RFID SWIPE CARD AND MONITORING SYSTEM

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ZINARA RFID SWIPE CARD AND MONITORING SYSTEM

By

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DECLARATION

I, **Crezia Chiriya** hereby declare that I am the sole author of this dissertation. I authorize theMidlands State University to lend this dissertation to other institutions or individuals for the purpose of scholarly research

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APPROVAL

This dissertation entitled **RFID Swipe Card and Monitoring System** by **Crezia Chiriya** meets the regulations governing the award of an Honours degree in Information Systems of the Midlands State University, and is approved for its contribution to knowledge and literal presentation.

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ABSTRACT

The purpose of this research was to reduce fraud at toll collection points by ensuring that all toll fee revenue is collected at one central point and also to reduce the risk of theft and loss by doing away with the handling of cash at tollgate stations. To get an insight into the operations of ZINARA, a number of methodologies were used by the researcher which included interviews, questionnaires, and observations. The use of these methodologies helped to get detailed information, including shortcomings of the system ZINARA was using. The fact finding techniques used found out that the system that was in use took a long time to serve one motorist and this resulted in queues forming at toll stations. The system was also found to have loopholes and motorist could easily evade paying by conniving with toll operators. The RFID system was developed and documented using Microsoft Word 2010, PHP programming language, Dreamweaver CS6 and MySQL database server. The developer adopted a direct changeover strategy since it is not possible to do parallel processing on a toll gate system and besides, once the new system was in operation, there was no manual system to fall back on if the need arises. It was suggested that the FRID system could be further improved by networking the entire toll collection points across the country so as to enable vehicle and goods tracking.

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My supervisor, Mr S. Musungwini played a very big role in the success of this project. Had it not been for his guidance and support this project would not have been a success.

DEDICATION

I dedicate this work to my mum, Mrs M. Chiriya who is my pillar of strength, brothers and sisters in Christ for their prayers. May the God of my father Prophet Emmanuel Makandiwa meet you at the point of your need.

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LIST OF ACRONYMS

ZINARA	Zimbabwe National Road Administration
DoR	Department of Roads
Zimra	Zimbabwe Revenue Authority
DFD	Data Flow Diagram
DBMS	Database Management System
PHP	Hypertext Preprocessor
RFID	Radio Frequency Identification
SADC	Southern Africa Development Community
ICT	Information and Communication Technology
ROI	Return On Investment
CBA	Cost Benefit Analysis
ICDL	International Computer Driving Lessons

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CHAPTER 1: INTRODUCTION PHASE

1.0 INTRODUCTION

The research seeks to find an improved method of collecting tolls around the country in Zimbabwe. The system under study is an improved toll collection system that detects, bills and account for vehicles passing through tollgates. The system will use a Radio Frequency Identification (RFID) technology. RFID is a technology that makes use of radio frequencies to capture an object's information as it moves. The system utilizes a smart card and a computerized system that identifies vehicles and then electronically collects the toll based on the vehicle's characteristics. The system deducts the required amount from the vehicle owner's account. The aim is to reduce congestion, increase operating efficiency which in turn will improve travelling time. Vehicles will not stop but will only slow down, use a smart card which will deduct the toll fee from the account of the vehicle owner. This will eliminate the need for drivers to stop at toll booths and pay cash.

The system also aids in accounting or tracking of vehicles from one point to the other. This information is in the interest of both the sender and the receiver of the goods so they may plan accordingly. In future, the system can be designed so as to allow real-time tracking or satellite surveillance through networking all tollgates. RFID has the ability of reading objects out of the line of sight and whilst in motion. It is not affected by adverse weather conditions or chemicals and so it works in all weather conditions. RFID use will reduce the need for cashiers, supervisors, drivers and other staff at toll collection points.

The proposed system will reduce delays caused by exchange of cash and the issuance of receipts at toll points. A prepaid system is convenient and very safe in terms of cash transfers to banks. The product makes use of a boom gate which gets instructions, depending on the vehicle account status, from a small computer.

1.1 BACKGROUND OF THE STUDY

Background information according to Kendall and Kendall (1987) determines your basic understanding concerning the problem under investigation. It also gives confidence of the value of the investigation of the study and its findings.

Toll collection is a major source of fund for road and bridge construction, road maintenance and improvements of the overall road infrastructure in Zimbabwe and Southern Africa. Implementing tolls in Zimbabwe was also a strategy adopted by the Government so as to avoid tax increases to the already burdened people in the country. Tolls guarantees a steady flow of revenue and the rate of evasion is very low as compared to other forms of taxes.

In August 2009, Zimbabwe introduced Road Tolls following a Government policy on the major highways of Zimbabwe. To relieve pressure on the national fiscus, tolls were implemented for the purpose of pooling together funds in the name of the Road Fund. The collected tolls ranged from as little as US$1 to as much as US$5 with small cars forking out US$1 while haulage trucks fork out US$5 at every toll collection point. Recently the fares have been revised upward with small vehicles paying US$2 while haulage trucks pay US10. The money is to be solely used to fund road construction projects and maintenance works in the country's highways. The project also funds urban council roads, DDF and Rural District roads.

As a starting point ZIMRA worked together with the Ministry of Transport to build structures which would be used to collect tolls. Toll collection started on 18 August 2009 which marked a historic event in Zimbabwe. As it stands today there are 24 structures put in place to collect tolls from motorists travelling along the highways of Zimbabwe. When the project started, ZIMRA made an arrangement with the Zimbabwe National Road Administration (ZINARA) to collect tolls on behalf of ZINARA and retain a 10% administration fee. Security was provided by the Zimbabwe Republic Police (ZRP). Recruitment and training of staff who would work at toll gates was the responsibility of ZIMRA. Signage in line with SADC guidelines was also put in place by the Department of Roads in conjunction with ZIMRA to inform motorists of the existence of toll gates. Toll collection was done manually by having a cashier with a receipt book

in the road under some temporary shelter. The cashier would collect the required fee, issue the road user with a receipt before proceeding.

This system had so many loopholes which deprived the Road Fund of so much revenue. In October 2013, ZINARA took over its responsibility from ZIMRA which coincided with the introduction of a computerised tollgate system which is now in place. Since ZINARA takeover, revenue has increased probably due to the computerised system that ZINARA is using. Despite the project being welcomed by many in Zimbabwe, problems of accountability, corruption, revenue leaks and lack of transparency have come up from different stakeholders. The general citizens of Zimbabwe and the road users' confidence have diminished over the collection process.Ever since the introduction of tolling in Zimbabwe in 2009, an average of US1.5 million per month was being raised. The figure almost doubled when ZINARA took over the collection.

1.1.1 Background of the Organisation

Organisation background is the history, knowledge, including any other information relating to the organization being investigated (Tiger 2003). Zimbabwe National Road Administration (ZINARA) is a corporate body which was established by the road act in 2002. Its core business is to see to it that the country's road network is in good and passable condition. It works hand in hand with Ministry of Transport and Infrastructural Development. ZINARA is responsible for coming up with road charges for users and for collecting those charges and other revenue for road fund. The collected funds are also audited by ZINARA to ensure that the funds allocated each authority is used for the purpose for which it was intended. This will help to accelerate the rate at which decisions are made concerning budgets and equipment hire. Besides funding road authorities, ZINARA monitors the execution of works and helps the Ministry to set maintenance, design and construction standards as well as ensuring adherence to the set standards.

ZINARA is seen as a reservoir where various charges for road use are depicted as small streams feeding into the reservoir. These small streams are Abnormal Load, Vehicle Licence,

Fuel Levy, Road Transit and Toll Fees as well as Grants and Loans. The diagram below shows how funds flow into and out of the reservoir as shown by red arrows.

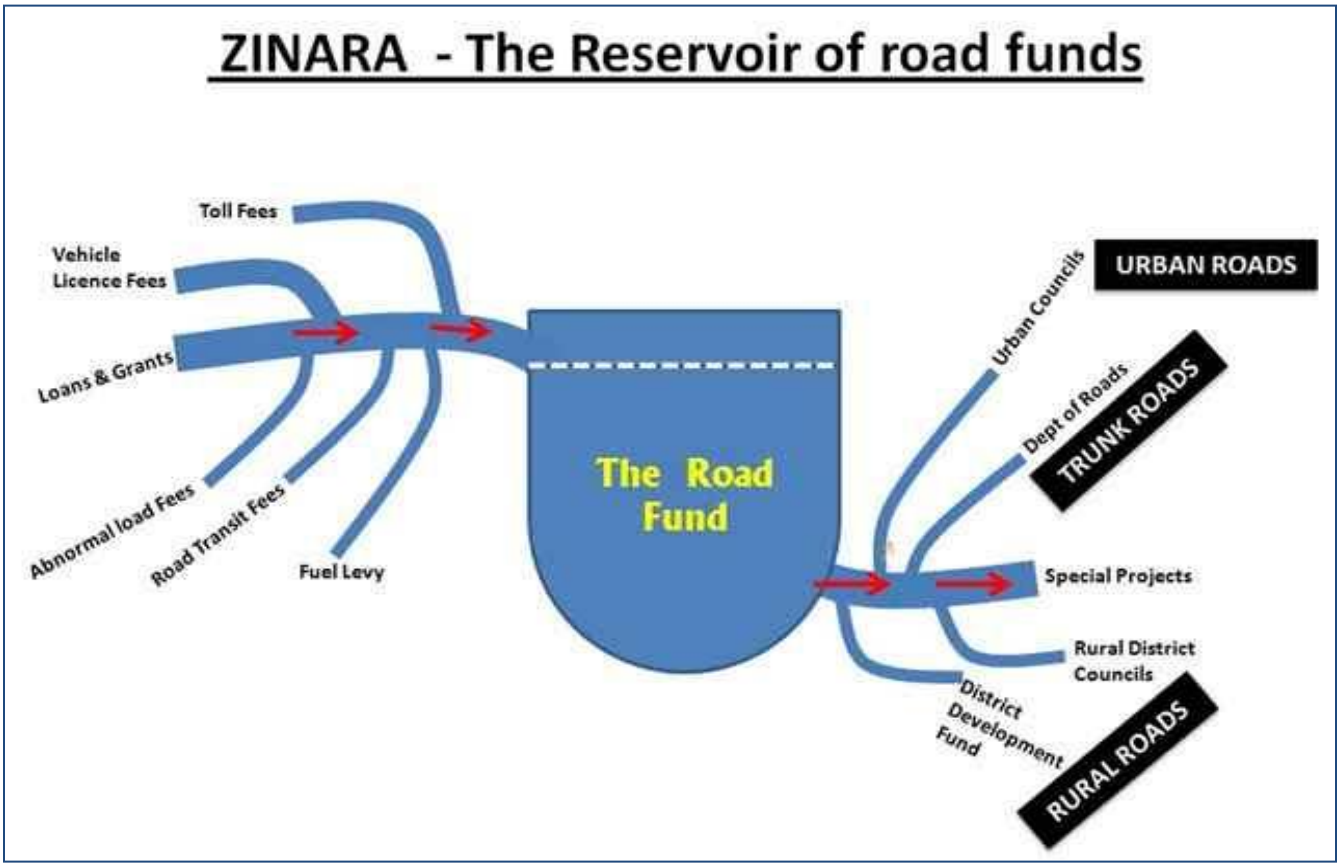


Fig 1.1 **The Road Fund**

From the Road Fund, funds are disbursed to various authorities such as Department of Roads for construction and maintenance of trunk roads, Urban Councils for maintenance of urban roads, DDF and RDCs for rural roads construction and rehabilitation. Emergency works and special projects in certain areas mentioned above are also funded.

1.1.2 Organisational Structure

According to Abramonwicz (2009), organisational structure depicts the hierarchy and how related elements within the organisation are organised to achieve a common goal. The figure below shows how the ZINARA structure is organised.

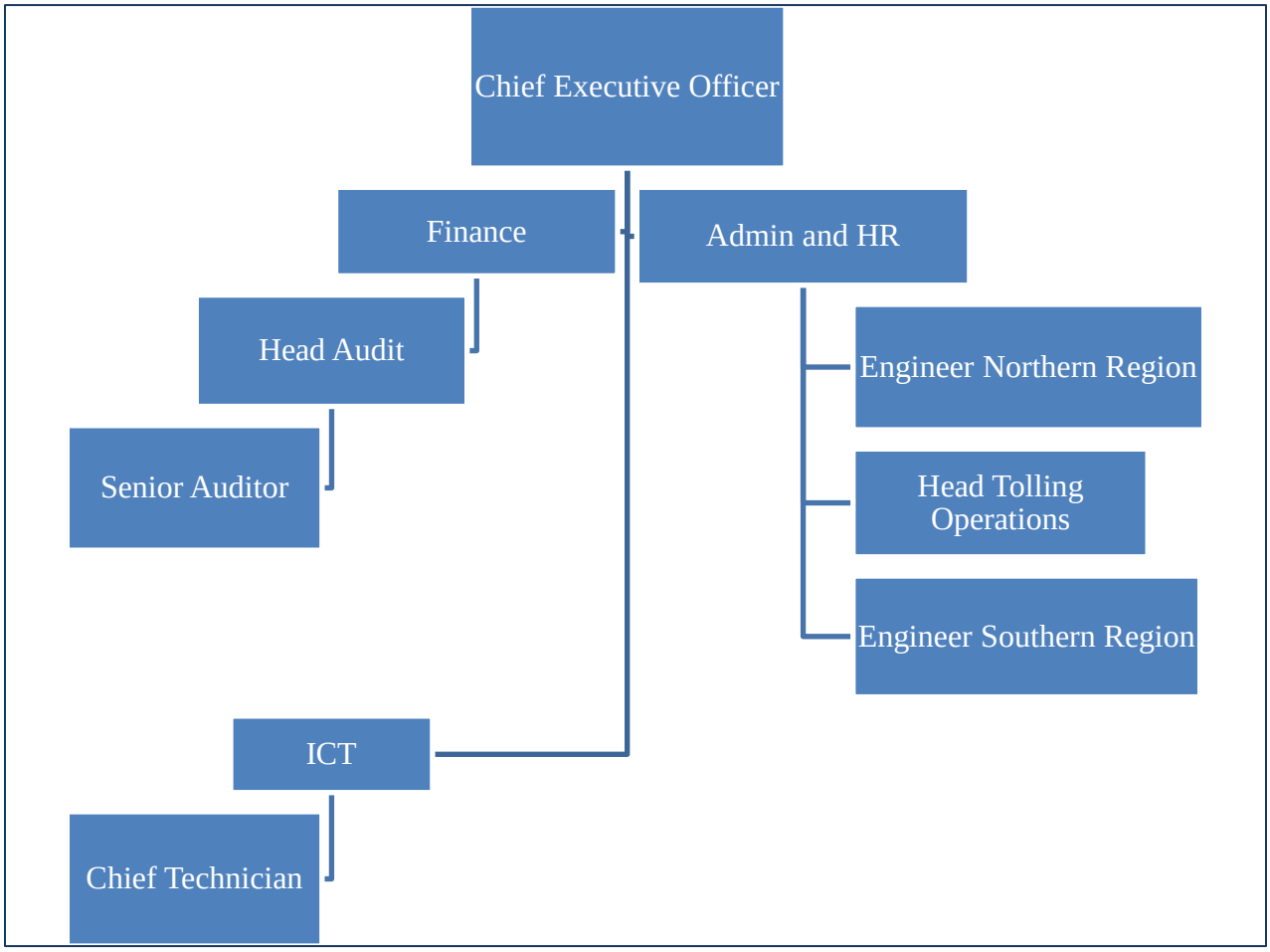


Fig 1.2 **: Organogram**

1.1.3 Vision

Bruce M, (2009) sees a vision as a statement that defines why your organisation will be in existence tomorrow and what it is doing today. It points to where the organisation seeks to go from where it is now, setting goals and their accomplishment dates. ZINARA's vision is:

- To become a world class road fund manager, providing a secure, stable and adequate reservoir of funds.

The RFID swipe system will promote ZINARA vision by ensuring that all fees and levies collected with minimal loopholes

1.1.4 Mission

A mission statement serves to announce why your business exists and what it is doing today. It brings out the uniqueness of your products or services both to customers, employees and the general public. The RFID system fits well with the ZINARA mission of collecting funds from motorists. The mission statement for ZINARA is:

- To effectively fund maintenance of the national road network through fixing, collection, disbursement & monitoring of funds usage for the preservation, enhancement and expansion of the network to achieve economic growth and sustainable development.

Corporate Values

ZINARA is guided by the following corporate values:-

1. Transparency
2. Accountability
3. Safety
4. Integrity
5. Fairness

6. Excellence
7. Innovation

Core Business

a) In consultations with the Minister of Transport, Communication and Infrastructural Development ZINARA is responsible in fixing Road User Charges and to collect or any other revenue of the Road Fund.
b) Management, control, allocation and disbursement of moneys collected from the road fund.
c) To monitor the implementation of road maintenance works by road authorities.
d) To assist the Minister in setting maintenance, design, construction and technical standards and to monitor adherence to such standards by road authorities.

1.2 PROBLEM DEFINITION

Problem definition gives a clear understanding concerning the problem that needs to be addressed prior to any work plan. The cause or source of the problem has to be identified first and the system boundary has to be made clear (Leffingwell 2003).

The current system of toll collection in Zimbabwe leaves a lot to be desired. The possibility of fraud from toll gate cashiers is very high because there is no monitoring system to make sure that every vehicle that passes is correctly billed. There are also difficulties in coming up with adhoc statistical analysis of how many heavy or light vehicles have passed through all toll gates around the country. Risk can be incurred during the transportation of cash to banks or even at the toll gate centres there is high risk of theft in the current system. Since there is no central database that captures all the activities happening at each toll gate, preparing financial statements such as profit and loss and balance sheet because there is no central database that captures all the activities happening at each toll gate.

- Expenditure incurred in buying both running and constant expenses like transporting toll gate personnel everyday and revenue to banks, raw material, for example, printing paper and printer cartridge.
- Each transaction seemed to take twenty minutes to complete.

1.3 AIM OF THE RESEARCH

According to Grey (1999), aim refers to set goals that need to be achieved. The aim of the RFID toll collection system is to ensure that the correct amount is collected and that collector and user fraud is greatly discouraged. It eliminates delays caused by collecting tolls manually and it will also provide a more efficient solution for toll collection and management in highways. The system will enable control and remote monitoring of tolls by the use of smart cards technology.

1.4 OBJECTIVES OF THE PROPOSED SYSTEM

Objectives, as put across by Tannenbaum (2001), are targets that are specific, attainable, realistic and measurable that the system should achieve within a set time. The proposed system makes use of RFID cards that are swiped at every toll gate around the country. This card will be issued by ZINARA whenever a new vehicle is registered and is loaded with cash through the use of EcoCash or through all post offices across the country. When a vehicle passes the toll gate the card is swiped and automatically deducts the amount from the card balance. This facility will be met by the following objectives:

1. To reduce fraud by ensuring that all revenue is collected at one central point.
2. To easy the process of summing up all financial statements by uploading all financial data to a central database through the use of a key field to identify all toll gates.
3. To greatly reduce the risk of theft by doing away with the transportation of revenue or collection of cash at toll gates.
4. To reduce the running costs and constant expenditure on fuel during transportation of revenue.

5. To make it easy for calculation of statistical adhoc reports since all the data will be on one central database.

1.5 INSTRUMENTS

According to Burns and Grove (2003), an instrument is a blue print used to accomplish a purpose such as carrying out a research study. A range of instruments such as the internet, books, journals and newspapers among many others can be used to get information and to understand the system under investigation.

The following sources of information will be used by the analyst:

- Roads Manuals
- Road Acts
- The internet
- Electronic journals

1.6 HYPOTHESIS

Hypothesis is defined by Steve, (1994) as tools that the researcher is going to make use of during the development of the software product. The new system will be developed using the following tools:

- PHP (Hypertext Pre-processor) - PHP is a multi-platform programming language that can run on Windows, Linux and many other Operating Systems.
- MySQL- is a database server which is multi-threaded and implements client/ server applications. It is easy, fast and robust which makes it more popular among other databases especially when using it in dynamic content sites.
- Java Script – simple client-side scripting language that runs very fast without having to wait for the server to give an answer.

1.7 JUSTIFICATION

Justification of the study as viewed by Steve (1994), points to accrued benefits coming from the system to be built.

- The current toll collecting system requires an average of fourteen personnel. The introduction of the proposed system will greatly reduce operations costs and improve traffic management.
- Enforcement against Violations is fair and transparent.
- Potential losses from payment evasion are easily identified, quantified and mitigated
- The level of compliance with this system is fairly acceptable and efforts for enforcement are fair.
- The system will provide smooth flow of traffic at toll points
- The inconvenience which comes with handling cash and the need to provide change to users will be eliminated
- This system offers convenience and quick service to road users
- Pollution caused by acceleration and de-acceleration at tollgates is reduced because the vehicle does not need to stop.

1.8 CONCLUSION

The developer after having noted down all the shortcomings of the system in place, how it is affecting the functioning of the organization, he then moved on to consider each objective to be achieved by the new system. Checking the feasibility of the project, analyzing potential adverse effects that may affect the development and implementation of the project was the next step. Feasibility study focuses more on the economic side, the social side, technical and schedule aspects.

CHAPTER 2: PLANNING PHASE

2.0 INTRODUCTION

This phase is going to make an assessment to find out if it is feasible or possible to go ahead with the development of the system proposed in chapter one. The decision will be made after considering the technical, social, operational and economic factors likely to affect the development of the proposed system. The benefits that will accrue to stakeholders and the business value the system will bring to the organization should be established. Here the developer will check and establish if the benefits that will be brought by the new system exceeds the cost of development. The sequence of activities to be carried out and their durations are outlined in the work plan table and the Gannt chart. The outcome of the study carried out in this phase will determine whether to go ahead with the development of the system or to abandon it. The decision will be made after an analysis of risks that may affect the project as well as constraints to the development of the project.

