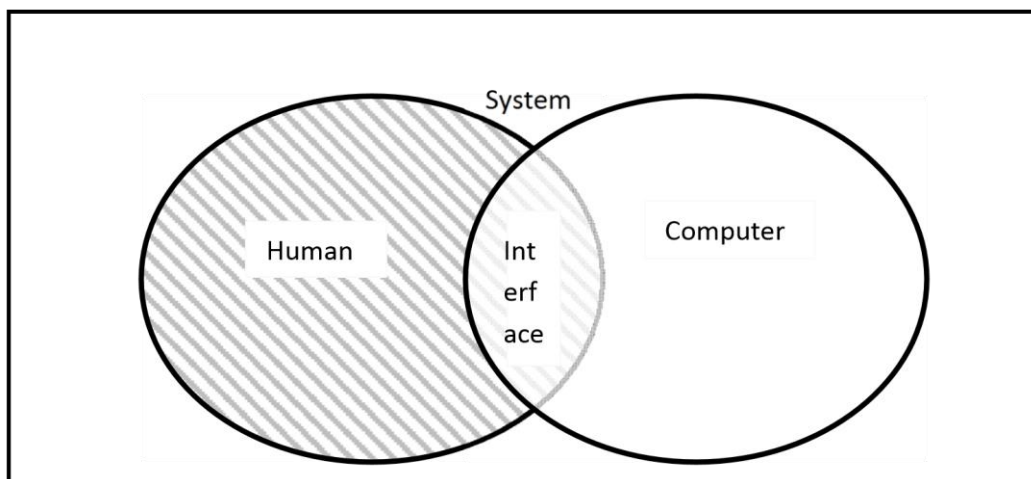The table below illustrates the relationship between humans, system and computer.

Figure 4.10 Human-Computer interaction

The System interface should be designed in such a way that it is easy to learn, easy to use and allow for easy and fast navigation. For a system interface to be labelled as good, should fulfil the following criteria;

- ➤ User familiarity
- ➤ Consistency
- ➤ Recoverability
- ➤ Minimal surprise
- ➤ User guidance
- ➤ User diversity

