



UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING AND INFORMATICS

**FRAMEWORK FOR AXLE LOAD MANAGEMENT INFORMATION
SYSTEM FOR KENYA**

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DECLARATION

This project as presented in this report, is original work and has not been presented for any other University award.

Signed: _____

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This project has been submitted as part fulfilment for Master of Science in Information Systems of the University of Nairobi with my approval as the University Supervisor.

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Abstract

Road construction is an expensive venture both for Governments and its citizens. A well-constructed road - in good usage - should last for about ten years without major repairs; however most roads in developing countries do not last that long due to several reasons ranging from poor workmanship to overloading which is the major culprit for failure of most roads.

In Kenya, most transporters utilise every opportunity available to overload to make more money with few trips. Ironically when the roads are run down they rise up and blame the Government for poor road condition. This necessitates the need for strict axle load control and compliance to protect the road infrastructure.

The current axle load control is based on Cap 403. Laws of Kenya and is not effective since it is manually operated. Weighbridges operations are not automated leaving room for all manner of record manipulation.

A robust web enabled Axle Load Weigh-In-Motion (ALWIM) computer system connecting all the weighbridges and running on a centralised server and database to monitor the axle load of the transporters over time is the solution to axle load control in Kenya. This project demonstrates how developed ALWIM prototype is a proof of concept and evaluation of its framework. This work was achieved by designing a framework for a computer based axle load control system, design based on framework for axle load at weighbridges, and creating a repository of past offenders to assist in legal enforcement of the axle load as in Kenyan law.

ALWIMS is a deterrent to perennial overloading as transporters can be easily tracked and prosecuted wherever they commit an offence. The system makes overloading virtually impossible since transporters have to be cleared by the system after court process to be able to proceed with the journey. Data retrieval, report generation is made easy due to centralised nature of the system. The envisaged system is no doubt a solution to the overloading problem which has been a headache for decades and a tool for protection of quality roads.

Further works is recommended for the full implementation of automation of axle reading as the vehicles step on the scales and captured and stored in the database without human intervention.

TABLE OF CONTENTS

List of Tables.....	7
List of Figures.....	8
Abbreviations	9
CHAPTER 1 : INTRODUCTION.....	10
1.1 Background.....	10
1.2 Problem Statement.....	11
1.3 Research Objectives	11
1.4 Research Questions	11
1.5 Assumptions and Limitations of the research	12
CHAPTER 2 : LITERATURE REVIEW.....	13
2.1 Introduction	13
2.2 Weigh in motion system in United Kingdom.....	14
2.3 Weigh in Motion system in Australia.....	15
2.4 Weigh in motion system in the United States	16
2.5 The current Kenyan Weighbridges.....	18
CHAPTER 3: METHODOLOGY.....	20
Introduction	20
3.1 Analysis	20
3.1.2 Research Approach (overview).....	20
3.1.2.1 Approach to Process Modelling.....	20
3.1.2.2 Approach for design for proposed framework.....	20
3.1.3 Sample size	21
3.1.4 Data analysis.....	22
3.1.5 Reliability test.....	22
3.1.6 Analysis Representations.....	22
3.1.7 Analysis of the product test	23
3.2 System design.....	27

CHAPTER 4 : IMPLEMENTATION AND RESULTS	35
4.1 Introduction	35
4.2 Platform of implementation.....	35
4.3 Automatic counter	36
4.4 Single axles.....	38
4.5 Axle groups	38
4.6 Axle configurations	38
4.7 Scale types.....	39
4. 8 Weighing Module.....	40
4.9 Weighing results – no overload detected.....	41
4.10 Weighing results – overload detected.....	41
4.11 Runaway vehicles.....	41
4.12 Management of information and Reporting Module.....	41
4.13 Prototype of ALWIM application	42
CHAPTER 5 – DISCUSSIONS, CONCLUSION AND RECOMMENDATIONS	44
5.1 Results Analysis	44
5.2 Discussion.....	44
5.3 Limitations and Constraints.....	45
5.4 Conclusion.....	46
5.3 Recommendations for further work.....	46
REFERENCES	47
Appendix I User Manual	49
Table 11.....APPENDIX IIISample of data captured in the field	55
APPENDIX IV Map showing Weighbridges locations in Kenya.....	73
Appendix V SAMPLE SOURCE CODES.....	74

List of Tables

	Page No
Table 1	Fines for Excess Axle Load or Gross Vehicle Weight19
Table 2	Coding key.....23
Table 3	Statistical analysis Table.....24
Table 4	Cargo frequency Destination Table.....25
Table 5	Cargo Origin Analysis.....25
Table 6	Sample of system data.....37
Table 7	Max allowable GVW according axle Configuration.....39
Table 8	Current status/types of scale on ground.....40
Table 9	Axle configuration Picture Appdx I.....54
Table 10	Sample of analysed data Appdx II.....55-62
Table 11	Transporter further analysis.....63
Table 12-13	Cargo analysis.....64
Table 14	Axle analysis.....65
Table 15	Cargo analysis by data in.....65
Table 16	Types of cargo analysed.....66
Table 17	Further cargo analysis-deviations.....66
Table 18-19	Statistical analysis.....69