2.1 WHY THE SYSTEM HAS TO BE BUILT

The following justifies the development and implementation of the new system:

- System objectives supports the organisation's vision and the mission.
- The objectives of the new system also are in line with the ZINARA's corporate values and its core business.
- The development of this system will provide a reliable 24 hour operation with reduced personnel requirements.
- Transaction times are greatly reduced thereby increasing lane capacity and elimination of queues.
- Since cash transactions are eliminated and there is no interaction between a road user and a toll collector, fraud risk is reduced.

Business Value

Business value, according to Baines (1999), measures the efficiency and how effective the new system is in delivering the required tasks. A firm should create value for customers, employees and distribution partners. Business value goes beyond economic profit and shareholder value. It includes employee value, supplier value, customer value, managerial value as well as societal value.

Every business aims at advancing in technology and so the new system will be an advancement in technology for ZINARA. Revenue inflows will be increased since payment evasion is curbed. Overhead costs are also reduced greatly due to the reduction in staff working at the toll sites and the need for cash transportation. Accountability of the collected funds is improved and errors caused by human calculations reduced. The public in general will benefit from the system in terms of time saving by avoiding waiting in queues to make payments.

2.2 FEASIBILITY STUDY

Feasibility study is an investigation carried out at the initial stages of development to ascertain the benefits of the proposed venture and also to see if it is practical feasible to undertake the venture and complete it successfully (Peter R. 2004). Feasibility studies are preliminary investigations into the potential benefits associated with undertaking a specific activity or project. In this phase the developer analyses and evaluates the viability of the proposed project by investigating and identifying all the factors that give reasons whether to proceed with the project or to discontinue it.

This phase is carried out focusing mainly on costs and the benefits of the proposed system. The factors looked into included operational, schedule, economic, technical and legal feasibility. Evaluation criteria, in this study the Return on Investments (ROI) determined the economic feasibility of the project. Another technique called the cost/ benefit analysis weighed the benefits against the costs to the project. The first factor to be looked into was the technical feasibility of developing the system.

2.2.1 TECHNICAL FEASIBILITY

Peter R. (2004) defines technical feasibility as a process of ascertaining the availability of the required hardware and software to accomplish the project. An assessment was made to understand the available technical resources the organisation has and how they can be applied to the development of the proposed system. The hardware and software needs were evaluated to determine if they meet the requirements of the system to be built. The technical expertise of the staff was also looked into to see if the available staff can handle the development of the project to completion.

Hardware Requirements

Transponder, antenna, RFID tags, PCI, printers, computers and routers.

Software Requirements

Windows 8 Operating System, MS Office 2013, Database software. Java, C++, Visual basic.

Remarks

Some pieces of hardware such as the RFID tags were not easily available in the country. However, the parts needed for setting up the billing and mechanical side were readily available in the country. The PCI is available in Zimbabwe though it is expensive. Some of the hardware and software required to build the system are already owned by the organization. The department had recently acquired new desktop computers which run on Windows 8 and came preloaded with MS Office 2013. Other software such as the Database software and Web browser are open source.

Manpower Requirements

All the users of the system are computer literate with at least an International Computer Driver's Licence (ICDL) or higher qualification. The developer has knowledge in Object Oriented Programming in the likes of Java, VB.Net, C++ and PHP. He is also well versed with MySQL and MS Access.

Comments and Remarks

The available technical resources can be easily upgraded to meet the requirements of the proposed project. The organization also has got the required technical expertise to undertake the project. After comparing the technical requirements of developing the system with the organisation's technical capability, the project was found to be technical feasible.

2.2.2 ECONOMIC FEASIBILITY

Peter R. (2004) views economic feasibility as measuring the benefits to be derived in comparison with the costs incurred in developing the system. The purpose of this assessment is to establish the economic benefits the organisation will derive from the development and implementation of this system. All expected positive benefits, both tangible and intangible are to be identified and quantified. The cost/ benefit analysis is carried out during this assessment so as to compare benefits and savings against costs incurred. The costs includes both development costs, operating costs and costs of acquiring hardware and software.

A ROI analysis was done to see if indeed there is justification to build the proposed project. An analysis of the time required to achieve a return on investments was done and the future value of a project is also considered.

Table 1.1 : Cost Benefit Analysis

Benefits	2015	2016	2016	2017
Time saving	$3000	$3000	$3000	$3000
Increased efficiency	$3000	$3000	$3000	$3000
Increased productivity	$4500	$4500	$4500	$4500
Improved resolution of problems	$3200	$3200	$4000	$4000
Speed generation of reports	$4000	$2000	$2000	$2000
Total Benefits	**$17 700**	**$15 700**	**$16 500**	**$16 500**

Costs

Costs	2015	2016	2017	2018
RFID Reader	$3500	$0	$0	$0
RFID Tags	$2000	$0	$0	$0
Software	$1000	$0	$0	$0
Capentry and Mechanics Equipment	$2000	$0	$0	$0
Labour	$3000	$0	$0	$0
Maintenance	$3500	$3500	$4000	$5000
User training	$3000	$0	$0	$0
Stationary and consumables	$2000	$2000	$2000	$2000
Total Costs	**$20000**	**$9500**	**$8000**	**$5000**

Table 1.2: Cost Benefit Analysis Results

	2014	2015	2016	2017
Total Benefits	$21 700	$15 700	$16 500	$16 500
Total Costs	$20 000	$9 500	$8 000	$5 000
Benefit/(Loss)	**$1700**	**$6200**	**$8 500**	**$11 500**

Comments and Remarks

From the outset, costs are outweighed by benefits and the overall profit shows a stable increase rendering the project economically beneficial.

Return on Investment (R.O.I)

The project's viability is calculated using this technique by weighing invested amount against the profit to be derived from the venture. The gains of the project is calculated by making it a percentage of the initial investment. It is calculated as follows:

ROI = (Net benefits) *100
Total Costs

Year 1 = 1 700 * 100 = 8.5%
20000 9500

Year 2 = 6 200 * 100 = 65.26%

Year 3 = 8 500 * 100 = 106.25%
8000

Year 4 = 11 500 * 100 = 230%
5000

The return on investment of the project is seen to be increasing year by year as shown by the above workings, giving a positive sign to the development of a new system. This has proven that costs of this project are lower than the benefit. ROI of this project shows a sharp increase of 221.5% from the first year to the fourth year. This increase is attributed to lowering of costs most likely development costs. Considering all this, the proposed RFID system can be deemed as feasible economically.

2.2.3 SOCIAL FEASIBILITY

Social feasibility is important to evaluate the effect the system will have on society and other stakeholders (Steve, 1994). The beneficiaries of the system rather than the organization is the focal point of this study. Both negative and positive impact to society is looked into with a view of producing a society friendly product. The effect the system will have on other organizations and other people outside of its organization is analysed in this phase.

The RFID System will affect the society in the following ways:

- Better utilisation of resources will lead to increased productivity, hence increased trafficability on the roads.
- It may challenge other companies to improve their technology services
- Accountability of tax payers' money will lead to appreciation by the public
- It will avoid fuel loss on the part of motorists

The system seems to impact the wider society in a positive way and is not in conflict with any legal requirements. For example, the data processing system is complying with the local Data Protection Acts. Because of these factors the project is deemed socially feasible.

2.2.4 OPERATIONAL FEASIBILITY

Steve (1994) defines operational feasibility as studying and establishing the usability of the system if it is developed and implemented. The organisation's willingness to support the proposed project and management commitment is reviewed here. This is a study that determines the operability of the system with reference to expectations of the users. The given solution has to fit in the existing structure of the organization and also comply with its IT policies.

The RFID system will lessen the workload of tollgate staff as well as staff at the offices who were overwhelmed with counting and calculating cash for banking every day. The training requirements will be minimal since most organization staff are compute literate and have been working with the previous system even though the feature of swiping was not there. The users have been involved in the planning and development of the project, and they found the system reliable and easy to work with. Management have also supported the project seeing that it will boost revenue and reduce overhead costs to the organization.. The proposed system fits well within the existing structure, the corporate culture and existing business processes of the organisation. The delivery date and the schedule of the project is within a reasonable timeframe and so the project is operational feasible.

2.2.5 SCHEDULE FEASIBILITY

According to Steve (1994), schedule feasibility is done to determine the likelyhood of completion of a project within the stipulated time frame. If the project has a high likelihood of completion by the desired due date, then schedule feasibility is considered to be high. A project that is delivered late is always considered a failure. Technology is moving at a fast pace and in this case quick delivery of the product is very vital. The probability that the RFID system will be completed on time was calculated and found to be high rendering the project schedule feasible. Given the technical expertise in the organisation, the project deadlines are reasonable.

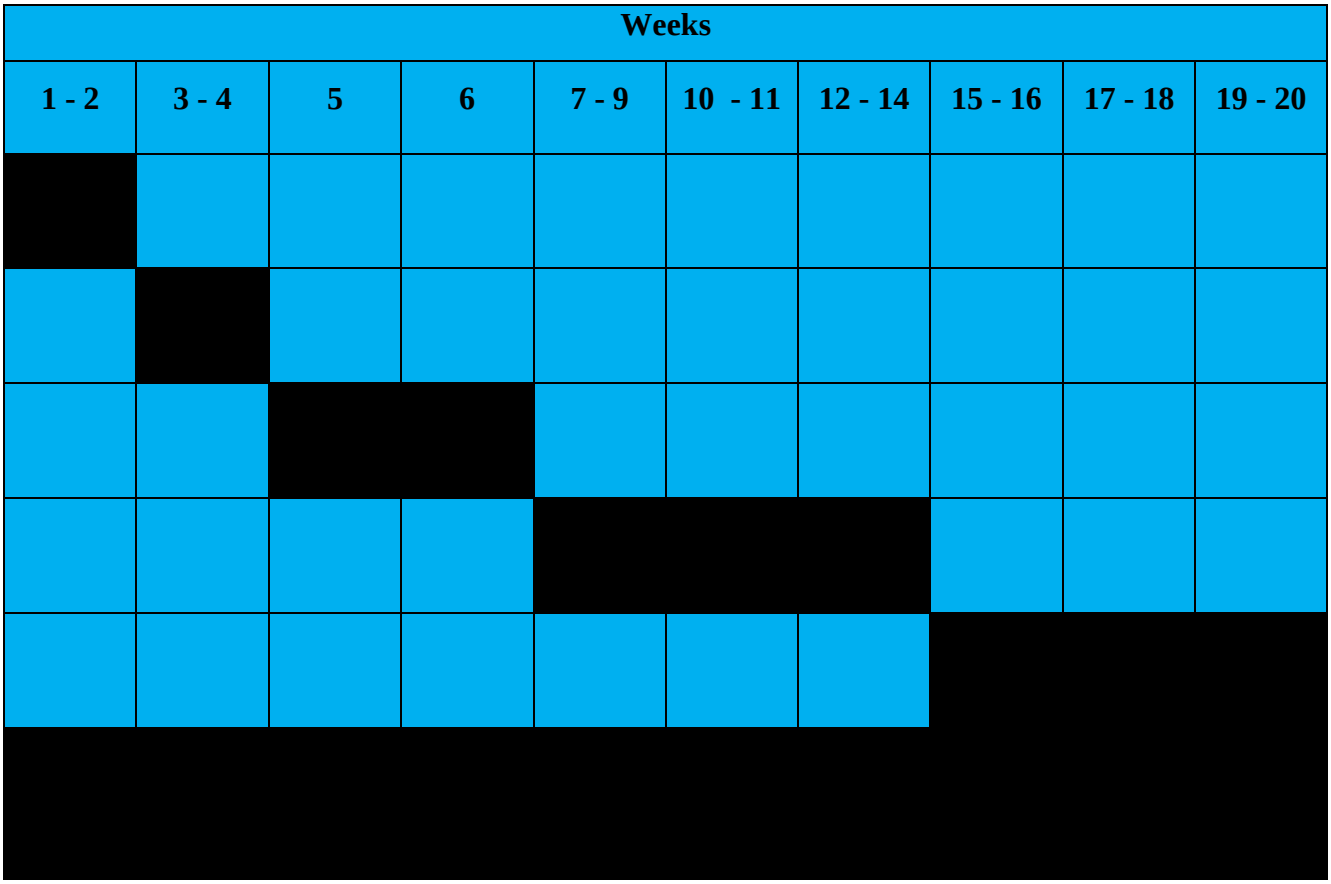
2.3 WORK PLAN

Kleim and Ludin (1998) are of the view that a workplan gives activities to be carried out in their sequential order including their start date and stop date. The developer designed a work plan which showed the different phases of the whole project to be carried out to completion. It estimated the start and finish dates for each phase as well as the duration. Table 3 shows the work plan drawn up by the developer while table 4 depicts the gantt chart which is a pictorial representation of the phases and their durations.

Table 3: Work Plan

Phase	Start	Finish	Duration (Weeks)
Proposal	14/07/14	21/07/14	2
Planning	24/07/14	04/08/14	2
Analysis	07/08/14	21/08/14	2
Design	22/08/14	16/09/14	8
Implementation	17/09/14	27/09/14	6
Documentation	14/07/14	27/09/14	20

Fig 1.3 : Gantt chart



2.4 RISK ASSESSMENT

Risk assessment is defined by Mike C. (2001) as identifying and calculating the probability of the occurrence of some adverse events that might hamper the development of the project. Identification and management of risks likely to affect the project has to be done by the organisation so as to ensure a successful project development. Undesirable events and risks were looked into with the hope of reducing or minimising the effect on the project. Mitigation plans were put in place for every identified risk using a proactive approach rather than a reactive one. For other risks, contingency plans were made so as to avoid complete disasters when certain types of risks occur. The sources of risks and the characteristics of the risks to the proposed system the developer identified include:

Business Process Risk

These threats are most likely to impact the RFID system as a whole. These could be destruction or loss of data. Reasons for business risks are many including human action which can be malicious or unintentional. They could also occur as a result of natural events such as a storm damaging the tag and making it unreadable. The environment where the system is setup can also influence some risks. Tags can be cloned and the organisation networks can be attacked. All these risks affect the business as a whole.

Business Intelligence Risk

Threats resulting from unauthorised entry into the system and accessing sensitive information can be very damaging to the reputation of the organisation. There are several ways that an adversary can use to gain access to the RFID system and obtain information. Eavesdropping is one way that can be used to get information on RFID transactions and reading tags. Usually the risk is often realised when some harm is done using the obtained information.

Privacy Rights

People's rights may be infringed or expectations compromised if information collected by an RFID system is used for other purposes rather than the intended purpose. There is a risk of that information being used for the purpose which the individual may find undesirable such as profiling customers. There is also the concern of being tracked or targeted because of the information getting into wrong hands. The organisation may suffer penalties of not complying with privacy regulations and even legal liability.

Externality Risk

Every connected system is vulnerable to attacks which can come as malware, software viruses or any other software vulnerability that renders the system inoperable. Hackers can gain access and perform a denial of service attack on the system or they may cause any other damage. The impact of these attacks range from inability to operate the system, performance degradation to compromising a critical application such as an RFID system.

Unavailability of the System

In case of failure of any one component of the RFID system, the entire system would be rendered non-functional. There are many causes of components failure which include a virus that may directly attack the system components of an RFID disrupting the correct functioning of the system. Radio interference can also cause readers to fail to accurately read tags. Unavailability of the system impacts negatively on business processes and can devastate the organisation.

Complexity of the System

The complexity of the RFID technology coupled with change is risky enough to the organisation

The other risk is of the sponsors failing to fund the project to completion since the money for the project was not availed to the project team in advance. The development team also runs the risk of not being able to complete the project within the set time frames.

Measures put in place to minimise the occurrence of those risks

Strong security controls and countermeasures are to be put in place to curb the various types of risks that are likely to affect the operation of the system. Some of the controls put in place are as follows:

- To curb the risk of unavailability of the system, the RFID system should be built with robustness and fall back procedures should be put in place in case of system failure.
- Frequency hopping techniques can be performed to avoid collisions and radio interference effects can be reduced by assigning fixed frequencies onto an RFID appliance. The system should be set up in an environment with less radio frequency interference, low temperatures and no humidity.
- Unauthorised access can be addressed by using a tamper resistance technology. This technology servers the connection between a tag and the antenna thereby disabling the tag completely.
- Before data is written to a tag, it has to be encrypted by the reader. This will protect sensitive data from unauthorised individuals who may want to read or alter information on tags. Data encryption prevents eavesdropping during over the air transactions.
- System backup has to be performed on a daily basis

2.5 CONCLUSION

The system proposed has proved to be feasible in all aspects analysed, it was agreed by management that the system, once developed and implemented will address the organisation's problem of collecting tolls manually. Both system users and other stakeholders will also benefit immensely from the introduction of the RFID Swipe system. A feasibility report submitted to the Chief Executive Officer, who is the head of office and after assessing the technical, operational, schedule and economic feasibility of the proposal, and having established that costs are moderate and the funds are available, a green light was given to the development team to go ahead with the next phase of development. The RFID System proved to be a project worthwhile to undertake having passed all the feasibility studies. The developer after considering all areas that might hinder or negatively affect the completion of the proposed system, was convinced with certainty that the development of the system can proceed to the next stage.

The reasons for proceeding being that it has

- Gotten management approval to proceed
- Proved feasible in all areas.
- Scheduling and completion dates are deemed reasonable.

The completion of planning in this chapter paved way for analysis of the system which is the next stage in systems development life cycle.

CHAPTER 3: ANALYSIS PHASE

3.0 INTRODUCTION

This stage involves requirements analysis which the proposed system aims to achieve. The major emphasis being production of a documents listing all the requirements of the new system. All the processes, inputs and outputs of the system have to be analysed so as to be able to come up with the requirements document. All the systems entities, attributes and connections between the entities are shown in database tables and are also depicted in entity relationship diagrams. The type of a database model has to be decided in this phase.

Systems Analysis is a critical activity whose major objective is to have an insight on the underlying limitations of the current system, to have a clear picture of the operations and functions of the system under study and to propose a number of alternatives to counter the negative effects of the existing system.

3.1 INFORMATION GATHERING METHODOLOGIES

As a systems analyst one would use:

- Interviews
- Questionnaires
- Observation
- Document review.

All the methods stated above have strengths and weaknesses whenever they are used to gather information. All methods supports the same aim of bringing the information together for analysis purpose. They aid the researcher in formulating solutions basing on the weaknesses or shortcomings of the present system.

3.2.1 Interviews

Peter R, (2004) defines interviews as methods of gathering information involving at least two people, that is, interviewer and interviewee. The obtained information is to be used in the analysis of the existing system to see its functionality and limitations. The researcher managed to get as much information as one would want by probing and encouraging the interviewees to expand their answers. Areas of discussion were determined by the researcher who made use of a wide range of questions to solicit ideas relevant to the study. The date and time of the interview was agreed upon by both the researcher and the respondents. All interviews were held in the ZINARA board room at Department of Roads premises.

Findings from the Interviews

The need for a Toll gate RFID swipe card based application system was highly emphasized by the organizational staff and also by the general public. The Group manager expressed his displeasure with the current system's inability to handle fraud thereby rendering it very inefficient and paving a way of defrauding the government. The risk of transportation of cash from the tollgate station to the backs was also mentioned as a major concern and a shortcoming of the current system.

Advantages

- The researchers were able to clarify questions to those being interviewed and thus were able to obtain clarified and easy to interpret responses.
- The researchers were able to obtain first-hand information from interviewees through body language.
- Immediate answers to questions made it possible for the researcher to make quick decisions on the spot.
- Areas that were not clear through observation and document review were clarified through interviews and all misunderstandings concerning the system were cleared.
- Because it was a one on one discussion, respondents felt so much at ease to respond freely without fear or rebuke from their superiors.

Disadvantages

- More time was spent clarifying questions or resolving misunderstandings between the interviewer and the interviewee.
- The researcher incurred so much in terms of costs which included travelling to the designated venue each time an interview was scheduled.
- It was difficult to get information from some respondents who for their own reasons thought that the information asked was confidential.
- In some case arguments arose concerning a certain issue which resulted in time wasting and other arguments were simply left unresolved.

3.2.2 Observation

Observation involves quietly monitoring the processes of the current system and the workers using the system to try and get as much information about the system under study (Peter R, 2004). Observations were carried out in the field on the toll gate stations where vehicles ended up queuing in the highway because some would pay using hundred dollar notes which took long to verify and issue change. Also it was observed that it becomes difficult to track who has done what and at what time. A sample observation score sheet is found in the appendices.

Advantages of Observation

- It provides the best way of obtaining unbiased information
- The researchers through observation interpreted the researched information correctly.

Disadvantages of Observation

- It proved difficult for the researchers to be in each and every department when a certain operation was being performed.
- It was demanding to the researcher in terms of personal commitment.
- The researcher observed that some workers during observation tend to change their normal behaviour after realizing that they were under observation.

3.2.3 Questionnaires

Brian J (1999) views questionnaires as another method of gathering information by distributing set questions to chosen recipients to get their views and opinions on a certain subject matter. Questionnaire are pre-coded questions written and given to respondents to answer and return back to the researcher. Management, a few toll operators and a sample of cashiers were handed questionnaires to answer by the researcher. This was an easy way of obtaining qualitative information about the system in place. The loopholes of the existing system were asked and respondents were asked to make their own suggestions and recommendations for improving the system. Most of the questionnaire respondents were of the view that the system is not that efficient because the total transaction time is too long. The issue of trying to get change from big notes also lengthened the processing time.