4.7.1 Functional Design Structure

The ZRP bus Management System, which is mostly a web based has two major parts, the desktop application that is meant for management and the android application that is meant for general users and drivers. The home / main page on the desktop application provides links for management to navigate to all their functions such as monitoring bus activities and viewing client feedback. On the other hand, the android application also provides links for navigation throughout the functions
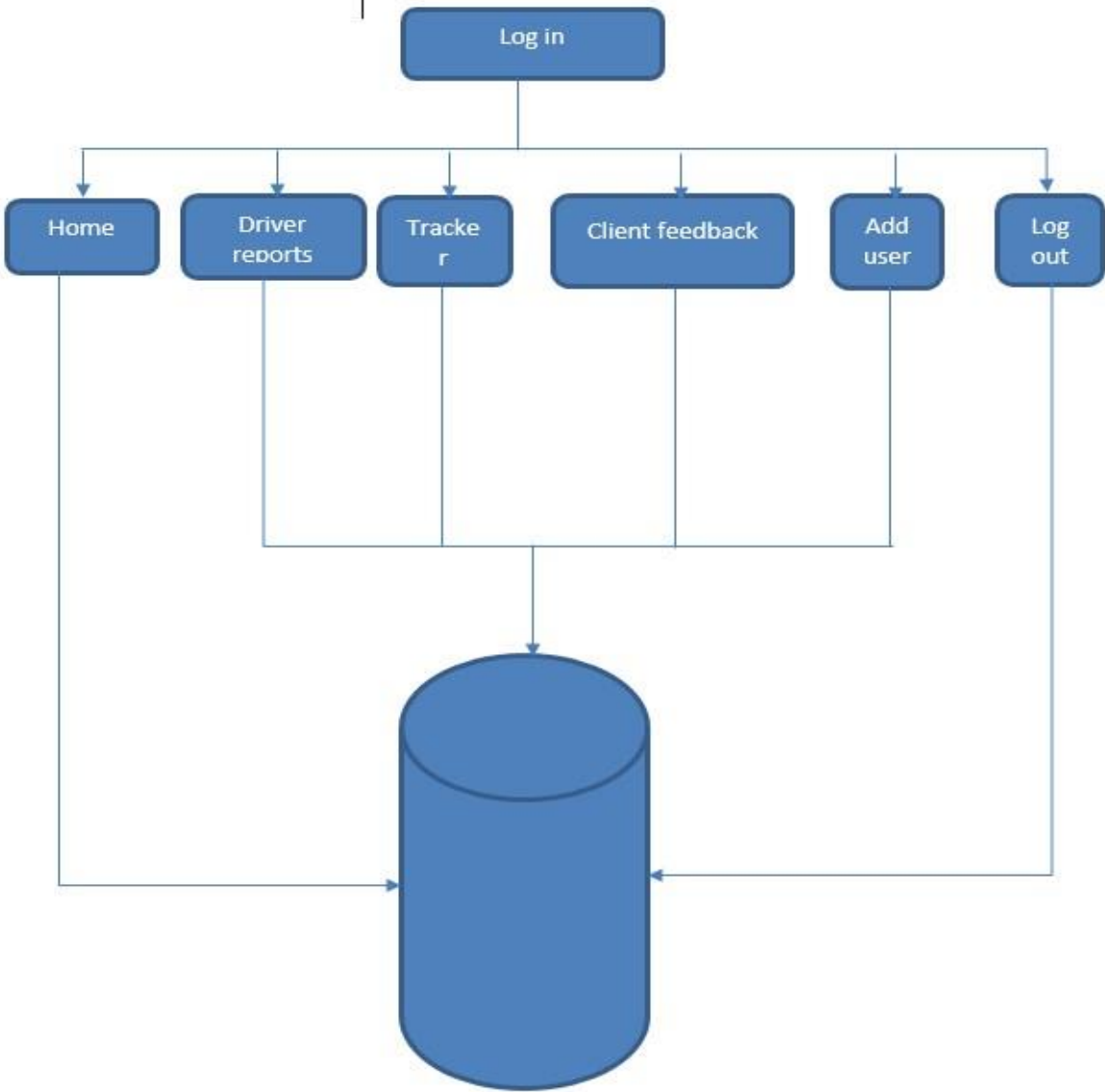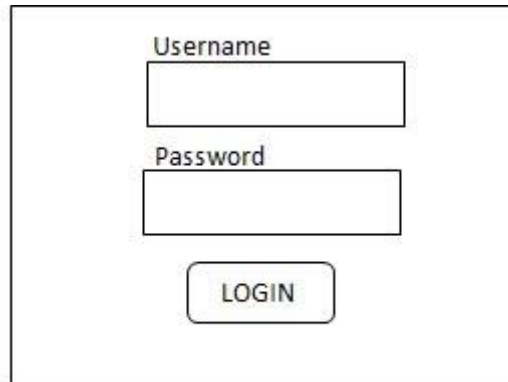

Figure 4.11 Functional Design

4.7.2 Login Form

This is the main entrance to the desktop application to be used by management, this form is the one which gives access for the user to the functions shown on the diagram. On the page there are two textboxes for username and password and a button for login. This is best shown in the diagram below.
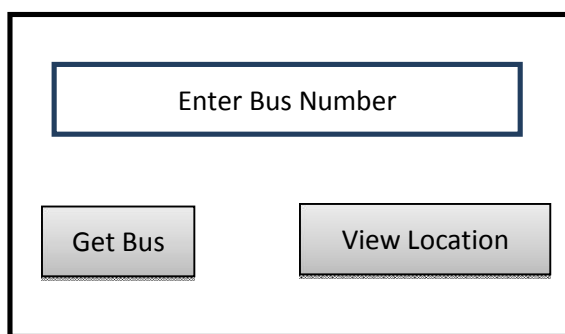

Figure 4.12 Login Form

4.7.3 Request for Bus Location Form

This is the form where the bus user can request for bus location and Estimated Times of Arrival by officers at pick up points. The user enters the bus ID in the textbox and by clicking get bus the user can see the ETA, by clicking on view location the user can now view the bus location over Google.

Figure 4.13 request bus location

4.7.4 Output design

Output design describes and shows how reports, both screen based and printed will look like in the proposed system. The user is most concerned with the results that the system produces and therefore output design is of paramount importance in development. How reports are displayed determines the acceptance of the system. Outputs of the system are used for decision making purposes by management. Below is a table of how messages about accidents are to be displayed.