List of Figures

	Page No.
Figure 1	Research conceptual framework.....17
Figure. 2	Bar chart/Pie chart of cargo frequency.....26
Figure 3	System Process model.....27
Figure 4	ALWIM system Architecture.....28
Figure 5	Flow diagram of weighing module.....31
Figure 6	Flow diagram of axle weighing process.....33
Figure 7	Overload detection process.....34
Figure 8	System Implementation Platform.....35
Figure 9	ALWIM prototype I.....42
Figure 10-11	ALWIN prototype II & Final model.....43
Figure 12	Bar chart of cargo Origin.....67
Figure 13	Representation of cargo68
Figure 14-16	Various data represented.....70-72
Figure 17	Map showing weigh bridges location in Kenya.....73

Abbreviations

ALWIM-----Axel load weigh in motion

ARRB-----Australian Road Research Board

BBZJ-----Barabara Zetu Journal from Roads Ministry

DOT-----Department of Transport

KENHA-----Kenya National Highway Authority

KERRA-----Kenya Rural Roads Authority

KRB-----Kenya Roads Board

KURA-----Kenya Urban Roads Authority

MOF-----Ministry of Finance

MOR-----Ministry of Roads

MOTSA-----Ministry of Transport South Africa

RDBMS-----Relational Database Management System

SPSS-----Statistical package for social science

SSADM-----Structured System Analysis & design Method

TDC-----Traffic Data Collection (monitoring and enforcement systems)

WIM ----- Weigh in Motion

GVW----- Gross vehicle Weight

UK----- United Kingdom

CHAPTER 1 : INTRODUCTION

1.1 Background

Roads are an integral part of the transport system. A country's road network should be efficient in order to maximize economic and social benefits. They play a significant role in achieving national development and contributing to the overall performance and social functioning of the community. It is acknowledged that roads enhance mobility, taking people out of isolation and poverty

The basic principle of weigh in motion (WIM) technology were developed in the 1950s. However, adequate instrumentation, data processing and storage and suitable mass sensors were non-existent or crude.

One of the earliest efforts to develop a WIM system was in 1952 by the United States Bureau of Public Roads (Norman and Hopkins 1952). The system's mass sensor included a reinforced concrete platform, constructed in the surface of the pavement. The platform was supported at each corner by columns to which resistance wire strain gauges were bonded. The system output consisted of an oscilloscope trace that took 10 seconds to acquire for each vehicle. Axle weights, spacing and vehicle speed were computed by manually analysing the oscilloscope readings.

For many years, researchers have sought to develop systems that could weight vehicles whilst they were travelling along the highway, at the same time retaining the accuracy of static systems for enforcement purposes or, of sufficient accuracy to enable traffic to be screened for later static weighing. In Kenya, like in most countries, roads are the key mode of transportation. The cost of operating a road transportation system, entails two main components, the cost of operating fleet of vehicles using the road and the cost of constructing, maintaining and rehabilitating the roads themselves.

During a four year duration from 2006 to 2009 Kshs. 57,228,541,885.09 was used for rehabilitation of roads in Kenya, while Kshs. 58,780,698,540.19 was used in new road construction across the country. The current development budget for the year 2011/2012 stands out to be Kshs74,400,000,000. - MOF budget department.

Vehicle axle loads is the one key element in road pavement design that affects the two components since it affects the road condition, reduces the life of the road, increases vehicle operating cost (VOC), affects the economy of the country adversely affects all Road users whether they participated in the destruction of the road or not . Hence the need for effective Axle load control through weigh in motion as opposed axle by axle weighing which is an inconvenience to abiding transporters, creates a snile up along Kenyan roads(Upto 5km of traffic in Mariakani), and is prone to corruption.

1.2 Problem Statement

There is lack of a framework based on a centralized controlled computer database and application on a wide area network linking all the weighbridges stations with Road Ministry Headquarters. The system to be developed based on the prototype would eliminate the manual recording axle load as the computer system picks the axle readings automatically.

Operations at various weighbridges are currently largely manual with long queues resulting from weighing all vehicles whether overloaded or not and subjecting the transporters to several weighing at every weighbridge.

1.3 Research Objectives

- (i) To design a framework for computer based axle load control system;
- (ii) To design a prototype based on framework for axle load control at weighbridges;
- (iii) To create a repository of past offenders to assist in legal enforcement of the axle load.