Advantages of questionnaires

- Respondents have time to consider their responses before writing them down on the questionnaire.
- It allowed for anonymous input and thereby producing precise information
- The respondents answers were standard
- They were economical to administer and they save time

Disadvantages of Questionnaires

Notwithstanding all the merits of questionnaires they have their own weaknesses which we noted during our information gathering process and these included the following:

- One on one interaction with the respondent is not possible and as a result, wrong interpretations may be made to questions which may compromise the validity of answers given
- There was non-compliance by other staff members who simply chose not to complete or return some questionnaires.
- There was no room for probing or expansion of questions, therefore respondents were not expressing their opinions to the full or explaining further

3.2.4 Document review

Document review is a way of collecting data by reviewing existing documents which may either be internal or external to an organisation (Lusthaus C. et al 1999). The developer carried out a documented research to compare current systems, new technologies and the constraints currently experienced by different systems that have a similar ethos as the one under construction. Documents reviewed included reports, funding proposals, newsletters and meetings minutes.

Advantages of Document Review

- Relatively inexpensive
- Provides good background information
- There are no obstructions
- Provides an insight into areas that are not directly observable
- Concerns uncovered by other methods may be brought up

Disadvantages of Document Review

- Shallow information is obtained.
- Outdated information may be obtained
- Biased, inaccurate and incomplete information may be obtained
- Collecting, reviewing and analysing many documents is time consuming

3.2 ANALYSIS OF EXISTING SYSTEM

The current system is a computerised system which has its own drawbacks whereby the entire cash collection, data retrieval, reports management and the issuing process is done manually and all records are kept at each station, that is, its not centralized. To help analyse the current system, the following were used:

3.3.1 Inputs

Point Of Sale Member.

These are the details required from a POS member:

- Name
- Surname
- National Registration Number
- Contact Address
- Cell phone Number
- Username
- Password

Car details.

These are the details required when registering a vehicle:

- Make
- Model
- Chassis Number
- Engine Number
- Plate Number

Point Of Sale Details

These are details captured whenever a vehicle passes a toll gate:

- Vehicle Class
- Amount Tendered
- Date and Time

3.3.2 Processes

Processes undertaken are:

- Vehicle Registration

When a new vehicle is registered, the vehicle details are captured mainly taking note of the vehicle make and model so that the system will know how much to deduct when that vehicle passes a toll gate.

- Synchronization of transactions

Transactions are collated and sorted at Provincial offices and summaries are sent to Head office where reports are prepared basing on the received information and reports from Provinces.

3.3.3 Outputs

Outputs produced include:

- Reports of all transactions of each toll gate.
- Reports of all exempted vehicles for each station
- Profit and loss analysis

3.3 PROCESS ANALYSIS

Jeff M (2001) defines process analysis as a process of breaking down and examining each process of the system in relation to operations, inputs and outputs that shall take place. This process analysis is carried out to highlight what is happening in the current system. Activity diagrams aids by highlighting clearly the sequence or order of activities in the system.

3.3.1 Context Diagram

"A Context Diagram is a single picture that has the system of interest at the centre, with no details of its interior structure or function, surrounded by those elements in its environment with which it interacts" (Stuart Burge 2011). The boundary of the system can be defined clearly by the use of a context diagram. All interacting elements of the system are identified thereby giving a clear comprehension of the system under investigation. Below is a context diagram illustrating with who the system interacts with.

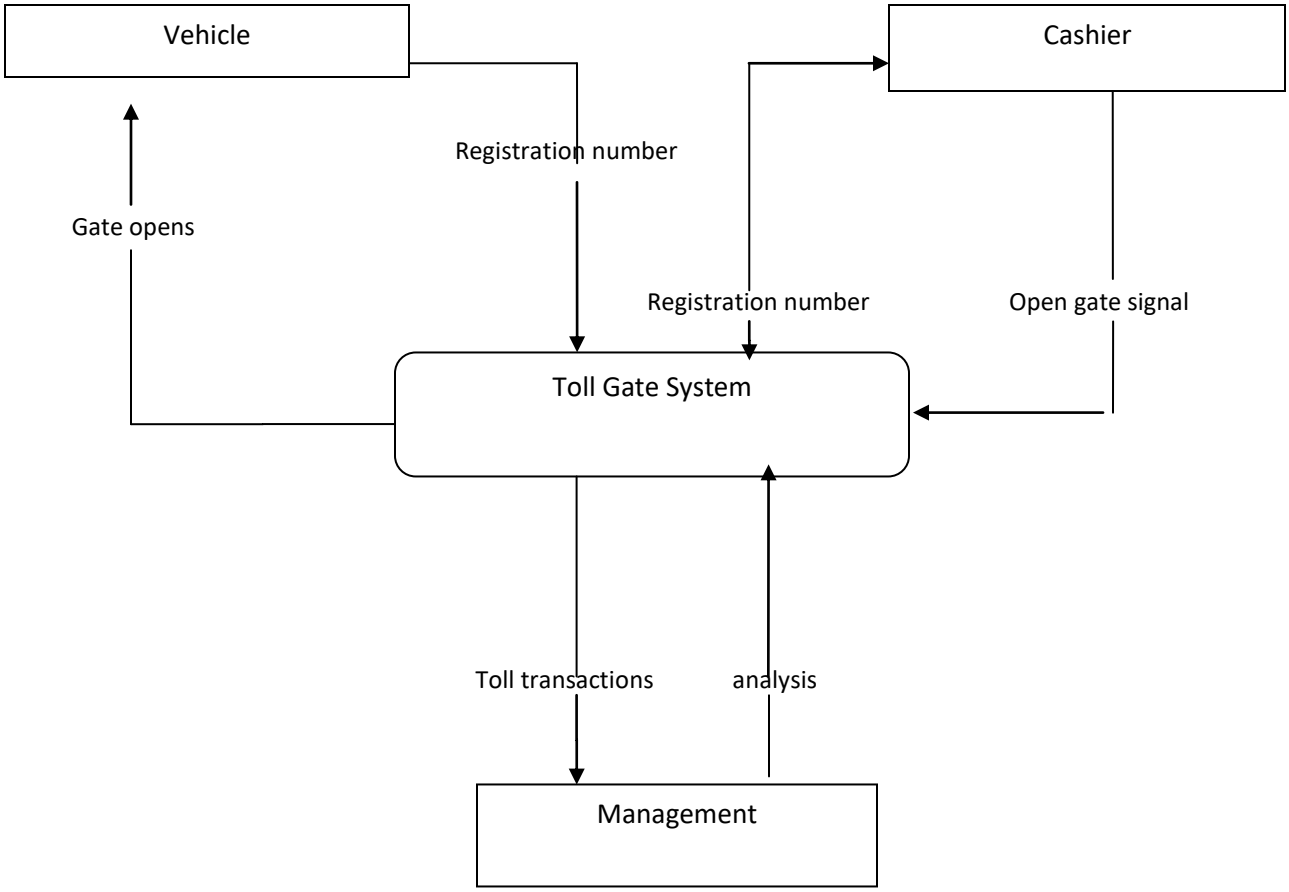
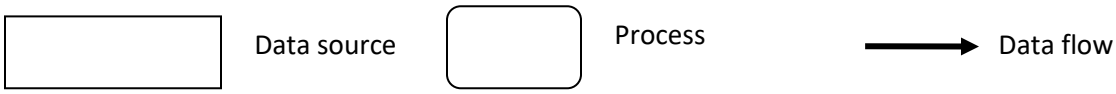


Fig 3.1: **Context Diagram : Existing System**

Key



3.3.2 Dataflow Diagram

A data flow diagram is a drawing that shows how a system's environmental entities, processes and data are interconnected (Stuart Burge, 2011).

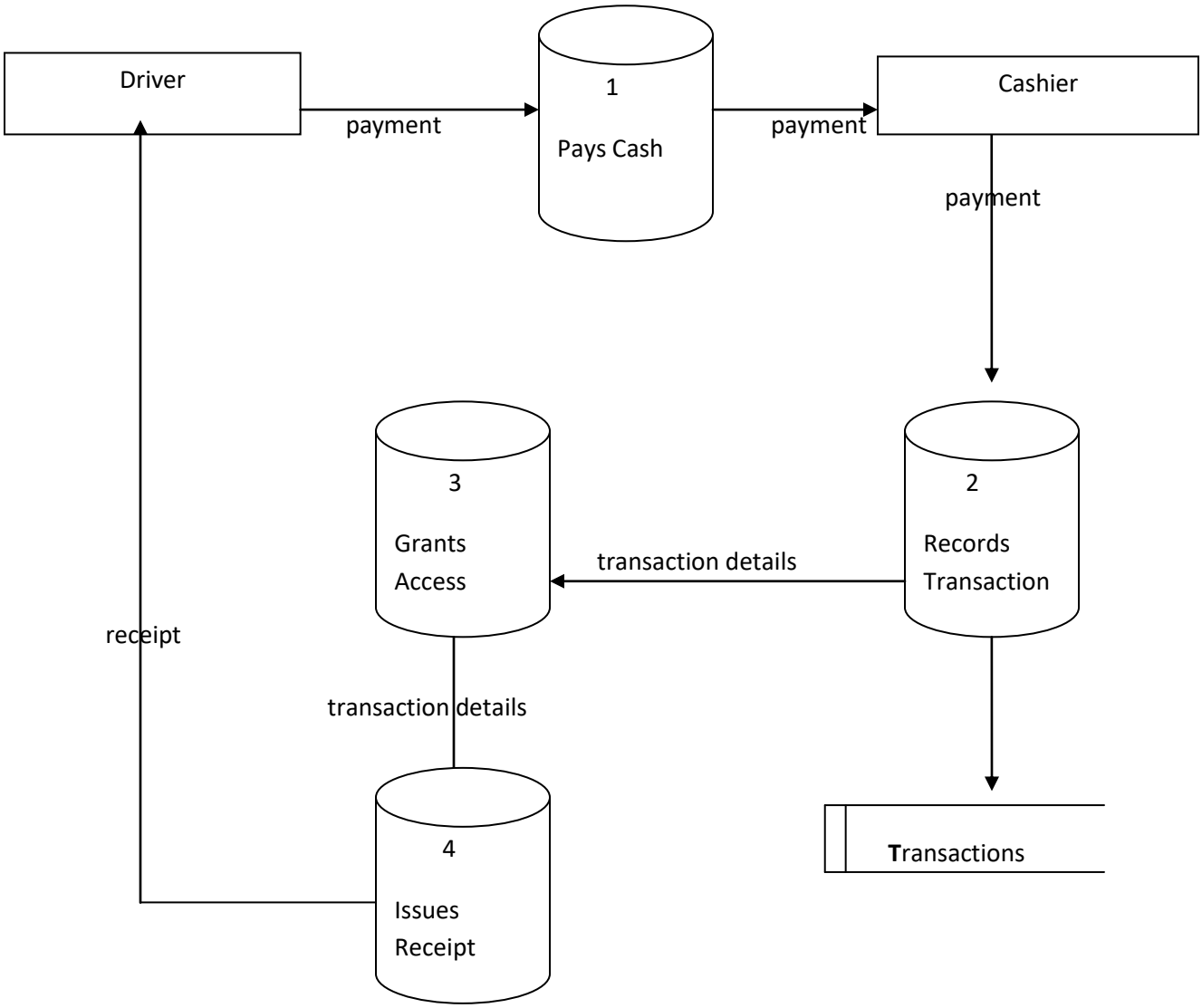
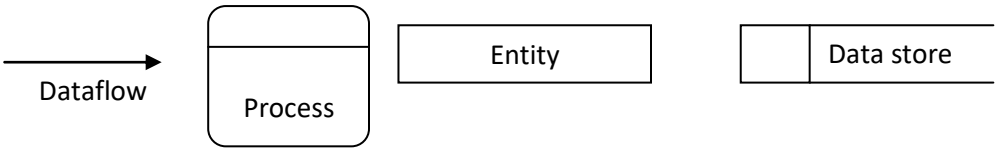


Fig 3.2**: DFD : Existing system**

KEY



3.4 WEAKNESSES OF CURRENT SYSTEM

- Physical processing of transactions is liable to mistakes and human. It is also very cumbersome to produce reports

- Lacks security, any malicious user can manipulate the system and gain access to sensitive and confidential information
- A lot of money is spent on stationary and paperwork.
- If a disaster occurs at the point all the data will be lost since the data is stored at the site.
- Risk of theft due to the fact that cash is transported for long distances to the bank.

3.5 EVALUATE ALTERNATIVES

There are so many means and ways of addressing the current problem of the organisation concerning the system. The different ways have to be looked into and analysed noting the weaknesses and the strengths of each alternative. The alternatives that were considered for the solving of the problem are listed below:

- Improvement
- Outsource
- In-house development.

3.5.1 Outsource

Outsourcing is whereby the organization seeks assistance either partly or its entirety from external consultants outside the organization to develop the software project (Kellogg Foundation 1998). The organisation has to weigh the merits and demerits of developing its own software and that of outsourcing the services of another organisation. If outsourcing is chosen then the organisation will have to carry out a rigorous training for the users of the system and brace up for maintenance costs of the system.

Advantages of Outsourcing

- The system will be tried and tested by other companies and so there is a sense of security among staff and management
- Upgrading and other support of the system can be offered by the suppliers
- Usually there are less or no errors to outsourced systems
- The system will be developed by people with more technical expertise than the staff of the organisation since that is their core business
- Costs can be greatly reduced by outsourcing because development costs are eliminated

Disadvantages of Outsourcing

- Costs involved in training users is high
- Problems with compatibility, interfacing the system with systems already in the organisation may prove difficult
- Staff demotivation can arise and anxiety among employees who may see the move as affecting their future in the organisation
- Lack of capabilities/ features - Open software packages tend to have far fewer features and capabilities than commercial equivalents.
- Poor customer response - A well-run commercial software company will immediately turn around customer requests for enhancements. With open source, if you don't do it yourself you are at the mercy of a disjoint community of developers.

3.5.2 Improvement

The current system's errors and omissions cannot be dealt with by simply impovement. Microsoft Word is currently in use for documentation and reports creation which is manual for the receptionist and all other enquiries including all communication channels are manual.

Merits of Improvement

- There will not be any need for much training since staff are already familiar with the system.

- It is cheaper to improve a system since the same equipment and software can be used.
- There are no hassles that come with changeover
- Time is not wasted on consultations and gathering information.

Demerits of Improvement

- Improving the existing system requires keeping of a lot of records that describes the operations of the system and this is a disadvantage when it comes to space.
- Working with files can be very frustrating and tedious for the data entry clerk so if the system is improved, the filing and entry processes will still remain manually
- The efficiency of the system is compromised because of the response rate to a request
- Files offer no security as far as access is concerned because restrictions are harder to enforce
- The system is slow, insecure and prone to various computer security threats. It is trendy to have reliable automated business system in the business system.

3.5.3 In-House Development

Kellogg Foundation (1998) views development as engaging staff already in the organization to develop the software product in-house. A system is developed by the staff within the organisation using their expertise. The developers and the management enjoy flexibility in this case because there are no binding regulations to either party. This development strategy encourages innovativeness on the part of staff members and their technical skills are sharpened. If requirements change midway, it is no big deal because the time frame can be adjusted without inconveniencing the other party as in the case with outsourcing. The working relationship between developers and the users of the system is clearly defined and well understood by both parties since they are members of the same organisation.

Merits of In-House Development

- It produces a system that conforms to the requirements of users
- There is ready support and maintenance in case of modifications

- The system will conform to the structure of the organisation and will easily meet policies and procedures.
- Maintenance and operational expenses are low and are done as and when required.
- There is a sense of ownership of the system by the organisation

Demerits of In-House Development

- Expensive when development software and equipment have to be purchased.
- The required expertise may not be available in the organisation
- There may not be enough commitment among the development staff and this may cause the project to fail.

3.5.4 The Preferred solution

The preferred solution to the shortcomings of the current system is the development of software in-house. Developing software in-house besides boosting the morale of staff members of the organisation, it also develops their skills. User requirements differ from organisation to organisation and so in-house development better satisfies these user requirements. After the system has been implemented, there would be no need for outside reliance concerning maintenance and modifications since the developers are within the organisation. There is also the issue of flexibility in terms of schedule and funds since it will all be controlled by the same organisation.

3.6 ANALYSIS OF REQUIREMENTS

Abramonwicz (1999) defines requirements analysis as outlining functional requirements and the relationships that are found among system elements. In the light of the above problems identified in section 3.4 the following aspects were taken into consideration:

3.6.1 Functional Requirements

The following is what is expected of the new system:

a) Data entry

The following should be allowed as far as data entry is concerned:

- **Capturing members -** driver details, and station and amount deducted.
- **Verification and Validation**

  Data should not be allowed to be entered or saved in the system before it is verified and validated for correctness and integrity.

- **Report generation**

  Timely and as and when reports should be generated through a report generating module of the system. These reports will assist managers in making quicker and better informed decisions that will improve the operations of the system.

- **Central Database**

  A centralized database is to be used which stores all registered vehicles in the country. All vehicle details from any tollgate station in the county is accessed through terminals connected to the ZINARA database.

b) Security

Security is one of the key or priority features of a database system. Without proper security measures data in the database is vulnerable and it loses its integrity. The creation of user groups and giving users access levels will greatly aid in securing the database.

c) Reports

Specified reports are to be produced by the system whenever they are required. Below are some of the reports that the system is expected to produce:

- Total number of vehicles passing through a toll gate every month
- Total amount of cash paid in by vehicle owners.

d) Audit trail

All changes made to critical areas of the system should be tracked and reported. Any user who has made a change in critical fields should have his/ her name stored including the date and times and the nature of changes made.

Use Case

The interactions between the system and the user in their sequence are all shown in a diagram called a use case. The system behaviour is depicted independent of the inside organisation of the system. The data or information that is passed on between the cashier and the driver is illustrated in this diagram.

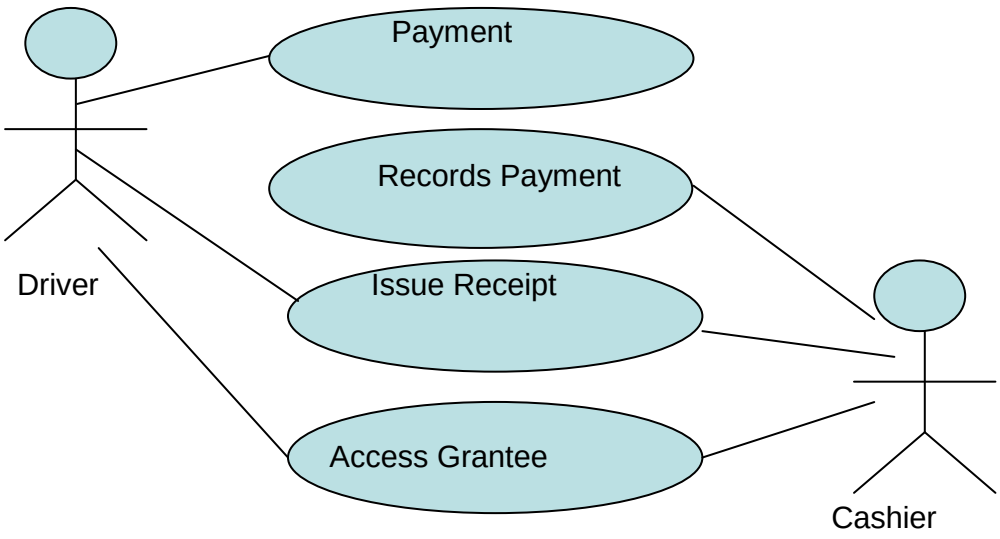
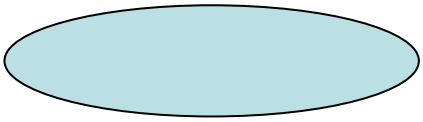


Fig 3.3: **Use case for the existing system**

Key

Symbol	Description
	Actor
	Use case
	Uses

Summarily, functional requirements can be outlined as:

- Allows administrator to create accounts and login.
- Usernames and passwords including all vehicle data and their attributes necessary for the operation of the system are to be stored in a secure database.
- Stores all daily transactions.
- Record the above transactions and their time of occurrence.
- Transactions are to be shown in a report format
- Unauthorized access should be denied to other staff members

3.6.2 Non-functional requirements

a) User-friendliness

The graphical user interface that is user friendly, allowing flexibility and speed in data entry is preferred.

b) Response time

The time taken to receive a response after sending a request or a transaction should be very minimal.

c) Transaction throughput

During peak times the possible transactions the system can manage on average is the throughput of the system.

d) Constraints

There are always things or happenings that are anticipated during the development that may obstruct, limit or slow down the progress of development.

(i) Technical constraints

There may not be the required technical skills among the available staff to undertake several modules at the same time.

(ii) Time constraints

Time may be a very big constraint to finishing the product on schedule especially is project schedule was not done properly.

Summarily, non-functional requirements can be outlined as follows:

- An easy to use and comprehend interface should be provided by the system for all users
- Reliability and consistence are features to be availed by the system including less down time
- Portability, maintainability and ease of installation
- Multi-user states or scenario should be supported by the system
- In cases of failure, the system should be able to recover data without any difficulty.

3.7 CONCLUSION

After all possible options to solving the organisation's problem were evaluated, it was the management's opinion that since all requirements are capable of being met, the development could proceed to the next level which is designing of the system. The development team was therefore given a green light to move on with what they have recommended as the best solution to the problem.