Bus id	Message	Sent by	Cell number

Figure 4.14 Output

4.8 CONCLUSION

The basic structure and architecture of the new system under development has been discussed and the next stage is the actual implementation of the system to produce something implementable and tangible which will be discussed in the next chapter; the implementation phase.

CHAPTER 5: IMPLEMENTATION PHASE

5.0 INTRODUCTION

The implementation phase, is the last phase in system development which as defined by Somerville (2007) is the process that involves delivering to the users the working. The implementation phase is concerned with performing various tests regarding the system to correct errors and make sure it is working as expected. A successfully implemented system should fulfil user requirements and should face little or no resistance to change.

Implementation involves processes that result in the delivery of a working system to the user.

During this phase, the following activities are expected to be taken:

1. Construction and Coding
2. Application testing
3. Installation
4. Maintenance

5.1 SYSTEM CODING

System coding is involved with the design and creation of programs that perform various functions and therefore can be integrated to form modules, sub-systems and finally the whole system. Connecting to the database is another important aspect in system coding.

The desktop application of the system under study was designed and coded using VB.net whereas the android application was developed using Android Java. Connections to the database were done using the SQL server R2 database.

Pseudo Code

Cornell and Croket (2008) define Pseudo-Code as a way to explain programs or algorithms or plans of code using plain English. Pseudo code should show a general, full overview of the proposed system operations from data input, processing and output through various reports.

The Pseudo code for the proposed system is shown in the following page

User Login Module

// Validates user details and authentication

Accept *Username, Password*

    Select *username and password **from** users table.*

    Where *username and password match the entered details.*

    If *match is found **Then***

    Direct *user to user's main Page*

Else

    Display *error message of login failure*

 // Close User Login Module

Connecting to the database

Check if connection has been made

If not yet set then

Set the connection

    Else Ignore

Updating data in the database

Get the key fields

Check if record does exist

If not then

Report error

Else

Validate all the information

If some of the input is invalid

Report error

Else

    Using the established connection, save record

5.2 TESTING

Sommerville (2007) asserts that before software is delivered to the users, It needs to be tested against the objectives, requirements specification and other system and module tests to make sure that it is working as expected. Testing was done on system and application to make sure that there are no errors and also testing was done regarding its acceptance by its end users.
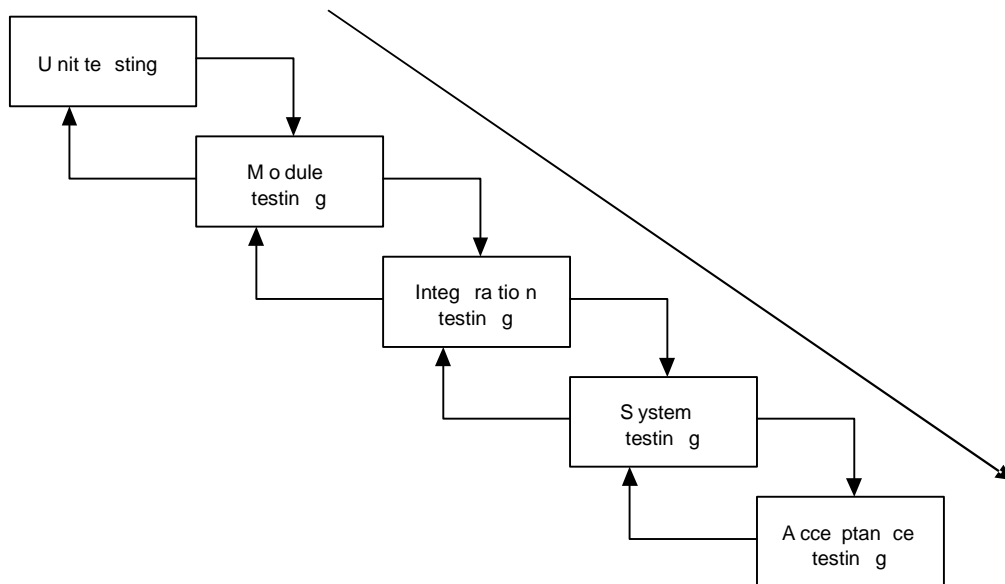

Figure 5.1 Testing procedure

5.2.1 Unit testing

Unit testing was done by testing each program or unit independently to make sure that it is working properly. In addition on the android application, tests were carried out class by class, to make sure each class is working as expected. Unit tests is usually done to make sure that application units are working which thereby helps in problem or error identification. Unit testing is done to verify the, computations, functionality, logic, and error handling of each unit.