1.4 Research Questions

- (i) Is there a suitable and effective framework for axle load control for Kenyan Roads?
- (ii) Can an information system be used to control axle load at weighbridges?
- (iii) Can a system be used in tracking offenders and enforcement of axle load?

1.5 Assumptions and Limitations of the research

- (i) The records at the stations (though manually recorded) are accurate enough to be used for the study. The fear of difficulty in obtaining information even with written permission due to constant suspicion is real. It also assumed that Truck drivers would cooperate to give accurate information.
- (ii) There would be no hostility from the cartels and other stakeholders. Since big money is known to change hands between the players of this industry.
- (iii) Access to research data would not be hampered with bureaucratic red-tape

Limitations;

- (iv) The MOR may not have requisite ICT resources for system testing and implementation.
- (v) There may not be adequate support and goodwill to implement the system i.e. internal deliberate frustration to implement the system.

1.6 Chapter Summaries

Chapter 2 is Literature review, a summary of history of axle load to the current weigh in motion systems being used in different countries parts worldwide, especially developed countries.

Chapter 3 is the research methodology, which is divided into two parts (i) Analysis and (ii) Design. A systematic approach used collect, analyse and present the research findings, data analysis and techniques used in data representation, detailed design of flow diagrams.

Chapter 4 is a detailed implementation process of the research findings, recommended platform for implementation and the expected reports from the system.

Chapter 5 is discussion, conclusion and recommendations; states hoe the objectives were met, contribution of this research as a provision to a solution of overloading is goes further to suggest further research to areas which is not conclusively addressed by this research.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

The requirement to weigh civilian traffic vehicles is thought to date back to 1741 when the UK government of the day introduced the Turnpike act, which decreed that tolls were to be paid for use of roads according to the weight of the vehicle.

Massive *steelyards** were installed but vehicles had to be lifted before their weight could be measured. The solution to this lay in the production of platform scales or weighbridges onto which the vehicles could be driven. From late 1940's mechanical weighing began to combine with electronics, but it was not until the invention of the load cell that complex and bulky systems and knife edges were replaced (Avery Berkel 1999).

The two main types of static weighing systems in use today consist of stationery platform and portable wheel scales. The accuracy of both systems makes it eligible for enforcement purposes (scheuter 1998).

A truck scale consists of a scale frame that supports the weight of a truck without major bending, a number of load cells, junction boxes and weight indicator. These traditional platform scales are available in a wide range of sizes and weighing capacities, in both pit mounted and surface mounted versions which calculate to an accuracy of less than 0.5% (scheuter 1998).

Portable wheel load scales have been developed to allow for measuring wheel and axle loads, as well as GVW. Each wheel is measured individually, although their precision is somewhat lower than platform scales.

Depending on how many scales are used, additional errors may be introduced because of weight transfer between the axles due to longitudinal tilting of the vehicle, incorrect sensor levelling. Site unevenness, sensor tilting, mechanical friction in the suspension, and residual friction forces induced by braking. The influence of these factors on the results of axle group of GVW, is reduced by using the same number of scales as number of wheels in the axle group or the whole vehicle. A set of 6 wheels load scales can achieve a maximum error band of less than 1% for the GVW, but they are slow and require a lot of labour. A set of 2 wheel load scales can achieve a maximum error band between 1% (good site and vehicle in good condition) and 35% (average site and vehicle in poor condition) for the GVW (scheuter 1998).

**Invented by the Romans in 200BC, steelyards consisted of a beam with a sliding poise to counterbalance the load.*

Static scales offer advantage of allowing accurate calculation of the vehicle weight. However, from the data collection and weight enforcement perspective, they are subject to a number of drawbacks. Benekohal et al (1999) conducted a study at a static weigh station in Illinois where it was found that 30% of all trucks could not be weighed because the weigh station was temporarily closed to prevent a queue. In addition the average truck was delayed by approximately 5 minutes. Aside from the inconvenience imposed on truck drivers, a greater problem, exists with regard to avoidance of weight enforcement stations by overweight trucks.

Cunagin et al (1997) showed that the number of overweight vehicles decreases with increased enforcement activity, however vehicles attempt to bypass these permanent truck weight enforcement stations. It was found that violations at permanent weight enforcement stations were minor, whereas those on the bypass routes were much more severe. A total of 0.8% of the trucks were overweight at the fixed scales, whereas 19% were in violation on the bypass routes during the study.

Recent WIM measuring campaigns in Sweden have shown that the level of overloading cannot be estimated from static weighing, due to the avoidance of Police weighing locations by offending vehicles.