CHAPTER 4: DESIGN PHASE

4.0 INTRODUCTION

The design phase will see the proposed system being designed with the aim of satisfying identified requirements from the previous phases. A design document describing accurately how the system is to be built is first made basing on requirements from the analysis phase. This stage designs the new system basing on requirements gathered from users and from the data gathered whilst analyzing the existing system. The design phase is the most critical stage in the systems development life cycle. During systems analysis, we came up with the logical design which we are at this stage converting into physical design. The objective of the design phase is to transform the requirements into detailed system specifications covering all features in the system.

4.1 SYSTEM DESIGN

System Design references the system analysis phase in order to present the system to be built (Ashworth and Slater 2003). For the system to satisfy stated requirements, the following design elements have to be defined:

i) Architecture design, describing the structure, the views including the behaviour of the system
ii) Physical design – this decides the input, processing, storage and output requirements of the system. It relates to how actual data is input, verified and processed by the system and also how the output will look like
iii) Logical design – which represents how data flows within the system, the inputs to the system and the outputs. Modelling is often used including the use of Entity relationship diagrams.
iv) Database design – A model of the database to be used is produced in detail.
v) Program design - designing of different modules that make up the system
vi) Interface design – showing how the user will interact with the system

How the System will Work.

The developer used quite a number of design techniques including a Data Flow Diagram (DFD), a Context Diagram, Sequence diagram as well as a package diagram to show various parts of the system, their relationships and how data flows. A DFD was used to show how data flows within the tollgate system and the various processes performed by the system. DFDs were used in this system because they were seen to be easy to understand. A Context Diagram was used to clearly show the boundary of the system in relation to its environment. It also shows how the entities interact with the system.

The RFID tollgate system will use passive RFID technology to read information from the smart card of the vehicle owner. The system consists of the following:

A Smart Card – the use of this card is to deduct the required amount of money from the owner of the vehicle's account. It is the same as a bank card with magnetic stripes used for several payment purposes. The card used in this project is the contactless smart card which is prepared.

Smart Card Reader – the reader reads the information from the card and sends data to the central database so that the money is deducted displaying the transaction on the LCD.

The Host Computer–the host computer has a database that stores information on all registered vehicles in the country. It performs data storage and checks availability of funds in the vehicle owner's account. All transactions of the day are stored and processed by the host computer.

As a vehicle gets to the tollgate, the driver swipes his card on the RFID reader which sends the card information to the central host computer. The details of the card are verified with information in the vehicle database and the account is checked for availability of funds. If the customer account has sufficient funds, the reader deducts the appropriate amount from the customer's prepaid card. A signal is sent that will electronically open the gate allowing the vehicle access. If the card has insufficient funds, no signal is sent to the gate to open. The vehicle owner will pay the toll fee together with a fine before he/ she is allowed access. The driver can also recharge his/ her card and then proceed with the toll collection fee process. The gate will automatically close after the vehicle has passed.

The system will:

- Allow users access to the system and perform daily transaction which include:

- Allow the driver to swipe his card and deduct the required amount from his card
- Allow the card to be topped up
- Allow vehicles to be registered so as to be able to use the swipe system
- Generate different types of reports

4.2 DESCRIPTION OF THE PROPOSED SYSTEM

a) Inputs

Vehicle Registration

New vehicles should be registered into the system and issued registration record and swipe card that will hold vehicle details. Details that are of major concern are the make, model and the engine number of the vehicle

Load of cash

In order for a registered vehicle to pass through a tollgate the card should be loaded with cash. The major parameters to be stored are the amount paid, the cashier and the date and time the transaction was done.

Swipe on toll gates

Whenever a vehicle passes a toll gate the driver should swipe and the balance in the card will be retrieved and after the transaction the systems writes the new balance on the card.

User registration

This includes details of users that make use of the system and this are categorised as follows:-

- Cashiers,
- Tollgate Operators,
- And management

The details of concern are the first names, surname, username and password.

b) Processes

The major processes in the system are the registration of new vehicle and the production of registration records. Loading of swipe cards is also another major process in the proposed system since that's the backbone of this tollgate swipe system. This process of loading card includes the access code and the amount loaded and the current card balance will be revealed.

The other major process is the swiping of the card at the tollgates and for every transaction the system checks the current balance of the cards and if the balance is sufficient for a pass then it will be granted but if it does not meet the required amount then a top up can be done at the site but with a penalty.

c) Outputs

The critical outputs of the system used by both management and the owners of the vehicle are as follows:

- Daily transactions, that is, top ups and swipes
- Receipts to drivers at toll gates
- New registered vehicles.

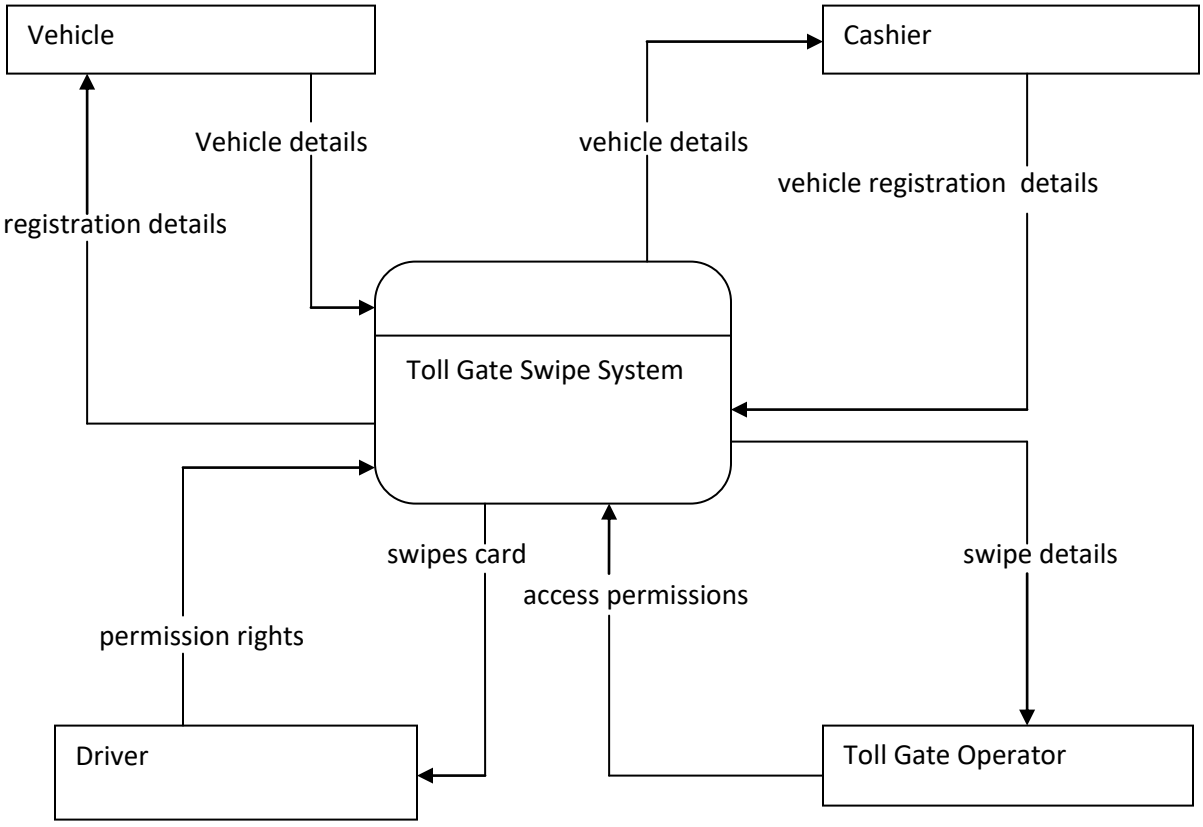


Fig 4.1: **Context Diagram of the Proposed System**

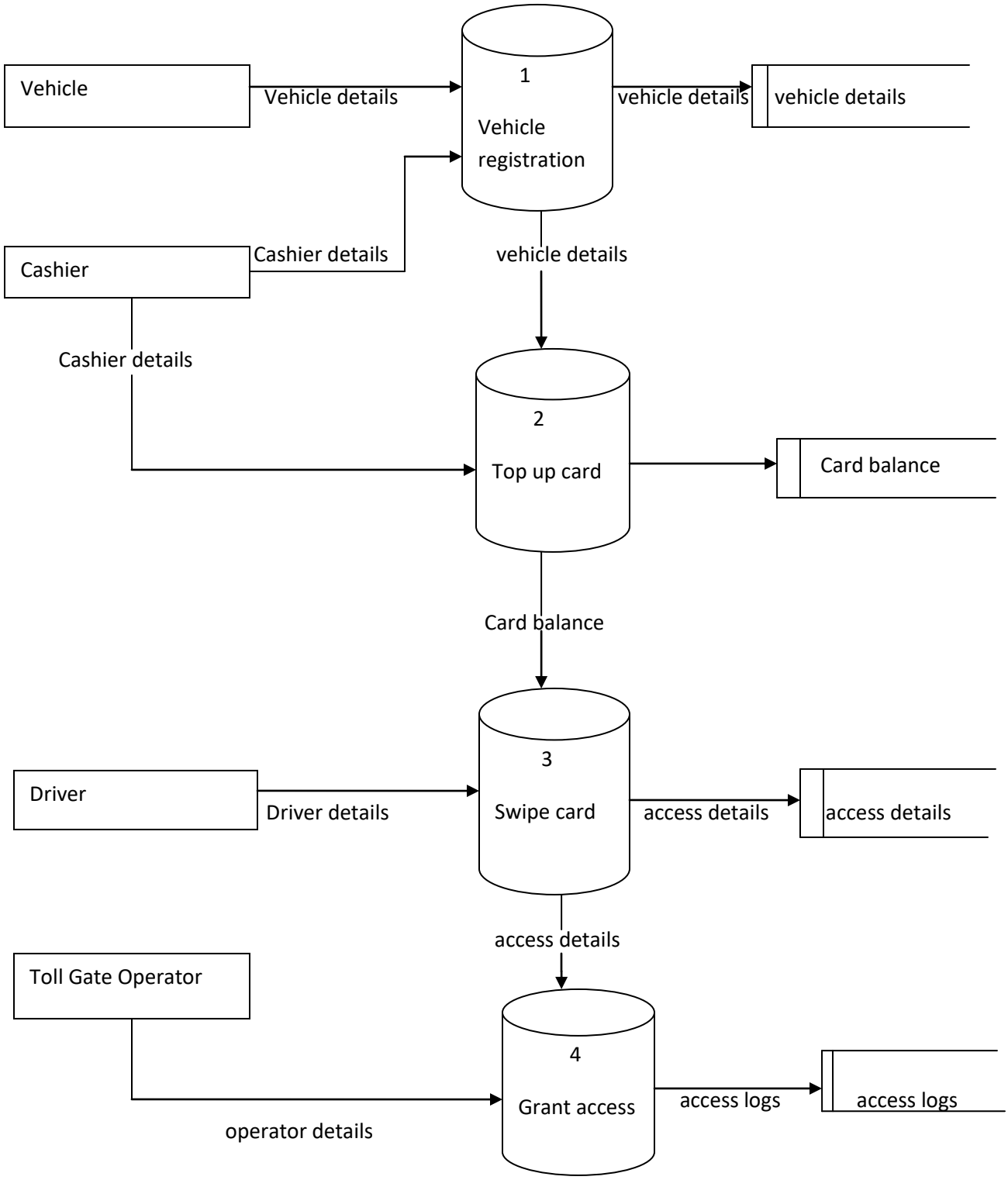
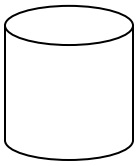


Fig 4.2 :**Data Flow Diagram (DFD) of the Proposed System**

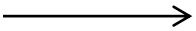
Key

Entity



Process

Data store



Information Flow

Design Considerations

- User friendliness

  The system has to be easy to use and to navigate between menus.

- Efficiency

  Besides meeting user requirements, the system must complete a transaction within the most reasonable time.

- Security

  Privacy and confidentiality are security concerns which the developer took into account during the design stage. The system was designed such that only authorized users have access to different parts of the system.

4.3 ARCHITECTURAL DESIGN

Kendall and Kendall (1987) describes architectural design as translating the abstract model into a specific design that is technical. This is the choice of the technologies on which the architecture elements depends. A database system was chosen for this project rather than a file system and a client server application was chosen. In this system, hardware and software configuration is strongly interrelated. Data in the database is arranged in layers or schemas. The layers are physical, conceptual and application layers. The DBMS transforms requests from the external schema.

4.4 PHYSICAL DESIGN

According to Peter R. (2004), physical design refers to the layout of computer nodes in the system. This is the design of the physical components the new system will operate on. This includes the hardware and associated software that runs on those hardware pieces.

Hardware requirements of the system

- 20 HP PCs
- 52x DVD ROMs
- 4 GB Memory
- Swipe cards
- 20 x HP LaserJet printers
- RFID gadget

4.5 DATABASE DESIGN

Database design according to Grey (1999), is the design of a collection of related data, organising it in such a way that there is no data duplication so as to avoid data redundancy. In this project, a relational Database model MYSQL is used. This database choice was made basing on the following benefits:

i) Besides being open source, MYSQL is recommended for its speed. Because is has fewer features as compared to other databases such as Sybase and Oracle, MYSQL runs faster.
ii) Data stored in MYSQL database is kept safe and secure since only authorised users are allowed access to it.
iii) It uses backup recovery techniques and log files in case of data loss or corruption
iv) MYSQL supports many development interfaces such as JDBC, ODBC and is also cross platform, that is, it can run in many different Operating Systems

The database of the toll system contains related files of data that is arranged logically. It is shared by all the tollgate stations across the country. The database is managed by a software known as a Database Management System (DBMS). Access to the database is restricted by the use of usernames and passwords. Two databases were designed, one containing the users of the system and their access levels. The other major database contains all registered vehicles in the country. These databases were designed from three different views so that each user only sees the part that pertains to them. Updating of the database is such that a change in one application does not affect other applications because the data is designed with independence of programs.

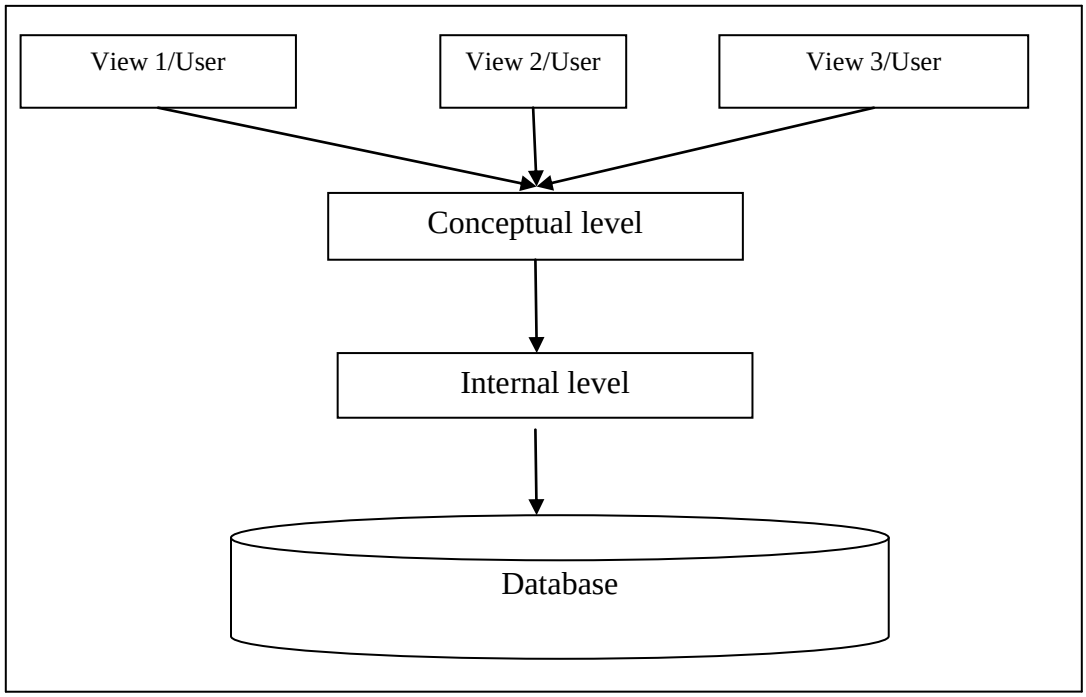


Fig 4.5: **The Database Architecture**

External level –This view provides an interface which is specific to the user and his/ her needs, simplifying interactions between the user and the database.

Conceptual level –This view describes the stored data and their relationships with other data elements.

Internal Level –This view shows how the RDBMS and the Operating System views and shares the data.

4.5.1 Reasons for Using Relational Database

- It support data consistency and input validation.
- A Relational Database provides full backup support and recovery procedures in case of loss and disasters.
- Data is stored into a central repository which in turn reduces costs of maintenance.
- Data manipulation such as delete, insert, retrieve and update is supported by this database.
- Users are able to simultaneously access the same data in the database without conflict hence concurrency is improved.

4.5.2 Tollgate Database Tables

Table 4.1: **Access**

Column	Type	Null	Default
id	bigint(20)	No	
access	varchar(30)	Yes	NULL

Table 4.2: **CarMake**

Column	Type	Null	Default
id	bigint(20)	No	
make	varchar(30)	Yes	NULL

Table 4.3**: Responses**

Column	Type	Null	Default
id	bigint(20)	No	
cellphone	varchar(30)	Yes	NULL
message	varchar(100)	Yes	NULL
status	int(11)	Yes	NULL

Table 4.4**: Tollgate**

Column	Type	Null	Default
id	bigint(20)	No	
tollgate	varchar(100)	Yes	NULL
location	varchar(150)	Yes	NULL

Table 4.5**: Transactions**

Column	Type	Null	Default
id	bigint(20)	No	
vehicleid	bigint(20)	Yes	NULL
Debit	double	Yes	NULL
Credit	double	Yes	NULL
Description	varchar(255)	Yes	NULL
date	date	Yes	NULL
user	varchar(50)	Yes	NULL

Table 4.6: **Users**

Column	Type	Null	Default
id	bigint(20)	No	
surname	varchar(50)	Yes	NULL
firstnames	varchar(50)	Yes	NULL
username	varchar(50)	Yes	NULL
password	varchar(50)	Yes	NULL
tollgateid	bigint(20)	Yes	NULL
access	int(11)	Yes	NULL

Table 4.7: **Vehicle**

Column	Type	Null	Default
id	bigint(20)	No	
model	varchar(50)	Yes	NULL
make	varchar(50)	Yes	NULL
enginenumber	varchar(50)	Yes	NULL
chasisnumber	varchar(50)	Yes	NULL
registrationnumber	varchar(50)	Yes	NULL
dateofcapture	date	Yes	NULL
address	varchar(100)	Yes	NULL
contactnumber	varchar(50)	Yes	NULL
accesscode	varchar(50)	Yes	NULL

4.6 PROGRAM DESIGN

This activity describes the program to be built by specifying the required programs. These are steps the programmer will undertake prior to coding the system. The program here was broken down into small manageable sub-programs called modules. Each module is expected to accomplish a specific task clearly showing how it interacts with other modules.

4.6.1 Package Diagram

A UML structure diagram called a Package Diagram was used to depict the structure of the system as well as to show dependencies between different modules. On the package diagram used, the Vehicle Registration package is dependent on the Database package while the Card Top up, Swipe Card and Reports package are independent packages.

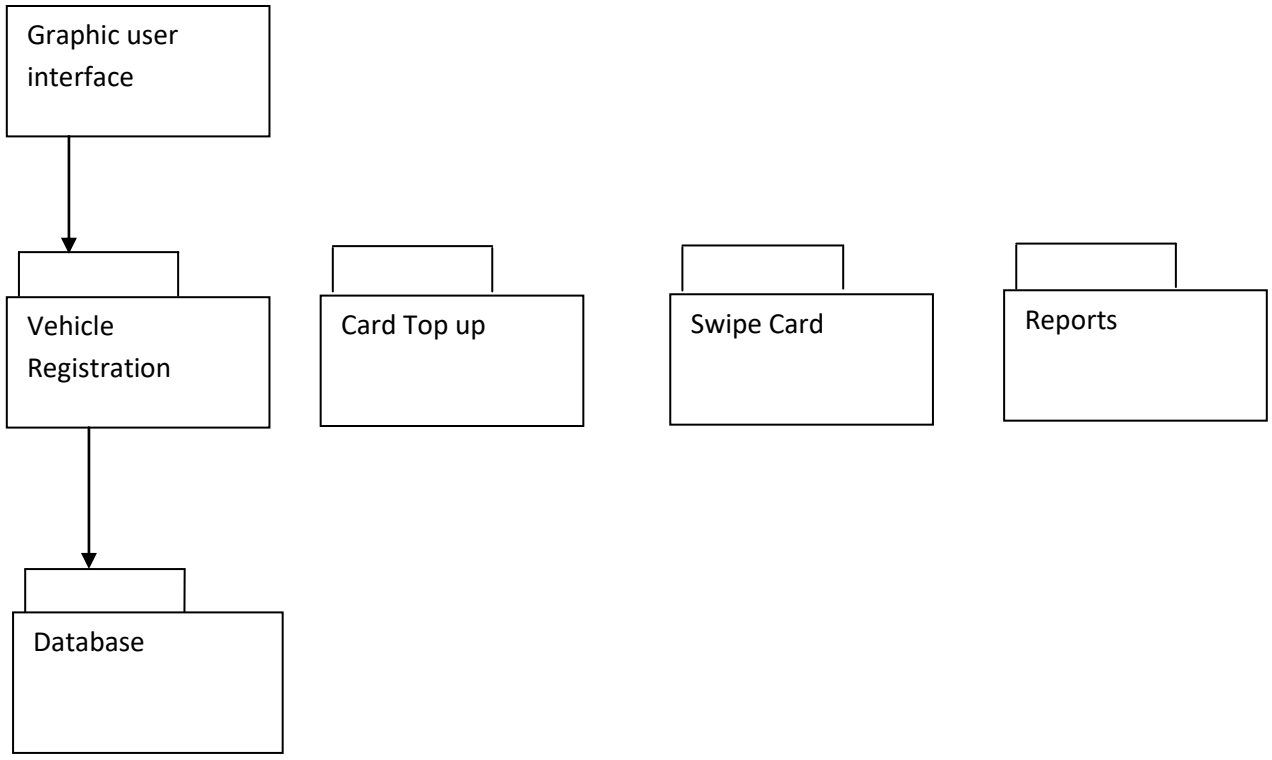


Fig 4.4 : **Package Diagram for the Proposed System**

4.6.2 Sequence Diagram

A sequence diagram is an interaction diagram which describes interactions among the system elements. The developer used a sequence diagram to visualize how the system behaves in a dynamic way and also to emphasize the time sequence of communicating objects. The diagram below brings out clearly how the Clerk interacts with the Driver, the interaction between the Database and the Operator including the transactions made daily. The messages that trigger those interactions are clearly depicted. For example, swiping the card and entering the pin triggers an interaction with the database.