5.2.2 Module testing

If units that perform complementary functions are bunched together, they form a module. Therefore module testing is the evaluation or assessment of a group of units that have been connected together to fulfil a function (Kendall 2005). Each module was separately tested for example the tracking module was tested on its own to see if it performed well together and also so that it would not cause any problem when integrated with other modules.

5.2.3 Subsystem testing

When one or more modules are connected together, they form a subsystem, subsystem Is is the testing performed to assess the compatibility of modules as they are added, with errors being corrected and additional units being added, if needed. The related system modules were tested for stress, data, and error integrity. The database, as a subsystem was tested too as it connected with various modules. Subsystem testing ensures the correctness of job streams. Subsystem testing is very critical because it ensures correction of module and objective mismatches that may occur during the development. It starts with at least two modules and ends with at most the second from last module. When all the modules are tested, it is then called system testing.

5.2.4 System testing

System testing, as defined by Kendall (2005) involves the testing of the complete developed system. The whole system is formed by integrating all the subsystems involved, with all the modules and their units involved. The system was tested as whole and this kind of test was carried out to make sure that all subsystem pull in one directions and that the final product is working as expected. System testing was performed against research objectives to test each objective one by one and computing the results. System testing is the final test performed before delivering the system to the client. It is done using data derived from the live environment to test its credibility in giving accurate results.

In testing the ZRP bus management system as a whole, two testing methods were used; black box and white box testing.

- ➢ **Black box testing-** This kind of test is performed to test the system functionality and it puts its focus on the overall system performance. With Black box testing, the tester does not need to open or know any code or internal design of the system because the system is tested as a black box. It seeks to errors such as incorrect functions, performance errors, interface errors and initialization errors (Eppingner, 2008). This testing method is therefore done to determine the abnormalities of the system as a whole.

- ➢ **White box testing** – unlike in black box testing, white box testing requires knowledge of the internal structure or design of the system and code. This method therefore makes use of the control structure of the bureaucratic design so as to come up with test cases that will be used to compare data results (Eppingner, 2008). When performing this test, the developers go through each and every line of code checking whether the correct syntax and methods are used.

5.2.5 Acceptance testing

This kind of test, according to Sommervile (2007) is the final stage before the system is put into use in the ZRP. It gives the users an opportunity to look at the system, enter data in it and identify any errors and omissions. This kind of test very importance because after all, the users know what they need most therefore it is logical to go back to them and give them an opportunity to have a grasp of their product before it is delivered to them. Acceptance tests are carried out continuously until the end users are completely satisfied with the system functionality and it seeks to correct everything from interface structure to program logic structure.

 Acceptance tests determine whether the system requirements specification was prepared correctly and whether user requirements were understood well by the researcher. Changes are made accordingly as suggested by the users with approval from management. Finally, when all problems and errors have been resolved and corrected and required changes have been made, the client signs for acceptance of the system and gives a go for final implementation.