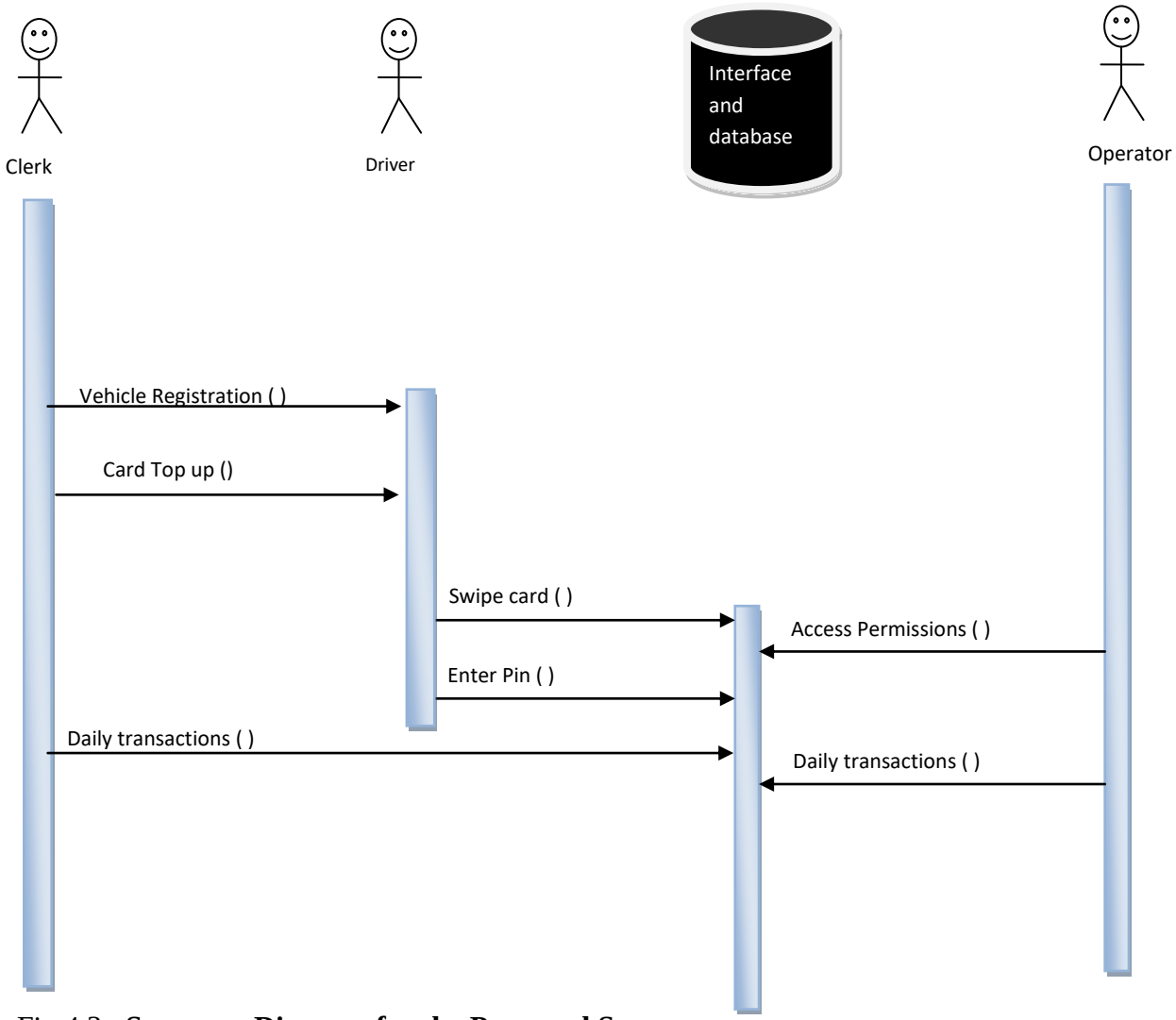


Fig 4.3 : **Sequence Diagram for the Proposed System**

4.7 INTERFACE DESIGN

Interface design is the design of graphical controls for interaction with the user in the operation of the system. The interface provides the means of interacting with the system while hiding complex or implementation details from the user. This is where menus are designed and input forms to enable data to be entered in the system. The input devices used and the means of entry are designed here.

4.8 INPUT DESIGN

ZantoZanto (1996) sees input design as the design of forms that facilitates data entry into the system. This is designing of the input forms that are used to enter data into the system. The most appropriate strategy of getting data in the system was selected. Accuracy was a major factor to consider since data should be input without errors and with speed. All the data needed by the system should be captured with no omissions or errors. Length of fields should be documented and sequence should match those fields from source document. The operator must be familiar with the format of the data and must find the input forms easy to use.

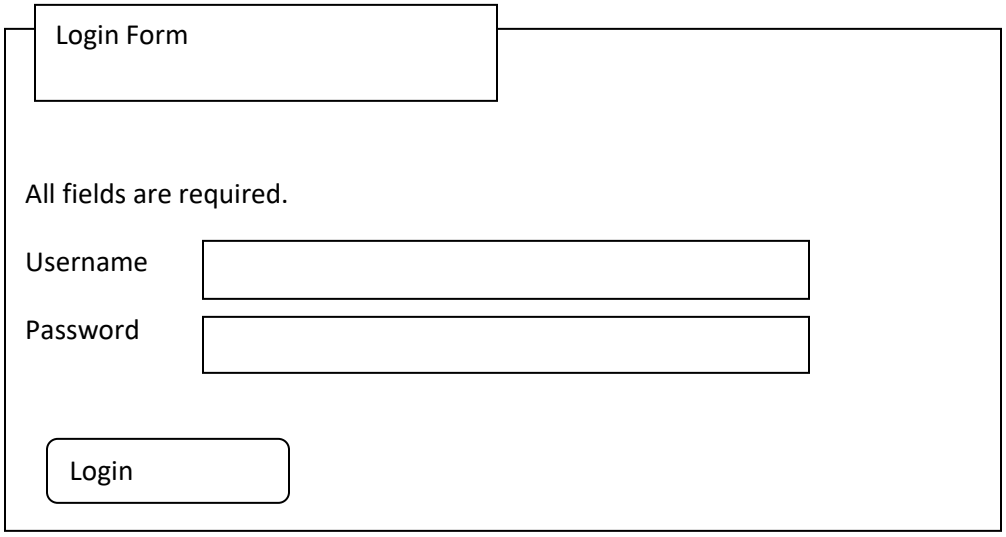


Fig 4.6**: Login form**

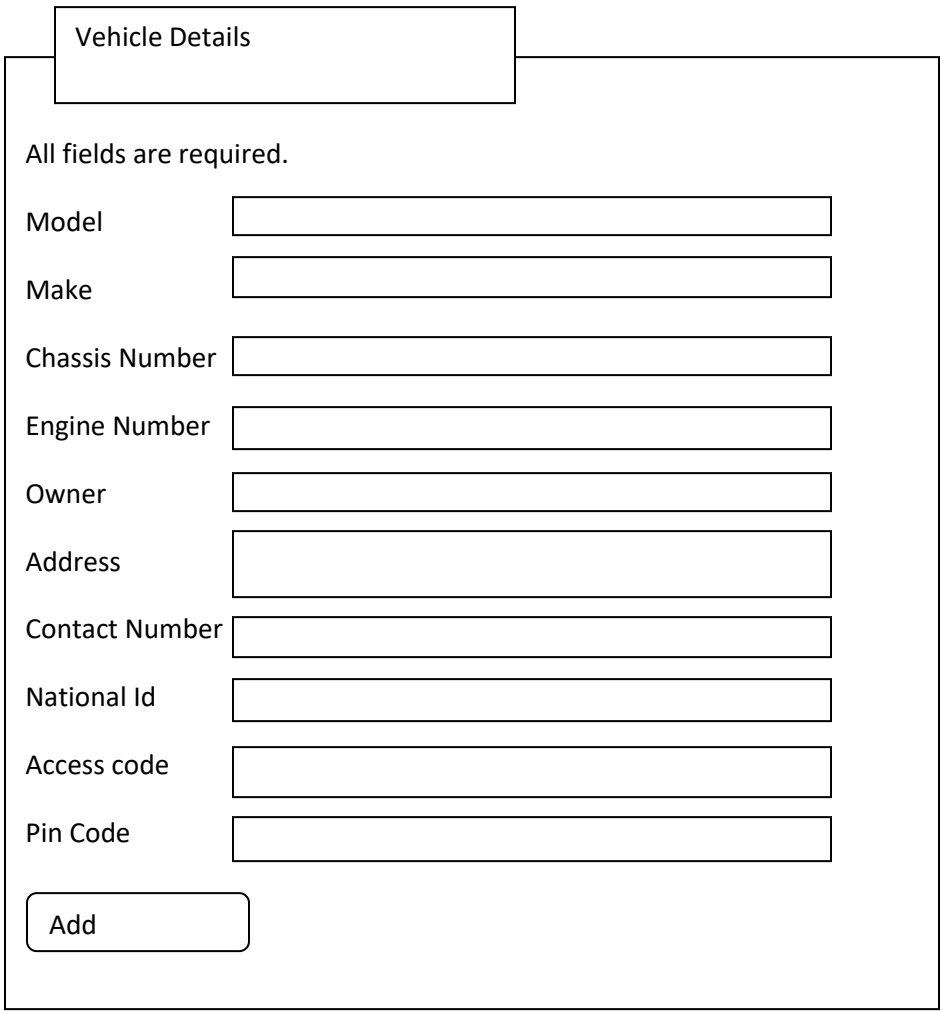


Fig 4.7**: Vehicle Details Form**

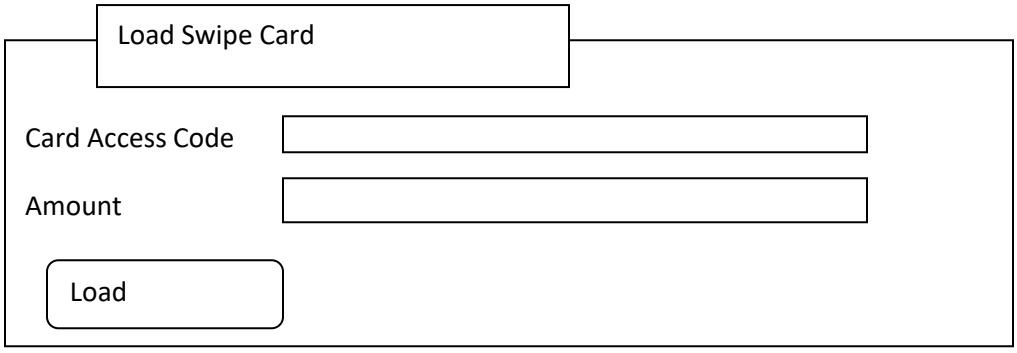


Fig 4.8: **Load Card**

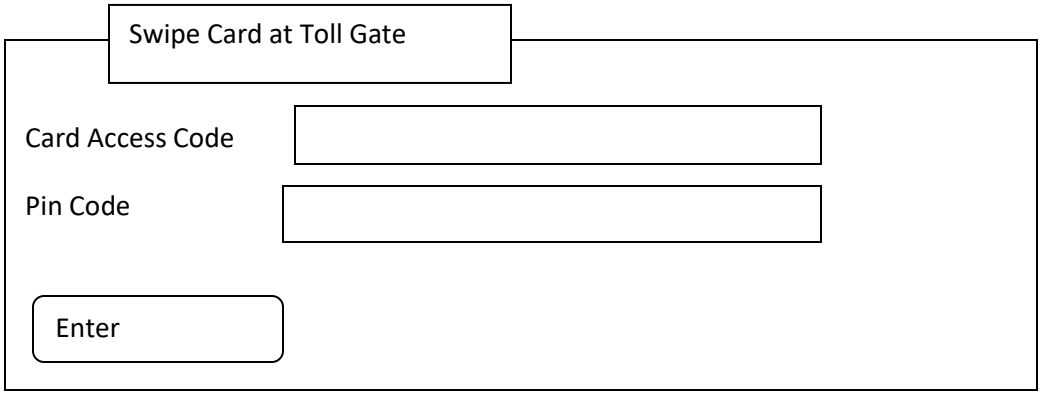


Fig 4.9: **Swipe Card**

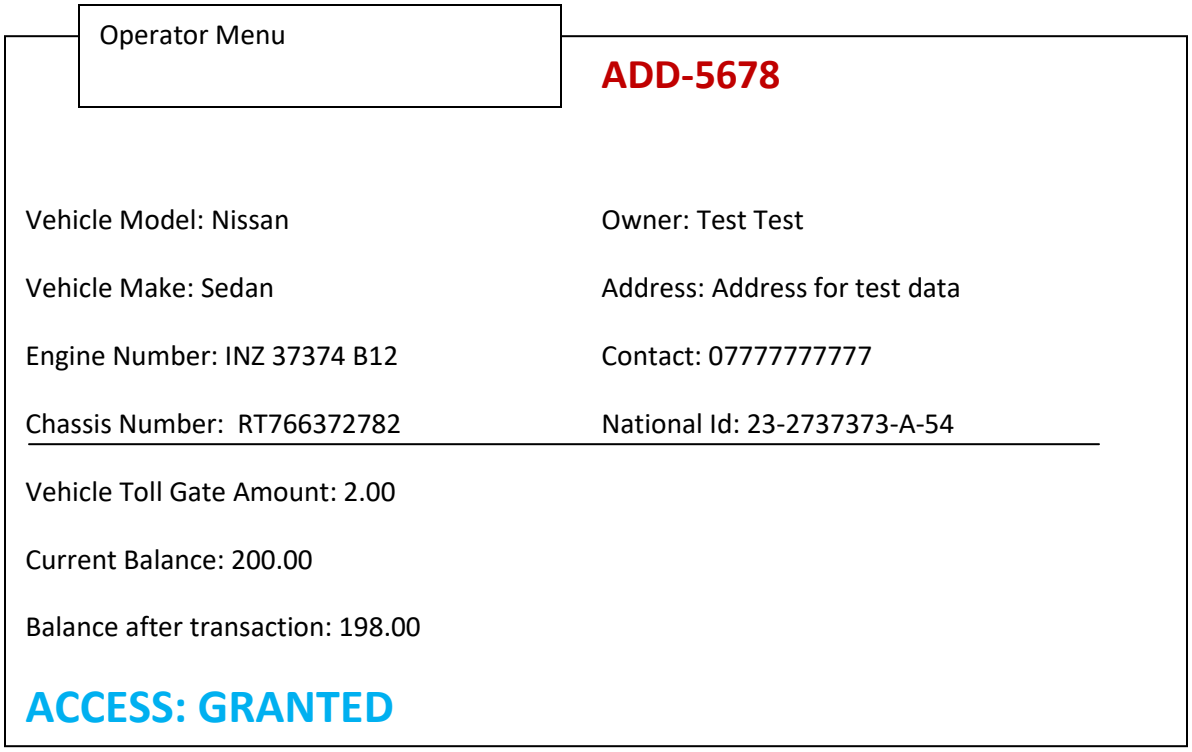


Fig 4.10: **Operator Menu**

4.9 OUTPUT DESIGN

Output design is the design of formats and structures of the reports to be produced by the system (Grey 1999). This design reveals how outputs will look like and how they are going to be used. The design of output should be made as simple to understand as possible. It mainly focuses on conceptual design of reports and forms produced from the inputs and processes done by the system. In this system, the outputs are both print and electronic. The layout of reports was discussed with management who insisted that information on reports should be clearly presented and should not be difficult to interpret.

4.10 CONCLUSION

This phase allowed the designer to have a complete overview of the system to be built. The design phase enabled the developer to check and ensure that the project is within the scope and that objectives are likely to be met. Once the system has been designed to correct specifications, the job of the developer becomes easy. The developer after having the assurance from the design phase that the system will be a success, he moved on to the implementation phase which is the final stage in the development of this system.

CHAPTER 5: IMPLEMENTATION PHASE

5.0 INTRODUCTION

The implementation phase is all about deploying the finished system in the working environment. The new system is now ready for use and so testing begins and any errors and bugs are corrected before installation. The implementation phase focuses much on ascertaining whether the system objectives as outlined in the problem definition have been addressed. Users were taught how to navigate and operate the system while management was also trained on how to interpret the different reports. This phase is where the conversion of the design document is put into machine understandable language.

The following implementation phases are to be undertaken in their order:

- Coding
- Testing
- Installation
- Maintenance
- User Manual

5.1 CODING

Coding refers to the process of using a language understandable by the computer to put interfaces designed on the ground (Grey, 1999). This is were the design document is converted into a language understood by the computer. The PHP programming language was used to code the system. The choice of PHP was based on the fact that it is free and open source and also for its capability for modularisation. MySql, a relational database was used to store data about users of the system, vehicles and their owners. MySql was chosen for its easy of use and also because it is open source. The programmer first converted the design specifications into programs, that is, instructions understandable to the computer. The development team agreed on modular programming so as to speed up the development process and to aid in maintenance later on in the project life cycle.

A database of all registered vehicles in the country was constructed first. The conceptual database design was mapped into tables with their associated attributes showing the primary keys and foreign keys. This was done to maintain data integrity within the database.

5.1.1 Pseudocode for the System

Outlined below is part of the pseudo code in the system

i. Access to the system

Input username in the input box

Input password in the input box

If username or password is wrong then

Message box “wrong username or password, try again”

Else

Access is allowed into the system

End if

End

ii. Adding a new user

Begin

If logged on as administrator

Click add user icon or link

Display new user details form

Input the required data in the appropriate input boxes

If data entered is correct then

Message box “User details saved successfully”

Else if Data entered is missing then

Error message “Please enter sufficient information”

Else If exists

Discard update

iii. Record Addition

Check for database connection

Check for required fields

If correct then

Check to make sure the records does not exist

If exists

Discard update

Else

Save new record

iv. Record Update

Make sure there is database connection

If not then make a connection, otherwise

Input the search criteria for key to the record required

Check criteria if is correct for fields

If correct search the required record

If found then

Display the record and update

Update only fields that can be updated

Check if data is valid

If valid then update record

Else

Roll back and ask user to rectify the error

Else

Display message “record not found”

v. Operating procedures

Check for connection to the database

Is it connected? If not, connect otherwise

Check the operation procedure to be done

If correct

Process the specific operation

If okay then commit operation

Process the specific operation

If okay then commit operation

Else

Rollback

Else

Show message “Error in operation particulars”

And

Redo

vi. Capturing details utility

{

Enter vehicle details;

Enter other details;

Store vehicle details in vehicles table in database;

Store details in relevant tables;

}

vii. Validation Utility

{

Validate relevant details;

}

viii. Output function

{

Read queried or sorted vehicle data;

Read sorted or searched data;

If project data exists then

{

Output to screen and/or printer;

}

Else

{

Error message is shown;

}

}

If other data exists then

{

Output to screen and/or printer

}

Else

{

Error message is shown;

}

5.2 TESTING

Stuart Burge (2011) views testing as the process of verifying and validating design output and logic to see if it conforms to the required results. Test data was prepared to test individual programs after they have been coded, compiled and are ready for use. When all the programs had been tested individually and debugged, the test of the whole system was done using actual data. Testing, debugging and analysis of results continued until the test results corresponded with the expected results. Users of the system were the last to be called to test the system, not for errors but to see if it actually meets their requirements.

5.2.1 Testing objectives

- The objective of testing was to find out if the system effectively meets all the objectives defined.
- The output was tested including the interfaces to see if the discussed shortcomings have been addressed.
- Functional requirements were also tested, that is allowing users to add, delete, retrieve and update records.
- Non-functional requirements including user friendliness, maintainability and security were tested

5.2.2 Testing audience

ZINARA Regional managers tested the system to see if it is performing according to their expectations. They were mainly concerned about functionality, availability and security of the system. Clerks who man the toll gate system tested the system efficiency and to see if it meets the requirements as they have given them. Other members of the development team also did test the system for both functional and non-functional requirements. Testing was extensively done to ensure that user needs have been met and that the system performs as it should. The validation and verification processes were carried out by the programmers of the system.

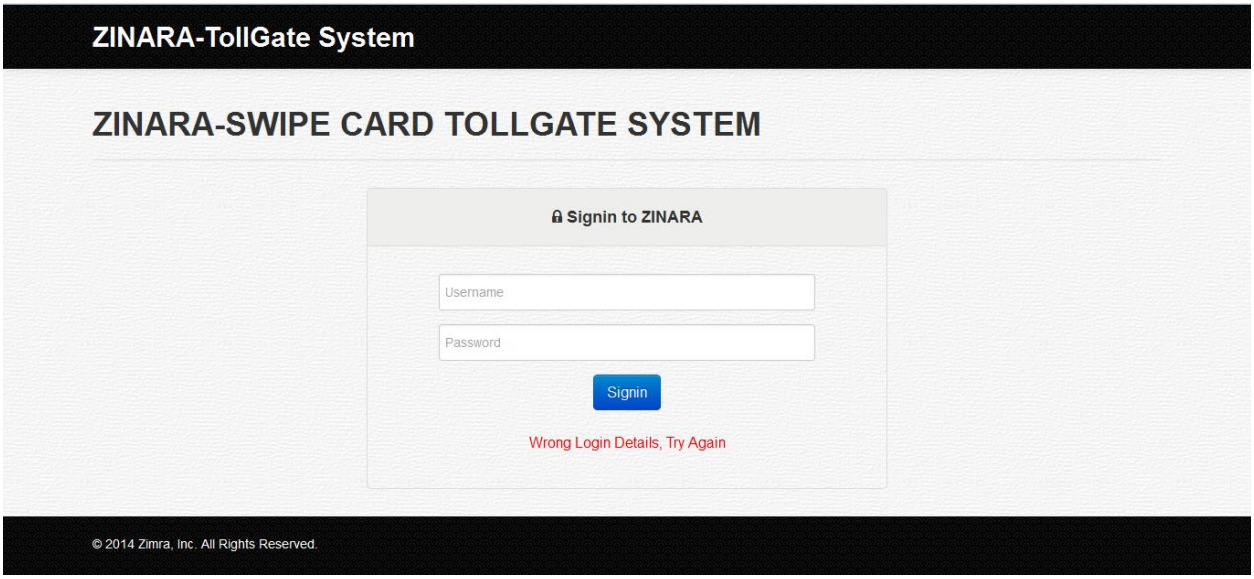
5.2.3 Validation

Behrouz A.F (2005) has the view that a system is validated to check if what it does is the right thing. Validation allows for determining whether the developer has built the product right. It essentially focused on testing whether the right system had been built and seeking to confirm that the finished product fully meets the user expectations. Both valid and invalid data was purposely entered into the system to see how the data will be validated and how the user will be informed by the system.

Test Scenarios

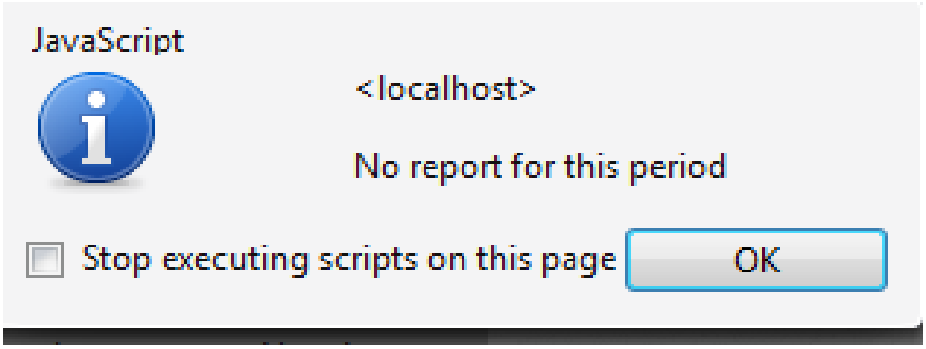
Scenario 1: when a user enters a wrong username or password,

A pop up message box appears as below showing that the password or username is incorrect and prompting the user to reenter.



Scenario 2: when the date entered for report generation is after the current date,

A pop up window appears as below informing the user to enter a valid date.



Scenario 3: When the correct password is entered,

A message to proceed is shown on the screen

Scenario 4: When a record is deleted through the delete command button,

The system should confirm removal of that record and the record should be removed from the database

Scenario 5: when a command to view records is clicked,

Every record entered should be displayed on the screen

Scenario 6: A command to view different types of reports,

The selected report should be shown in the correct format and the desired output

Scenario 7: Clicking of the EXIT button,

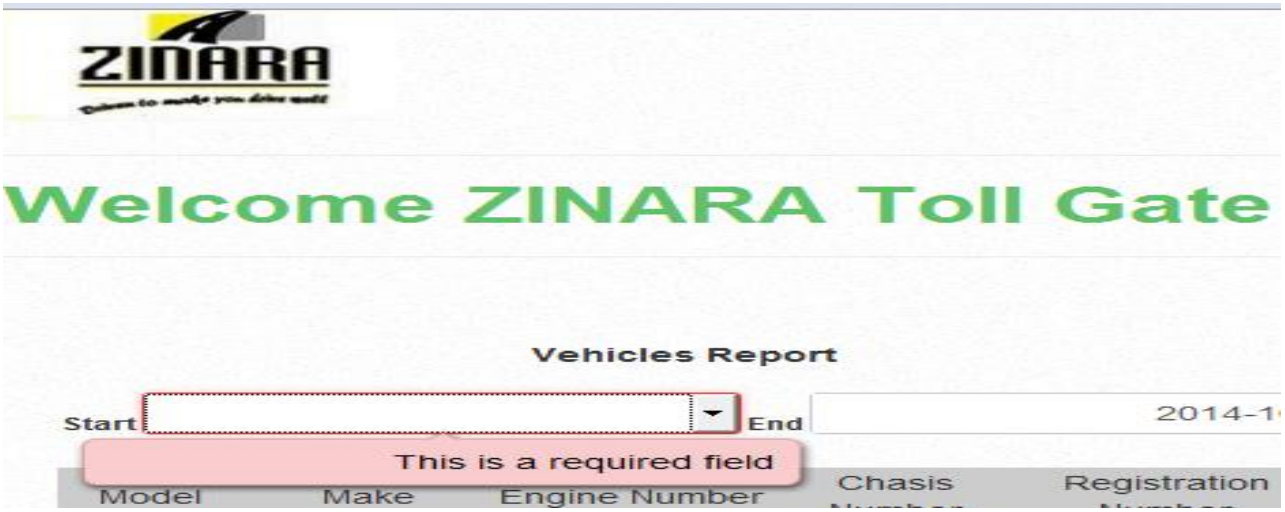
The Exit button should terminate the program

5.2.4 Verification

Verification according to Behrouz A.F.(2005) is the process of determining whether the developed system is the right one. Verification was an ongoing process throughout the development of the system. The developers were concerned with ensuring that they build the system in the right way, that is according to specifications. For the requirements to be met, the product had to be built rightly because experience has taught them that a system can be functional but not solving the identified problems.. Because of this awareness, they continuously carried out reviews of the product to ensure they do not digress from the expected outcome. The testers verified and tested to see if only correct input was acceptable in the system and if the output was as the expected ones.

Scenario1: when alphabetic characters are entered in an input box designed for numeric characters, the user is informed that the field requires characters only.

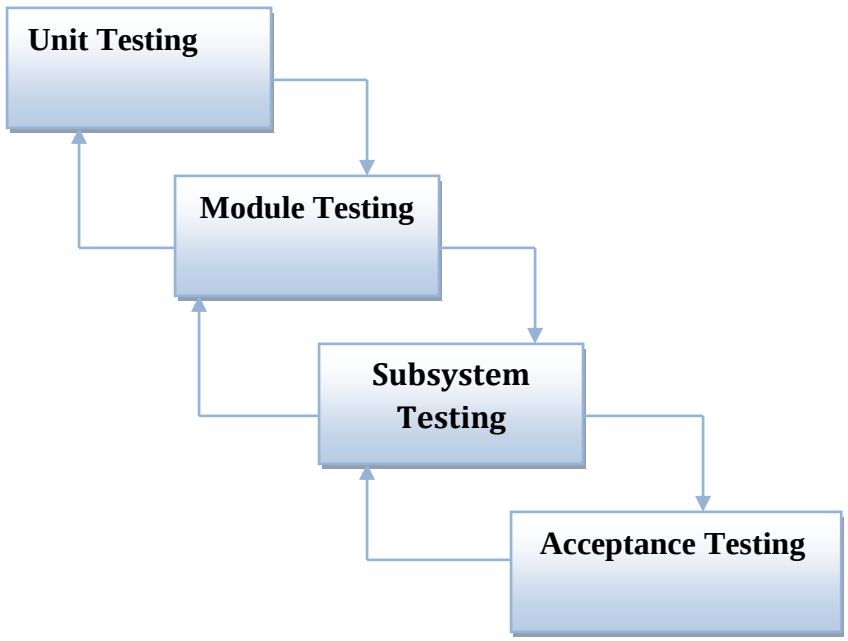
Scenario 2: When a compulsory input box is left unfilled, the below message is shown.



5.2.5 Testing Procedures

The diagram below shows the procedures that were taken to validate and verify the system functionality. The procedures are unit, module, subsystem, system or acceptance testing.

Fig 5.1: **Types of Testing**



Key:

System flow

a) Unit testing

Unit testing is testing of the different single programs of the system to see if they are functioning well (Baines B. 1999). This is whereby each component of the system is tested independently of other system components. After each component of the proposed system was tested and found to be performing as expected, another type of test was carried out.

b) Module Testing

Dependent components known as modules were combined and tested as standalone units. The Add New User module, for example, was tested to see if it indeed allows a new user to be added to the system. If a new user is added and then a confirmation message that the user has been saved appears then the test result is positive. Module testing was all about testing if the system can answer the following questions:

Is it possible to add new users in the system?

Are users able to change their passwords?

Is deletion, insertion and updating possible?

c) Sub-system testing

Baines B (1999) defines Sub-system testing as testing modules that are combined to see if they function correctly and to check for validation errors. Sub-systems were integrated and tested as a whole unit. Programs that must work together were tested to see if they coordinate well without producing erroneous results.

d) Acceptance Testing

Acceptance testing according to Brian H (2001) is when users test the system as a whole to determine satisfaction with the performance as well as functionality of the product. This test is carried out to check if the system users are satisfied and in agreement with the working of the system as a whole. All system users were asked to give their input to see if it achieves the stated objectives and whether it meets their requirements. They also tested non-functional requirements such as user friendliness and efficiency. The system was found to be meeting

all of the objectives and requirements. It was also said to be user friendly hence it was accepted by all the users with open hands.

5.2.6 Test Results

The ZINARA Swipe Card and Monitoring System proved to be easy to learn and use and is also friendly to use. All the requirements as per user definition were met by the system and validation and verification passed all tests. The tests were thorough and both management and users of the system were involved.

5.3 SECURITY

The business dictionary defines security as "the extent to which a computer system is protected from data corruption, destruction, interception, loss or unauthorized access". Security entails measures taken to ensure that there is no threat or danger to a system.

5.3.1 System Security

System security is defined by Tanenbaum A. (2000) as referring to measures put in place to safeguard the system from any danger or threat. Only authorised users are allowed access to the system. Different user levels were created by the Administrator so as to restrict unauthorised entry and to allow users only to view and update data which concerns them only. This means a user will only be allowed to access data that is relevant to his/ her duties. Usernames and passwords were assigned to users by the Administrator for authentication purposes. A database for data storage, with tight security measures was constructed and it can only be accessed and updated by authorised users. The system is vulnerable to other several kinds of threats which include among others:

- ✓ Virus attacks to the software programs
- ✓ Fraud by insiders
- ✓ Loss or destruction of data

5.3.2 Physical Security

Physical security include protecting the computer system and associated hardware from natural disasters and outside fraud and thefts. The ZINARA premises that house the RFID system was secured with burglar bars, razor fence and the doors had security locks. A fireguard and fire extinguishers were also physical security measures that were taken to guard against natural disasters.

5.3.3 Measures taken to counter the above mentioned security threats

- ✓ The Norton Antivirus software was installed to curb attacks on the system by viruses
- ✓ Use of passwords and usernames to restrict access to the system and to sensitive data
- ✓ Granting of access privileges to users by the administrator for updating, deletion and insertion of records and fields
- ✓ An Uninterruptible Power Supply (UPS) was installed so that there will be no disruptions in the event of a power cut.
- ✓ Backup is to be done on a daily basis so as to avoid loss of data if the system develops a fault
- ✓ Physical security walls are built around the place where the equipment is housed
- ✓ Fire extinguishers should be mounted in rooms where the system equipment is housed

5.4 INSTALLATION

Installation is running of the system on a test environment in order to design a training program (Peter R, 2004). When the system was accepted by the users, it was time to turn the theoretical into practical. Hardware and Software was acquired and installed.

Acquisition and configuration of Hardware and Software was made and the new system was installed in the machines. Setup of the database was done including recovery procedures and security measures. After static data was entered into the system, installation of the system was completed and the changeover strategy was devised.

5.5 TRAINING

Unless end user training is carried out effectively, the organisation will not benefit much from the use of the new software. After the system has been setup, training of users began. Before training began, an assessment of their technical skills was made so as to strategise and to estimate the time frame needed. It was discovered that the people who will use the system on a day to day basis have different technical skills and so different levels of training was arranged. On the job training was carried out by the development team. Training of end users proceeded quickly and smoothly because users were already familiar with the previous version of the toll gate manual system. The developers realised that inadequate training may translate to failure of the system and so to ensure that this does not happen, users were trained as follows:

- **Cashiers** – using both a hard copy of the user manual, cashiers were trained on the aspects of all their operations. They were trained on how to register a vehicle, how to load money into the card and to add all tollgate stations in the country.
- **Operators** – Operators were trained on the actual operations done at the tollgate stations. Swiping of the RFID card and issuing of receipts to motorists.
- **Management –** management was taught on how to access their reports. The training also presented a chance to explain and interpret the various reports to management.
- **System Administrators –** These were trained on how to create and manage user accounts as well as troubleshooting system problems. Back up and storage of system data was the other area covered in Administrators' training. The other area of training to Administrators was the security issues concerning system access and audit trails.

Advantages of Training

- Ensures a smooth and successful transition from the old system to the new system
- Training eliminates too much reliance upon developers
- Motivates and increases confidence among users
- Reduces the chances of disaster recovery

After the users were trained about the computerized system, working shifted from the old to the new system. The process is called changeover.

5.6 SYSTEM CHANGEOVER

During changeover, the developed system is put into use while the old one is retired or abandoned. Several methods could be employed to install the RFID Swipe card system. The management with assistance of the developer sat down to consider and come up with the best method of changeover for the ZINARA Swipe card system. The following changeover method were critically looked into and evaluated.

5.6.1 Direct Changeover: Direct changeover is the immediate replacement of the old system by the new system and is viewed as the least favourable approach. Direct changeover is the simplest, quickest and the most cost effective way of changing over systems. It is however the most risky of all the four approaches of changeover. The old system is instantly discontinued while the new system takes over. With this type of changeover, extensive training and testing of the new system is needed before changeover is done.

5.6.2 Parallel Run: In parallel run both systems, the old and the new are executed simultaneously for certain defined period. The same data is processed by both systems. This strategy is less risky but more expensive because results from the old system can be compared with results of the new system. The operational work is doubled but failure of the new system at the early stage does not affect the working of the organisation, because the old system continues to work as it used to do.

5.6.3 Pilot Run: In this type of run, the new system is run with the data from one or more of the previous periods for the whole or part of the system. The results are compared with the old system results. It is less expensive and risky than parallel run approach. This strategy builds the confidence and the errors are traced easily without affecting the operations.

5.6.4 Phased Approach: The phased approach is a compromise between parallel conversion and the direct cut over. Modules are put on the system one at a time and the results or outputs are noted before adding another module. Unlike the pilot run

where the entire system is given to one department or location, the phased approach gives all the locations a part of the system at a time. If any errors are encountered, they affect only the implemented module and not the entire system. It can be costly if the system is composed of many separate modules but generally it is less expensive than implementing a parallel run.

Comment: After the above four approaches have been discussed, and when all the pros and cons have been critically looked into, it was agreed that the direct changeover method be implemented. Although the direct changeover is the most risk and unfavourable of the four strategies, it was chosen because of the following reasons:

(i) It was not possible to do parallel processing on a toll gate system

(ii) Once the new system is in operation, there would be no manual system to fall back on if the need arises.

(iii) The approach was found to be the most cost effective way of changing over

5.7 DOCUMENTATION

The documentation of the system is also one of the most important activity in the system development life cycle. This ensures the continuity of the system. There are generally two types of documentation prepared for any system which are user or Operator Documentation and System Documentation. The user documentation is a complete description of the system from the user's point of view detailing how to use or operate the system. It also includes the major error messages likely to be encountered by the users. The system documentation contains the details of system design, programs, their coding, system flow, data dictionary and process descriptions. This helps to understand the system and permit changes to be made in the existing system to satisfy new user needs.

5.8 MAINTENANCE AND REVIEW

According to Oz and Jones (2008), Maintenance is carrying out modifications and refinements to the system during its life cycle. It is the modification of a software product after delivery to make it adapt to changing environments or new environments altogether. It has been seen that there are always some errors found in the systems that must be noted and corrected. It also includes reviewing the system throughout its entire life cycle. The review of the system is done in order to know the full capabilities of the system, to know the required changes or additional requirements and to study the performance of the system. If a major change to a system is needed, a new project may have to be set up to carry out the change. The new project will then proceed through all the above life cycle phases. Systems are continuously reviewed and maintained because user requirements are bound to change with time and as technology advances so does systems.

Advantages of Maintenance

- The total cost of maintenance is greatly reduced
- Urgent interruptions will be fewer as well as emergency cases caused by breakdowns
- The workforce will become stable
- The total labour required to maintain equipment will be reduced
- Unscheduled work is greatly reduced due to increases in planned workload
- Unnecessary damage to equipment is reduced

Swanson (1976) identified four categories of maintenance as mentioned below:

- corrective,
- adaptive,
- perfective and
- preventive maintenance;

5.8.1 Corrective Maintenance

The correction of reported and discovered errors in the system is viewed by Jeff M, (2001) as corrective maintenance. The focal point of this maintenance is to discover and correct errors that

came up when design and implementation were done. Users during the use of the software are likely to discover some malfunctions that were not visible at first, attending to these malfunctions is what is called corrective maintenance.

5.8.2 Adaptive Maintenance

Jeff M (2001) defines adaptive maintenance as making changes to the system so as to make it conform to the changes in the environment. The working environment of the use might change and so the maintenance team have to make changes so as to adapt the system to the new environment. Changes such as database upgrades to cater for vehicle population increase and even addition of extra features and functionality is covered in this type of maintenance.

5.8.3 Perfective Maintenance

Perfective maintenance as Brian H (2001) puts it, involves improving the product in terms of performance and functionality as needed by the users of the system. This entails modifying the product when it is already in use to get the best performance and also as a way of improving maintainability. The system should always be in a position to satisfy requirements of stakeholders at any given time. For this reason, it should constantly be modified to align it with user needs. The users will continually be involved throughout the life cycle to determine what is best at that particular time. Therefore perfective maintenance provides value addition to the system.

5.8.4 Preventive Maintenance

According to Piotrowski (2001), Preventive maintenance involves carrying out some procedures to guard against degradation or malfunctioning of the software product with the goal of increasing its usefulness. This involves taking actions on the software by modifying it during implementation to identify hidden and underlying slipups in the product before they turn into effectual faults.

5.9 SUGGESTED IMPROVEMENTS

The RFID Swipe card product can be further improved by:

- Networking the entire toll collection systems across the country so as to enable vehicle and goods tracking and so curb the theft of vehicles in the country.

5.10 RECOMMENDATIONS

Jansen, (1998) refers recommendations as suggestions made by either the developer of the system or the users of the system regarding the functionality and performance of the system in order to improve it. The following suggestions were forwarded to ZINARA management:

- Proper training of users is very vital in order for the system to function accurately.
- Security measures are to be adhered to so that the integrity and confidentiality of the data is preserved.
- All important data should be backed up to guard against loss and destruction of data.
- Maintenance should also be carried out by competent staff who will not compromise the system.

5.11 CONCLUSION

Project deliverable is now a fully functional system. It has undergone careful testing and it has proved to be a success. It has since been concluded that the product is now ready for operation at any appropriate time deemed fit by ZINARA management.

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Appendix A: Cover Letter

20 July 2014

Dear Sir

RE: BSc Information Systems Degree Questionnaire

The researcher, CreziaChiriya Registration Number: R12119E is a student doing her final year at Midlands State University. The researcher is conducting a research on the current operations of toll collection in Zimbabwe with the aim of suggesting ways of improving it. Your input will be regarded as private and confidential and will be used only for the purpose of the study.