5.2.6 Validation

Validation is concerned with the system being able to meet user requirements and user need, it puts focus on building the right system for the users. It is done to make sure that all that has been done has delivered what the customer expected. The developer checks whether the finished product meets the client expectations. In validation, the system has to go through various tests, errors being identified to make sure that the system gives the required results expected by the user. A system may be functional in all its aspects, but if it does feel the void in the need to end users then it is said the system has failed its users.
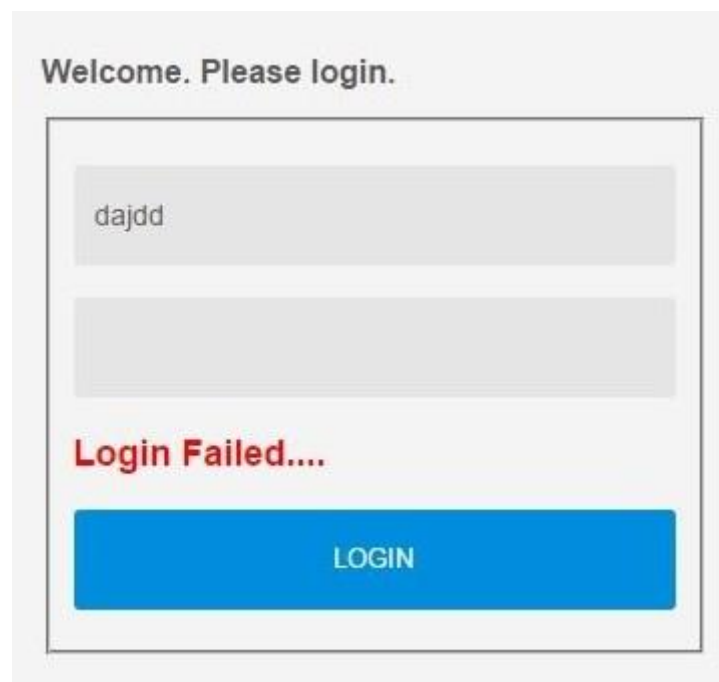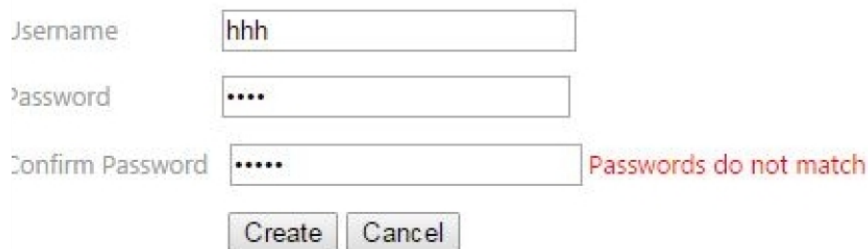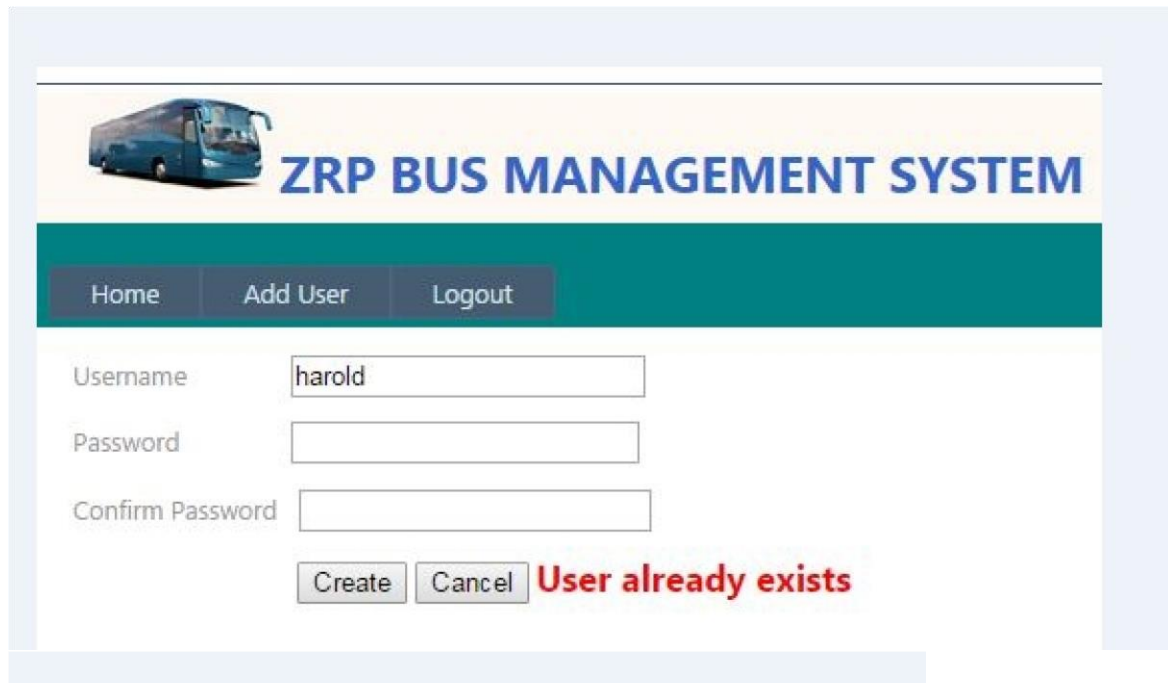

Figure 5.3 Log in interface

Figure 5.4 Adding as new user

5.2.7 Verification

Verification, o the other hand is concerned with building the system right as it compares the system to requirements specification documentation prepared by the systems analyst in translating user needs into requirements. With verification, the developer is concerned worth making sure that the system was developed as planned. The Information System developed for ZRP bus management system is well detailed and simple to use mainly owing to the User friendly Interface.

5.3 SECURITY

One of the most important things to be considered in this phase is the security of the system and within the system.

5.3.1 Physical Security

Physical security was achieved by adopting the following physical measures:

➢ **Physical Locks –** the database server is to be locked up in a room where access is to be restricted to a number of people and the tag system is to be used to make sure that there are records about anyone who accesses it and for accountability purposes. As an additional security feature, cameras will also be used to monitor all the activities around the server room.

➢ **Fire Control Equipment –**, smoke detectors have been set up in case of fire, that send an alarm as soon as smoke is detected in the room. Small fire extinguishers have also been set up inside and outside the server room.

5.3.2 Software Based Security

Physical security alone is not enough as it cannot guard against hackers and crackers as well as viruses. Therefore the following features have been put in place to guard the system equipment against software threats;

➢ **Database Access Passwords** – operating on Microsoft Windows Server 2008, access to the Server is only limited to users with the passwords required to connect to the Sever. Access levels have also been setup in accounts so as to limit users activities on the server and to enable monitoring.

➢ **System Passwords User Names and Passwords** – for all client computers where the desktop application software for bus management is installed for management, all managers are to be assigned user profiles that assign them logging in user names and passwords.
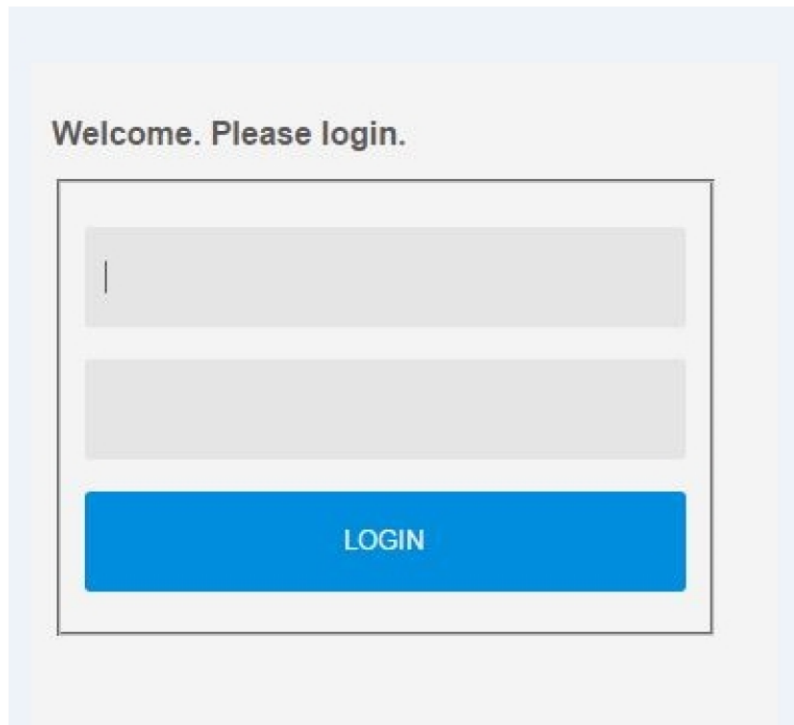
Figure 5.5 Log in form

5.4 INSTALLATION

The software is going to be installed from the CD Rom and a copy for backup is left with client and the other with the development Installation steps followed:

(i)   Insert the disk with the setup

(ii)   Click install

(iii)   Follow the steps for installation until complete.

(iv)   The shortcut to the application shows up on the desktop

(v)   Click to run the application 'ZRP Bus management system'

For the android app users, the apk file is to be deployed on the provincial website so that anyone who may want to use can download it. For convenience purposes, ZRP staff may physically come to the IT department to be given the apk file.

5.4.1 Training

If the users do not know how to use the System, it can be classified as a failure and to ensure that it is not users were trained as follows:

· **ZRP android app users** – users were trained on how to use the application and its significance. They were also trained on how to easily and quickly navigate the system.