Yours Faithfully

CreziaChiriya

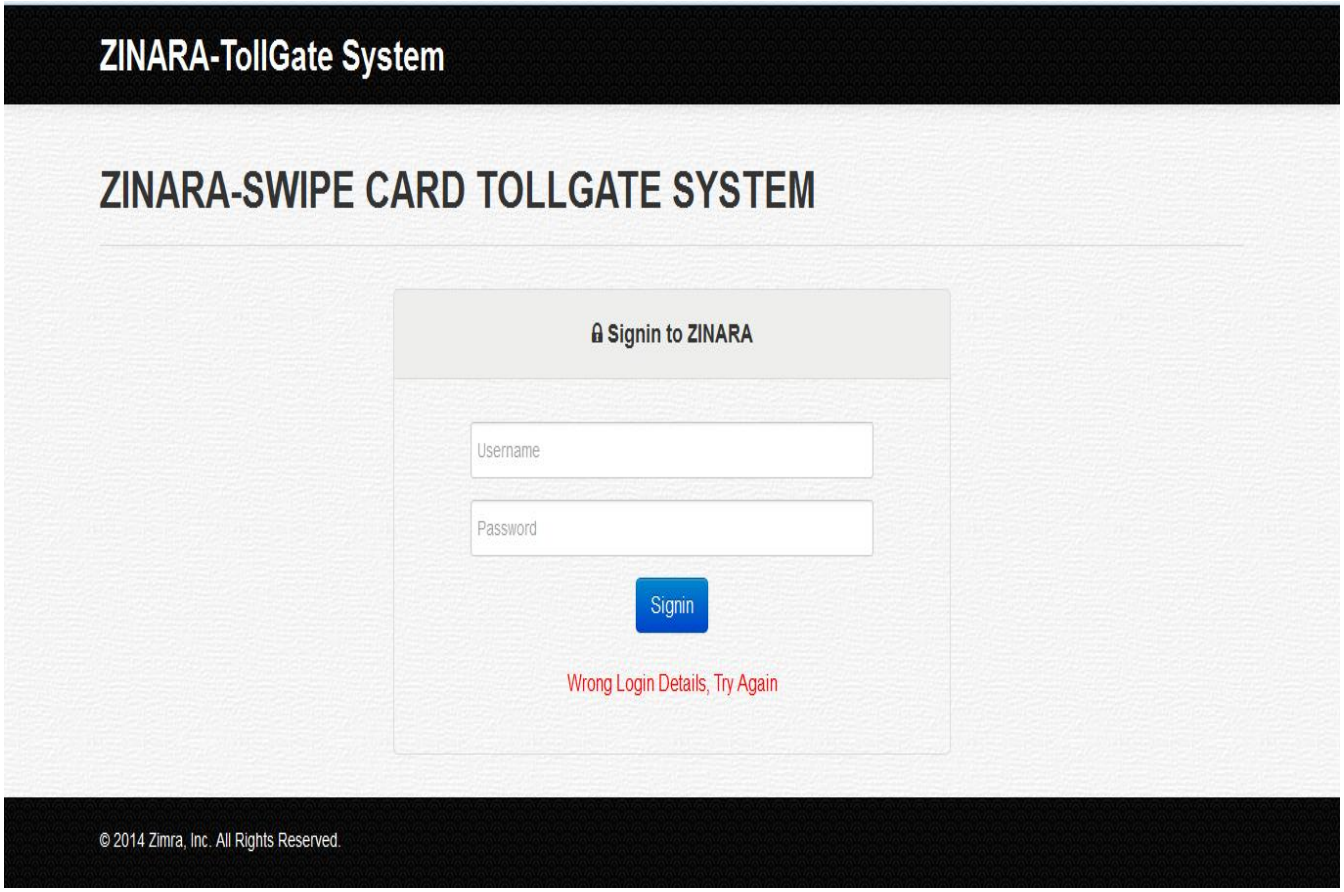
Reg. No. R12119E

Appendix B: User Manual

A user manual was developed to guide the system users on the system operations. It will cover the log in and exiting procedures. It will demonstrate how to register vehicles and save to the database. It will also demonstrate how to generate transaction reports for management and other stakeholders

1. Login

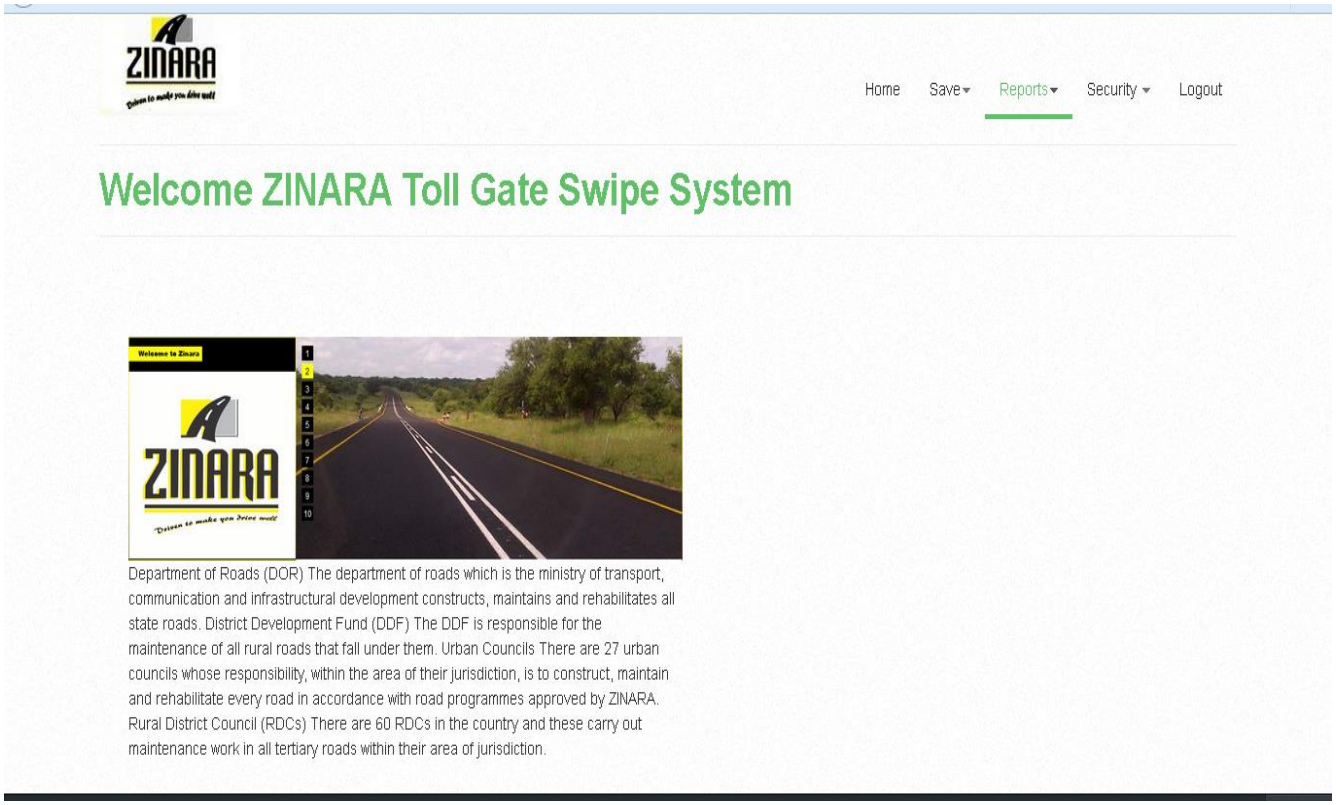
A user name and a password are used to access the system. The system administrator will log in the system and create the system authorized system users. A sample of the login screen is given below showing the username and password textboxes. A pop up message " Wrong Login Details, try Again" for wrong user details is displayed.



2. Tollgate System Home Page

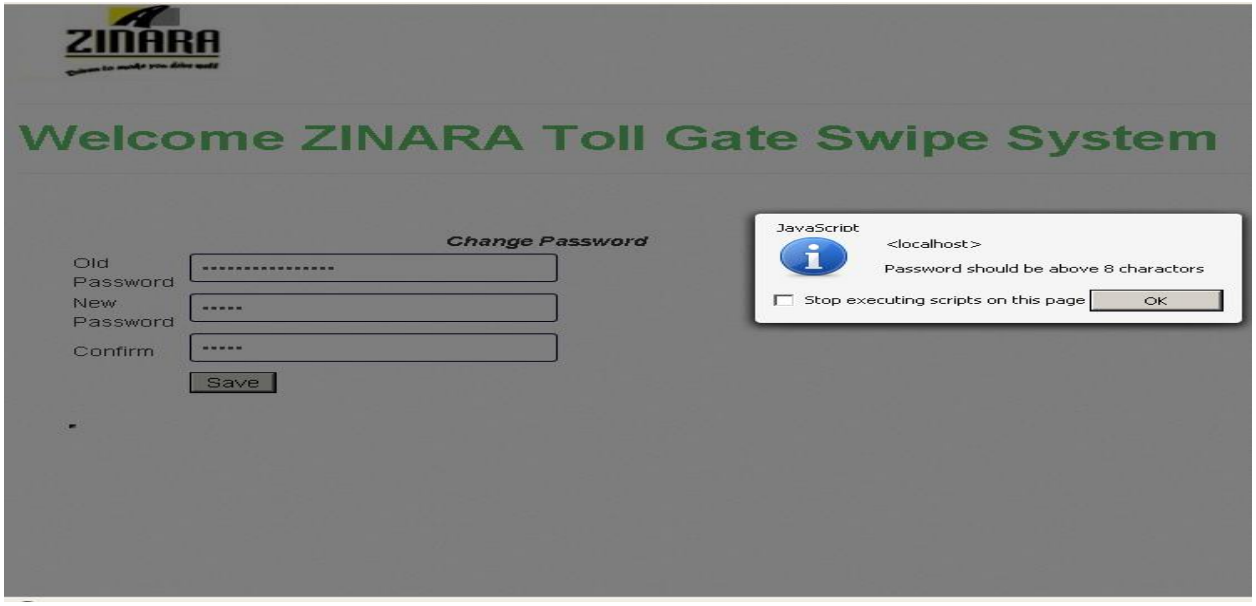
The system hope page is as shown below with menu options: Home, Save, Reports, Security and Logout. You choose the menu which corresponds to your access level. The options that are disabled means you are not authorized to view or access those menus. The manager is only given access to view reports and then logout. The operator is allowed to swipe cards and load cash only and then logout. The cashier can add a tollgate, register a vehicle, load card and then logout.

Backup is the duty of the administrator only.



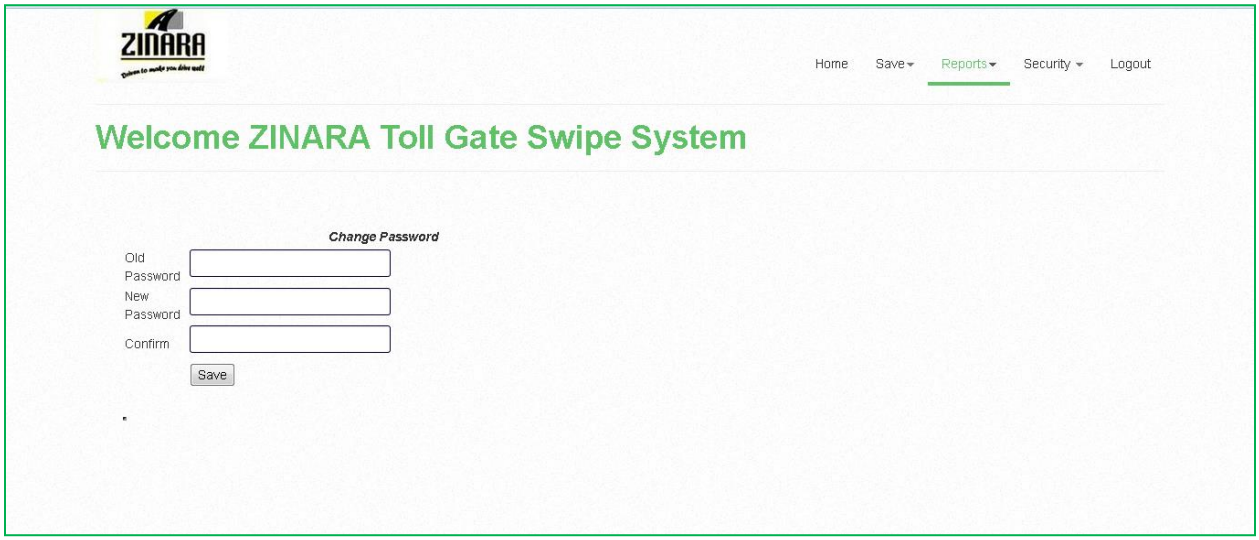
3. User input validation

The minimum password length is eight characters if a user tries to save a new password with less than eight characters a pop up message box is displayed indicating the that the password must be eight characters.



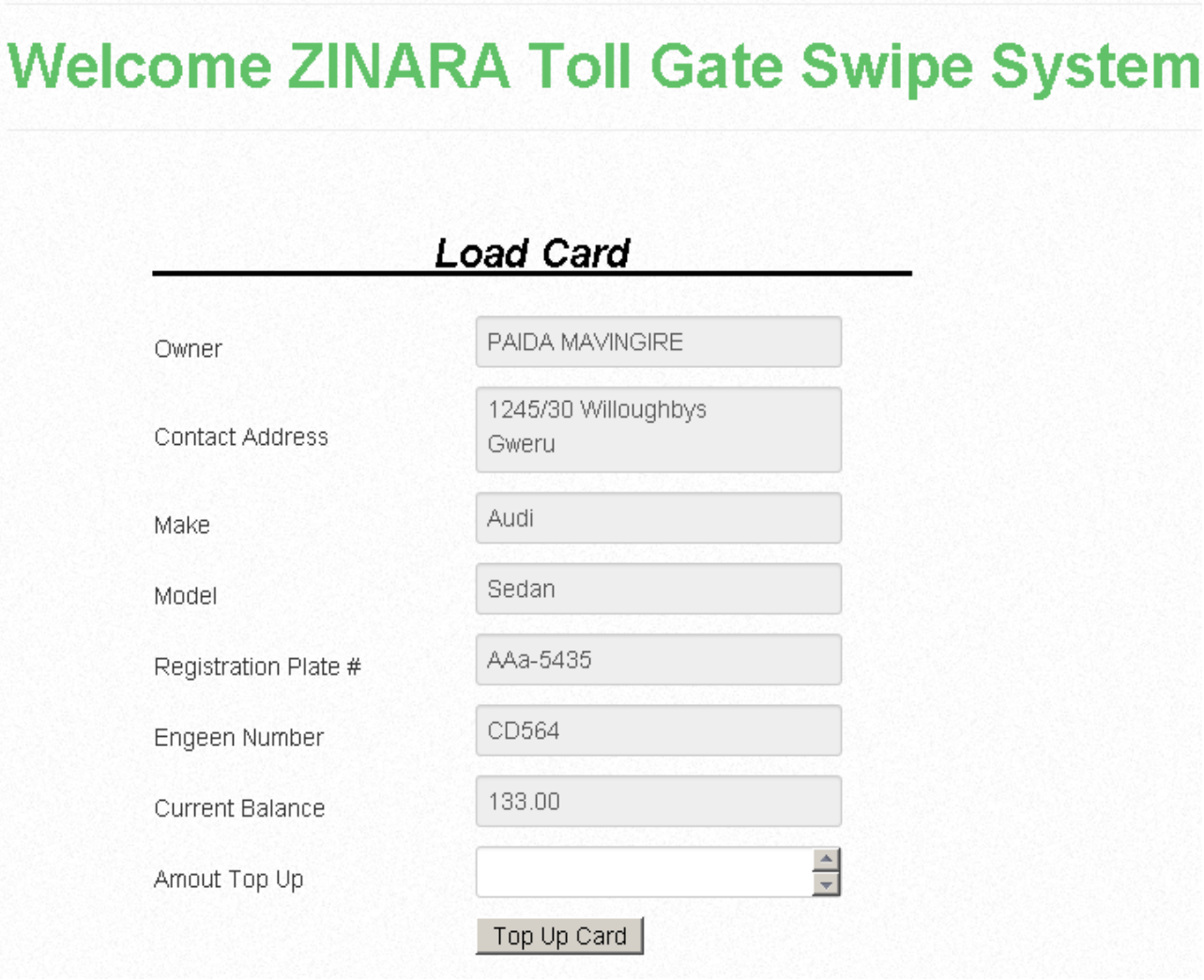
3. Change Password

All users are encouraged to change the default password which is digits 1-8 upon the first login. The required password is of length 8 to enforce security. The system will ask you to enter the old password and then the new password and confirm it before saving it. The below figure illustrate the form used to change the password.



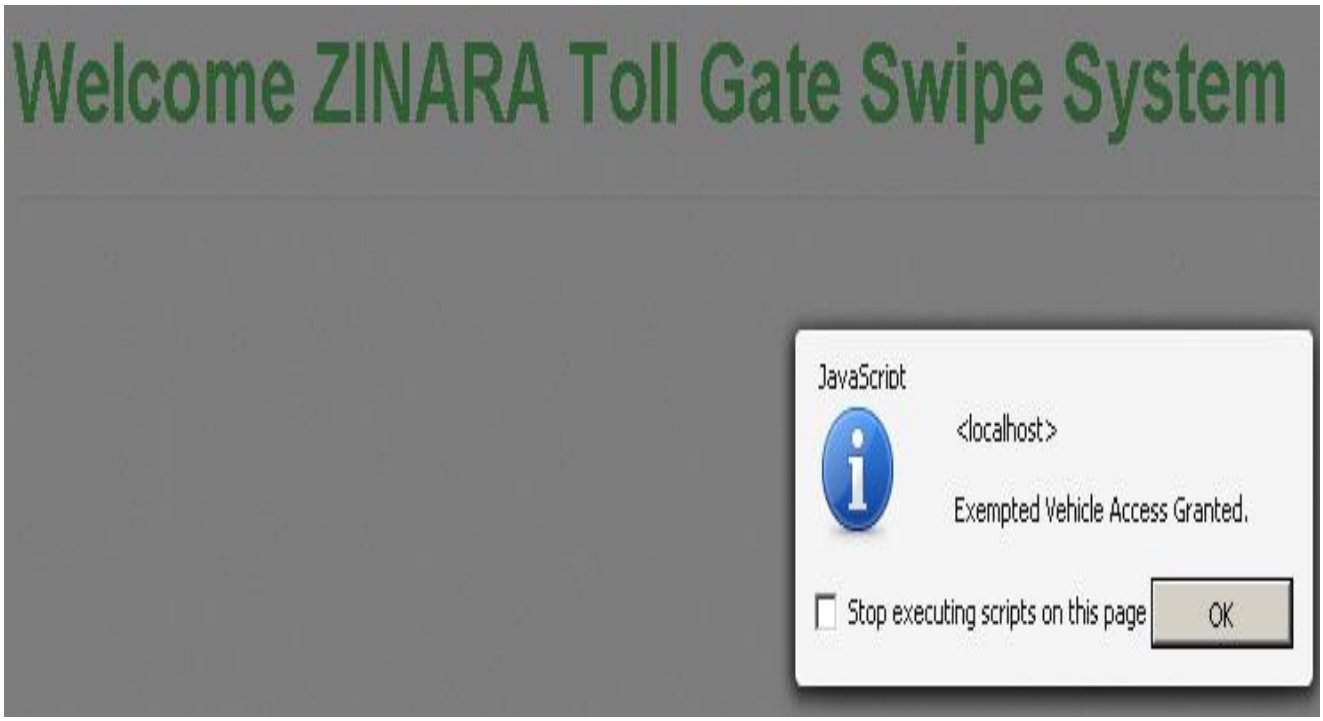
4. Loading card with cash at the Post Office

All road users are to be issued with swipe cards during vehicle registration which they will use to swipe at the tollgate site to gain entrance by causing the required amount to be deducted from their card account.



5. Exempted Vehicles

There are some vehicles such as Ministry of Transport employees' personal vehicles, state vehicles and other special vehicles that are exempted from paying the toll fee. These vehicles are treated differently in that they enter a special pin to gain entry at the tollgate station.



Foreign vehicles as well as those imported vehicles that have not yet been registered are given temporary swipe card to use during their time of stay or until they register in the case of newly imported vehicles.

6. Registering a vehicle

The first transaction to be performed on the system is the registration of a vehicle before anything else is done. A vehicle is registered by the cashier at the office who after registration will issue the vehicle owner with a pre-coded swipe card that will be used to gain entry at every tollgate. All the fields are required in this form. Please note that the phone number is a 10 digit number and the pin code is a 4 digit number. After entering the vehicle details, the cashier swipes a blank card to encode it and then asks the vehicle owner for a pin that he will be using to gain access at tollgate after swiping with the card given to him/ her. During vehicle registration, vehicle status is specified as either Non-Exempted or Exempted. The form below is the vehicle registration form to be used by the cashier.