· **Management/Administrators –** management was taught on how to access their reports. Training was also done on how to use the desktop application system. The training also presented an opportunity for explaining to the Management the content of the reports and how to make the most of these reports.

5.5 MAINTENANCE

Implementing a system and let to run without maintenance is a recipe for total system failure, therefore it is of great importance for maintenance plans to be made so that the system is always working at optimal performance.

System maintenance is vital because of the following reasons:

➢ Technology is ever changing, therefore the system has to adapt through required upgrades to software versions.

➢ Users' needs don't remain the same for ever in the evolutionary technological environment, therefore changes in users' needs need to be addresses through maintenance.
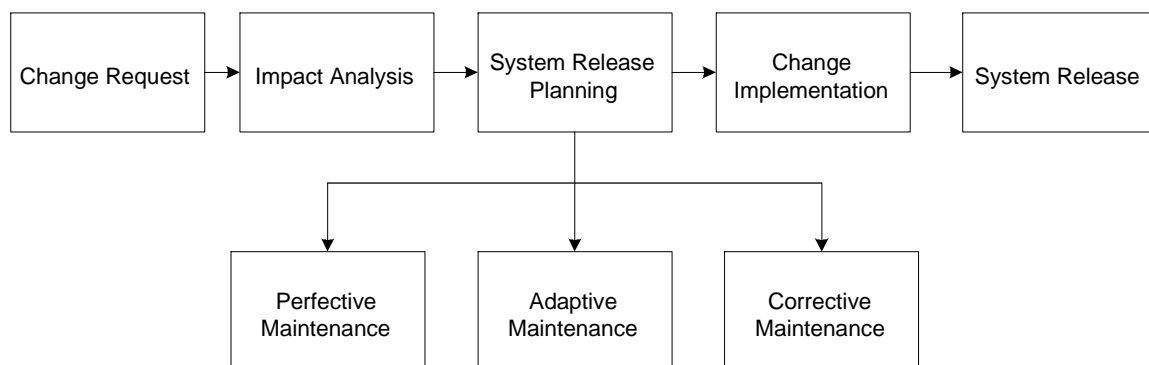

Figure 5.6 The Maintenance Process

5.5.1 Corrective Maintenance

As the system is used and as time progresses, errors are discovered and reported. These need to be corrected. This is where corrective maintenance comes into play. Once errors have been corrected, reviews and follow ups are made to make sure that they have been fully corrected and that they will not happen again in future. These check-ups are also done to make sure that no additional errors have been introducing by the recent corrections. It is important to make sure that all the changes and corrections made to the system are documented accordingly for reference and recording purposes.

5.5.2 Adaptive maintenance

Like any other system, the Bus management system and application operate in an everchanging environment. The changing of the environment also detects that the system be accordingly changed s there may be need to add more features on the android application and desktop application to make sure they adapt well to changes that occur in the technological environment. Adaptive maintenance also include features and activities such as server upgrades, introducing newer, improved versions of the application as well as adding new features if necessary, documentation of all adaptive maintenance activities is also very important to provide room for future developments by other developers. Once a change need has been identified, it is discussed and analysed as well as and d reviews are done on a daily, weekly and monthly basis to make sure that the changes have integrated well into the system.

5.5.3 Perfective maintenance

A system is not implemented perfectly always during development due to schedule constraints, financial constraints and resistance to change. Therefore, the ZRP ICT department has the duty to make sure that the system is optimally functional by identifying areas of improvement that may be requires in the system. The drive should always be to make the system better and as efficient as possible by adding missing functionalities (Eppingner 2008). But however, it is important to analyse the risks involved with playing around and tempering with system on whether it is worth it and this decision left in the hands of management after filling a change request form like just like any maintenance done, perfective maintenance activities and ideas should be properly documented for future reference purposes.

When to Do Perfective Maintenance

- ➢ Users require additional features to system
- ➢ New additions are identified within the market
- ➢ Changes will improve efficiency of the system

5.6 CONCLUSION

In this chapter, we have discussed the implementation process. Which covered the testing of the system to different sets of data , coding and construction of the system finally the installation ,and security of the system in the next chapter we are going to discuss the maintenance of the system.