7. System Reports

The manager is the only one who is allowed to view and print reports. The following reports are produced by the system:

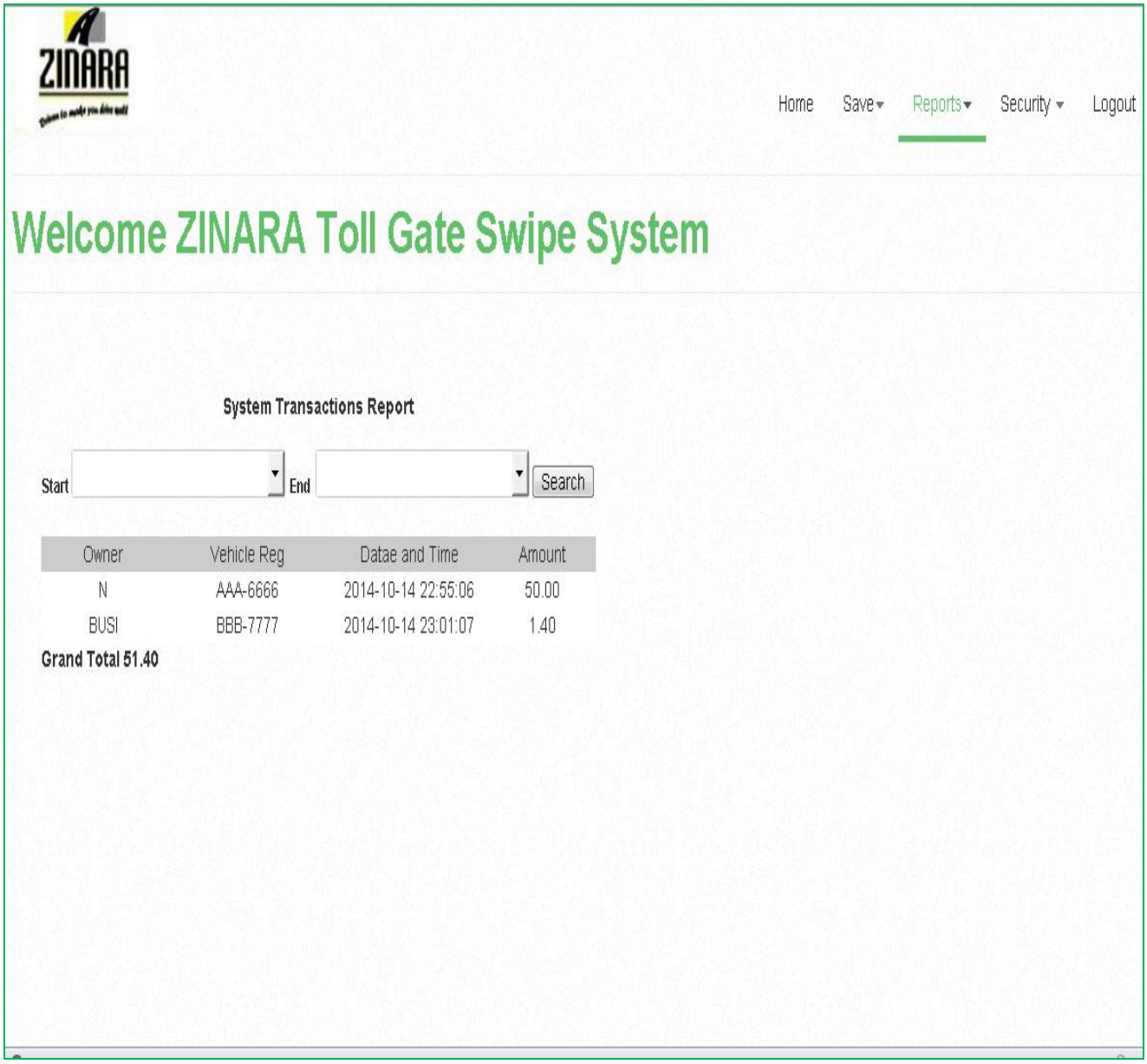
i) Deposit report
ii) Vehicles report
iii) Swipe transactions report
iv) Exempted vehicles report

v) Foreign vehicles report

All reports are printable using any paper size and any printer. Below is a screenshot for report generation by managers.

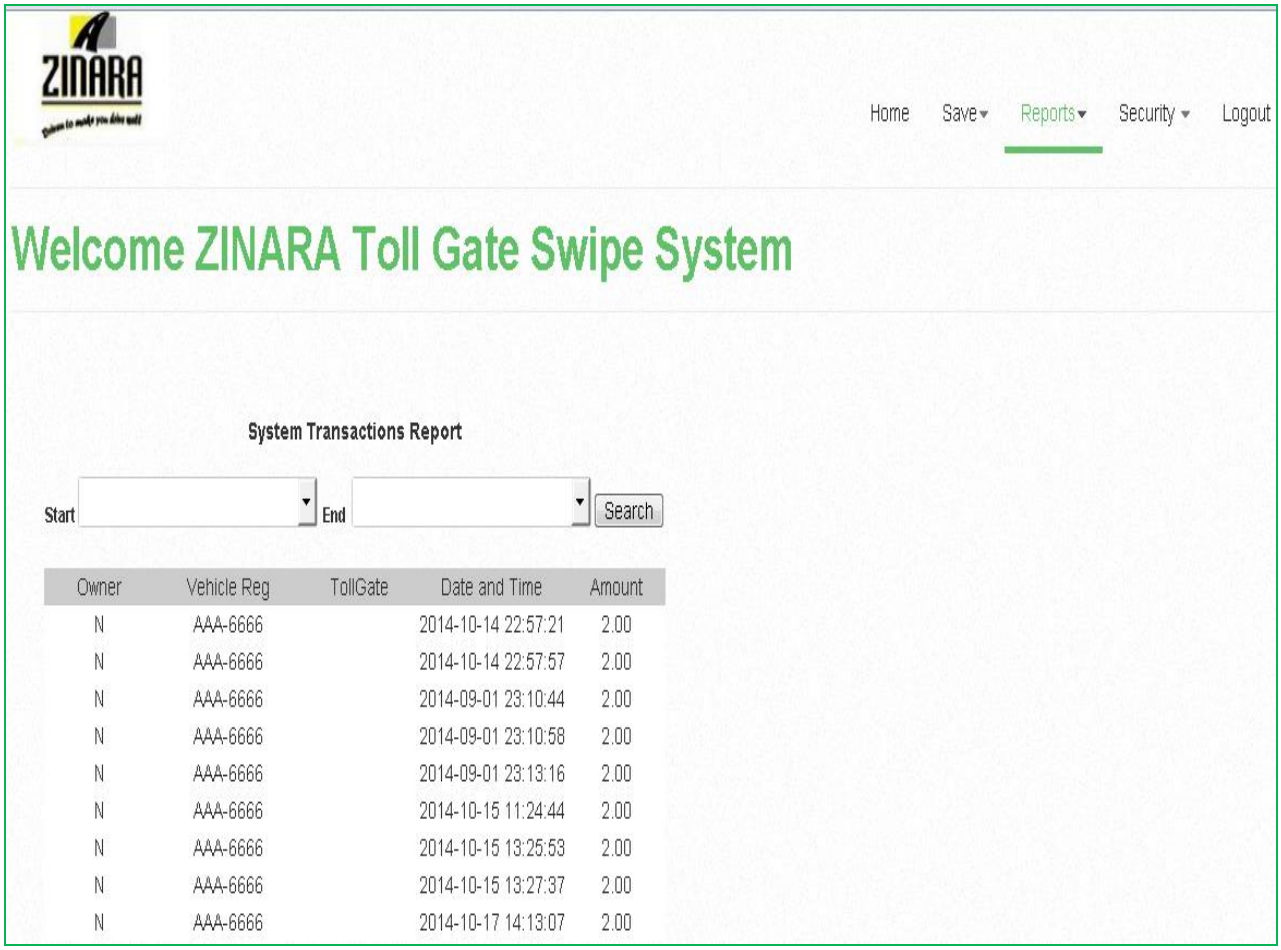
8. **Cash deposits or transactions report**

All cash from loading of card whether at the tollgate station or at designated ZINARA Load Card points is captured and shown in a report shown in the below format. Please note that swipe transactions are not included here because they are accounted for in another report known as swipe transaction report.



9. Swipe Transaction Report

The report below shows all transactions that has taken place within the selected report period. To view the report, select the period using a date picker provided by the system and click search. The report for that period will be displayed.



CONCLUSION

User manual and user training will help the users to fully understand and utilize the new computerized system. The screenshot from the system will help users to quickly grasp the concept being explained.

Appendix C: Interviews

Interview guide for ZINARA RFID Swipe Card System

Date: ……/……/2014

Sample of interview questions used for information gathering:

1. What are your duties?
   ……
   ……
   …….
2. What challenges do you face in carrying out your duties?
   .....
   .....
   .....
   .....
3. Can you explain in full how the system operate from the time the driver gets to the toll boots up to the time he departs
   ……
   ……
   ……
   ……
4. How long does it take on average to complete a transaction, that is from collecting the toll fee, issuing the driver with a receipt up to the opening of the gate?
   ……
   ……
   ……
   ……
5. Do you think the system is has any loopholes? If so what are they?
   ……..
   ……
   ……
   ……
6. Are there any changes that you would propose to be made on the current system? ☐ ☐
7. If yes what are they?
   ……
   ……
   ……
   …….

Appendix D: Questionnaire

Questionnaire guide for RFID Swipe Card system.

Date: ……/……/2014

Sample of a questionnaire used for information gathering: Put a tick in the appropriate box for your answer and answer the questions that follow.

1. Are you satisfied with the current system?
Yes ☐
No ☐

2. What security problems are you facing with the current system?
Yes ☐
No ☐

If No state reasons and recommendations.
……
…….... …….
3. How do you rate the current system? Good, Very Good, Excellent, Poor. Explain.
……

4. What do you consider as the main shortcomings of the current system?
……
……

5. What do you recommend as the possible solutions to the problems?
…….....
..... …..
6. How efficient and reliable is the current toll collection system?
……..…….
7. In this existing system, do you do any backup?
Yes ☐
No ☐

8.How long does it take to complete single transaction at the tollgate?
…….....
.....

9. Do you think there is any room for evading payment by motorists in this system?

10. How is the cash collected transported to the banks? Do you think this is a safe method of transporting cash.

11. How do you account for total amount of cash collected at a tollgate station?

Appendix E: Observation Score sheet

RFID Swipe Card and Monitoring System

Observation guide for: **Cashier** ☐ **Driver** ☐

Date: ……/……/2014

Focus of observation: …….

Brief description of session:
……
……
……
……
……
……

Areas of strength:
……
……
……
……
……
……
……
……..

Areas for development:
……
……
……
……
……
……
……

Appendix F: Snippet of Code

Code for Login

```
<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="utf-8">

<meta name="viewport" content="width=device-width, initial-scale=1.0">

<meta name="description" content="Bootbusiness | Short description about
company">

<meta name="author" content="Your name">

<title>ZINARA | TollGate System</title>

<!-- Bootstrap -->

<link href="css/bootstrap.min.css" rel="stylesheet">

<!-- Bootstrap responsive -->

<link href="css/bootstrap-responsive.min.css" rel="stylesheet">

<!-- Font awesome - iconic font with IE7 support -->

<link href="css/font-awesome.css" rel="stylesheet">

<link href="css/font-awesome-ie7.css" rel="stylesheet">

<!-- Bootbusiness theme -->

<link href="css/boot-business.css" rel="stylesheet">

</head>

<body>

<!-- Start: HEADER -->
```

```
<header>

<!-- Start: Navigation wrapper -->

<div class="navbarnavbar-fixed-top">

<div class="navbar-inner">

<div class="container">

<a href="index.html" class="brand brand-bootbus">ZINARA-TollGate System</a>

<!-- Below button used for responsive navigation -->

<button type="button" class="btnbtn-navbar" data-toggle="collapse" data-
target=".nav-collapse">

<span class="icon-bar"></span>

<span class="icon-bar"></span>

<span class="icon-bar"></span>

</button>

<!-- Start: Primary navigation -->

</div>

</div>

</div>

<!-- End: Navigation wrapper -->

</header>

<!-- End: HEADER -->

<!-- Start: MAIN CONTENT -->

<div class="content">

<div class="container">

<div class="page-header">

<h1>ZINARA-SWIPE CARD TOLLGATE SYSTEM</h1>
```

```
</div>

<div class="row">

<div class="span6 offset3">

<h4 class="widget-header"><i class="icon-lock"></i>Signin to ZINARA</h4>

<div class="widget-body">

<div class="center-align">

<form class="form-horizontal form-signin-signup" action="login.php"
method="post">

<input type="text" name="username" placeholder="Username" required>

<input type="password" name="password" placeholder="Password" required>

<div class="remember-me">

<div class="clearfix"></div>

</div>

<p>

<input type="submit" value="Signin" class="btnbtn-primary btn-large">

</p>

<p><div style="color:#FF0000;"><?php if(@$_GET["err"]==1){echo "Wrong Login
Details, Try Again";}else{}?></div></p>

</form>

</div>

</div>

</div>

</div>

</div>

</div>
```

```
<!-- End: MAIN CONTENT -->
<!-- Start: FOOTER -->
<footer>
<div class="container">
<p>
&copy; 2014 Zinara, Inc. All Rights Reserved.    </p>
</div>
<!-- End: FOOTER -->
<script type="text/javascript" src="js/jquery.min.js"></script>
<script type="text/javascript" src="js/bootstrap.min.js"></script>
<script type="text/javascript" src="js/boot-business.js"></script>
</body>
</html>
```

Code for Swipe Card

```
<script language=javascript type='text/javascript' src="jquery.js"> </script>
<script src="../../SpryAssets/SpryTabbedPanels.js" type="text/javascript"></script>
<link href="../../SpryAssets/SpryTabbedPanels.css" rel="stylesheet" type="text/css">
<style type="text/css">
<!--
.style3 {color: #0066FF}
.style4 {
        color: #000000;
        font-weight: bold;
```

```
        font-size: 24px;
}
.errstyle {
        color: #FF0000;
        font-size: 12px;
        }
-->
</style>
<style type="text/css">
<!--
.style5 {
        color: #000000;
        font-size: 14px;
}
-->
</style>
 <script src="SpryAssets/SpryValidationTextField.js" type="text/javascript"></script>
<script type="text/javascript">
<!--
function MM_validateForm() { //v4.0
  if (document.getElementById){
    var i,p,q,nm,test,num,min,max,errors='',args=MM_validateForm.arguments;
   for (i=0; i<(args.length-2); i+=3) { test=args[i+2];
val=document.getElementById(args[i]);
     if (val) { nm=val.name; if ((val=val.value)!="") {
```

```
        if (test.indexOf('isEmail')!=-1) { p=val.indexOf('@');
          if (p<1 || p==(val.length-1)) errors+='- '+nm+' must contain an e-mail address.\n';
        } else if (test!='R') { num = parseFloat(val);
          if (isNaN(val)) errors+='- '+nm+' must contain a number.\n';
          if (test.indexOf('inRange') != -1) { p=test.indexOf(':');
            min=test.substring(8,p); max=test.substring(p+1);
            if (num<min || max<num) errors+='- '+nm+' must contain a number between
'+min+' and '+max+'.\n';
      } } } else if (test.charAt(0) == 'R') errors += '- '+nm+' is required.\n'; }
    } if (errors) alert('The following error(s) occurred:\n'+errors);
    document.MM_returnValue = (errors == '');
} }
//-->
 </script>
 <script language="javascript">
function isNumberKey(evt)
{
var charCode = (evt.which) ? evt.which : event.keyCode
if (charCode > 31 && (charCode < 48 || charCode > 57)) {
if(charCode != 8){
alert("Enter digits only.");
return false;
}
}
return true;
```

```
}
</script>
<script language="javascript">
function lettersOnly(evt) {
evt = (evt) ? evt : event;
var charCode = (evt.charCode) ? evt.charCode : ((evt.keyCode) ? evt.keyCode :
((evt.which) ? evt.which : 0));
if ( (charCode < 65 || charCode > 90 ) &&
(charCode < 97 || charCode > 122)) {
if(charCode != 32){
alert("Enter letters only.");
return false;
}

}
return true;
}
</script>

<style type="text/css">
<!--
.style7 {
        font-size: 18px;
        color: #000000;
```

```
}
.style8 {
	color: #000000;
	font-style: italic;
	font-weight: bold;
	font-size: 18px;
}
-->
</style>
<div class="style4">
  <div align="center"><em>Swipe Card</em></div>
</div>
<form action="index.php?page=checkcard1.php" method="post" name="" >


  <table width="80%" border="0" bgcolor="#FFFFFF" align="center" style="border-
top:3px solid #000000;">


    <tr><td colspan="2"><div align="center">
      <p class="style3 style5">Please Enter the vehicle details below to create a new
vehicle.</p>
      <p class="style5 style3"><strong>Note: All fields should be filled.</strong></p>
        </div></td>
    </tr>
            <tr>
```

```
        <td width="267">Card Number</td>
        <td width="287"><label>
          <input type="text" name="card" id="card" required />
        </label></td>
    </tr>
     <tr>
        <td width="267">Pin Number</td>
        <td width="287"><label>
          <input type="password" name="pin" id="pin" required />
        </label></td>
    </tr>
                    <tr>
        <td></td>
        <td>
          <input name="Submit" type="Submit" id="Submit" value="Next"  />
</td>
       </tr>
    </table>
  </div>
  </div>
  </div></form>
<iframe name="my-iframe" width="0" height="0"></iframe>
```

Code for Registering Users

```
<?php
```

```
if(isset($_POST["button"]))
{
	include "../opendb.php";
	$nationalid=strtoupper($_REQUEST["nationalid"]);
	$chitupaarray=explode("-",strtoupper($_REQUEST["nationalid"]));
		if(sizeof($chitupaarray)!=4)
	{



		$error[]="- Invalid nationalID format";
	}
	elseif(!(is_numeric($chitupaarray[0])) || (strlen($chitupaarray[0])!=2)  )
		{
			$error[]="- Invalid nationalID prefix";
		}
		elseif(!(is_numeric($chitupaarray[1])) ||
!((strlen($chitupaarray[1])>=5)&&(strlen($chitupaarray[1])<=8)) )
		{
			$error[]="- Invalid nationalID middle number";
		}
		elseif((strlen($chitupaarray[2])!=1)||(!(($chitupaarray[2]>='A') &&
($chitupaarray[2]<='Z'))))
		{
			$error[]="- Enter a valid nationalID check-letter";

		}
```

```
                elseif((strlen($chitupaarray[3])!=2)||(!(is_numeric($chitupaarray[3]))))

                {
                        $error[]="- Invalid nationalID suffix, must be numerical and
have 2 digits";
                }
                 if($error)
 {
        foreach($error as $k)
        {
                $err.=$k.'\n\r';
        }
?>
        <script language="javascript">
        alert("<?php echo $err; ?>");
        </script>
<?php
        die("");
 }

                if($_POST["password"]!=$_POST["cpass"])
        {
                ?>
<script language="javascript">
                alert("Password did not match. Please verify your password inputs.")
```

```
                </script>
<?php
                exit;
        }
        if($_POST["tollgate"]=='0')
        {
                ?>
<script language="javascript">
                alert("Select tollgate to proceed.")
                </script>
<?php
                exit;
        }
        if($_POST["access"]=='0')
        {
                ?>
<script language="javascript">
                alert("Select access rights to proceed.")
                </script>
<?php
                exit;
        }



        $rs=mysql_query("select * from users where
```

```
nationalid='$_POST[nationalid]'");
        if($row=mysql_fetch_array($rs))
        {
                ?>
<script language="javascript">
                alert("User already added, try another one.")
                </script>
<?php
                exit;
        }

        if(strlen($_POST["password"]) < 8)
        {
                ?>
<script language="javascript">
                alert("Password should be above 8 charactors.")
                </script>
<?php
                exit;
        }

        mysql_query("INSERT INTO users
VALUES(NULL,'$_POST[surname]','$_POST[firstnames]','$_POST[username]','$_P
OST[password]','$_POST[tollgate]','$_POST[access]',NOW(),'$nationalid')");
```

```
        ?>
<script language="javascript">
                alert("Account created successfully.")
                parent.location='index.php?page=users.php'
                </script>
<?php
                exit;
}
?>
<script language="javascript">
function lettersOnly(evt) {
evt = (evt) ? evt : event;
varcharCode = (evt.charCode) ? evt.charCode : ((evt.keyCode) ? evt.keyCode :
((evt.which) ? evt.which : 0));
if ( (charCode< 65 || charCode> 90 ) &&
(charCode< 97 || charCode> 122)) {
if(charCode != 8) && (charCode != 32) {
alert("Enter letters only.");
return false;
}


}
return true;
}
```

```
</script>

<form action="" method="post" name="form1" target="my-iframe">

<table width="100%" border="0">

<tr>

<td width="50%">FirstNames</td>

<td width="50%"><label>

<input name="firstnames" type="text" id="firstnames" size="40" onkeypress="return
lettersOnly(event)" required>

</label></td>

</tr>

<tr>

<td>Surname</td>

<td><input name="surname" type="text" id="surname" size="40" onkeypress="return
lettersOnly(event)" required></td>

</tr>

<tr>

<td>NationalID</td>

<td><input name="nationalid" type="text" id="nationalid" size="40" required></td>

</tr

><tr>

<td>Username</td>

<td><input name="username" type="text" id="username" size="40" required></td>

</tr>

<tr>

<td>Password</td>

<td><input name="password" type="password" id="password" size="40"
```

```
required></td>
</tr>
<tr>
<td>Confirm Password</td>
<td><input name="cpass" type="password" id="cpass" size="40" required></td>
</tr>
<tr>
<td>Toll Gate</td>
<td><?php

include '../opendb.php';

$sql="select * from tollgate";
$rez=mysql_query($sql);
echo "<select name='tollgate' id='tollgate' >";
?>
<option value="0">--- <span class="style2">--Select Toll Gate-- </span>---</option>
<?php
while($row=mysql_fetch_array($rez,MYSQL_ASSOC)){

 echo "<option value='$row[id]'>{$row['tollgate']}</option>";
}

?></td>
```

```
</tr>
<tr>
<td>Access Level</td>
<td><?php

include '../opendb.php';

$sql="select * from access";
$rez=mysql_query($sql);
echo "<select name='access' id='access' >";
?>
<option value="0">--- <span class="style2">--Select Access-- </span>---</option>
<?php
while($row=mysql_fetch_array($rez,MYSQL_ASSOC)){

 echo "<option value='$row[id]'>{$row['access']}</option>";
}
?></td>
</tr>
<tr>
<td colspan="2"><label>
<div align="center">
<input type="submit" name="button" id="button" value="Save Record">
<input type="reset" name="button2" id="button2" value="Reset Data">
```

```
</div>

</tr>

</table>

</form>

<iframe name="my-iframe" width="0" height="0"></iframe>
```

CONTENTS