Taylor et al (2000) and Bettel Team (1995) reference studies in Virginia (Cottrell 1992) and Wisconsin (Grunamanis 1989) where the problem of weigh station evasion was also noted. In the case of Virginia, at two sites, 11% and 14 % of trucks were found to be overweight on routes used to bypass weigh stations, whereas the figure grew to 20.3% in Wisconsin.

It is believed that truck operators would continue to operate overweight vehicles as long as they can gain an economic advantage by either evading or paying a fine less than the profit received from overloading (Cunagin 1997).

Weigh in motion offers a solution to this problem by allowing vehicles to be weighed as they travel at full highway speed, or as part of integrated system where trucks can be pre-selected via the WIM system prior to entering the weigh station.

2.2 Weigh in motion system in United Kingdom

High Speed Weigh In Motion systems are installed in the main highway and weigh vehicles at normal highway speeds (20-120 kph)it detectst, count and classify vehicles from 5 kph to 200 kph. Accuracies to COST 323 Class B(10); +/-10% (or better), are achievable on well constructed roads. The Weigh In Motion system uses unobtrusive but easily installed piezo electric sensors as the weighing medium.

TDC have a number of bespoke High Speed Weigh In Motion solutions; the HI-TRAC 100+ is the main system with a long and excellent track record in installations worldwide. The HI-TRAC 100+ system can connect to 8 lanes of WIM sensors however smaller systems with limited connectivity

are available. The HI-TRAC EMU2 is the second generation of the popular high speed WIM and counter/classifying system; the EMU2 can connect to 2 lanes of WIM sensors.

The Roadtrax BL piezo electric sensor is manufactured for TDC by Measurement Specialties Inc and is available to Class 1 or Class 2 specifications. Class 1 sensors are used for WIM; these sensors produce a close tolerance output throughout their length. Sensors are available from 2M to 5.5M; covering most Low Speed Weigh In Motion systems are installed in a controlled environment such as a vehicle weight enforcement and inspection stations where the vehicle speed is controlled to approximately 5 kph. Accuracies to +/-1% are achievable providing the axle weigh bridge is installed in a concrete weigh lane constructed to TDC specifications. Automatic vehicle classification allows for immediate indication of vehicle overload dependent upon vehicle class and legal local weight limits.

TDC offer two bespoke Low Speed Weigh In Motion solutions; the LO-TRAC 100 and the LO-TRAC 200. The LO-TRAC 100 model includes interconnectivity to other systems (e.g. HSWIM systems) and includes functions to control traffic lights, entry barriers, etc, whereas the LO-TRAC 200 model has limited connectivity but stills functions as a weight enforcement system.

The TDC axle weighbridge; model WB30L, connects to either the 100 or 200 models, it is set in a pit frame which is itself set in the concrete weigh lane. The axle weighbridge utilizes four 10,000kg load cells and is structurally strong enough to withstand axle loads of up to 70,000 kg.

2.3 Weigh in Motion system in Australia

Accurate and reliable data on the nature and extent of heavy vehicle use of Australia's road network is extremely important. One means of obtaining this data in Australia is via the use of high speed Weigh - in - Motion (WIM) technology. Data originating from high speed WIM systems is used for infrastructure design and management, freight and trade regulation and vehicle mass limit enforcement and detection studies. In particular, high speed WIM system development, which has been pioneered by the Australian Road Research Board Ltd. The application of high speed WIM technology, current research in improving accuracy and experience with standardization. In Australia, WIM systems fall into two broad groups

with respect to the 'motion' in their weighing, namely low speed (\ll 15 km/h) and high speed ($>$ 15 km/h). There are two main reasons for low and high speed WIM systems, namely functionality and accuracy. The functional requirement is simply aimed at fulfilling low or high speed applications. The accuracy requirement is based on the current technical inability of high speed systems as deemed by Government to weigh accurately enough for prosecution or fee payment. The overwhelming majority of WIM systems used in Australia have been developed by the Australian Road Research Board Ltd (ARRB). there are currently in Australia five high speed WIM system

types, incorporating a wide range of technology including bending plate, capacitance pad, capacitance strip, load cell and strain gauge weighing sensors. In total there are currently 139 high speed WIM sites in Australia of which 90 per cent were developed by ARRB.

2.4 Weigh in motion system in the United States

METTLER TOLEDO WIM systems provide accurate, robust solutions for high-volume, in-motion vehicle weighing. Whether in a fixed weighing facility, in a stand-alone virtual weigh station, or in a data collection installation, these systems provide a more efficient and cost-effective alternative to static axle or full-platform scales

The core elements of the METTLER TOLEDO WIM System are the dual staggered weighing sensors in the roadway. As a vehicle crosses these sensors, at speeds of up to 80 mph, the vehicle's speed, axle configuration and individual wheel, axle and gross weights, are measured. This WIM data can then be provided to a local PC or remote system for reporting, further data analysis, or integration with information from other peripheral devices.

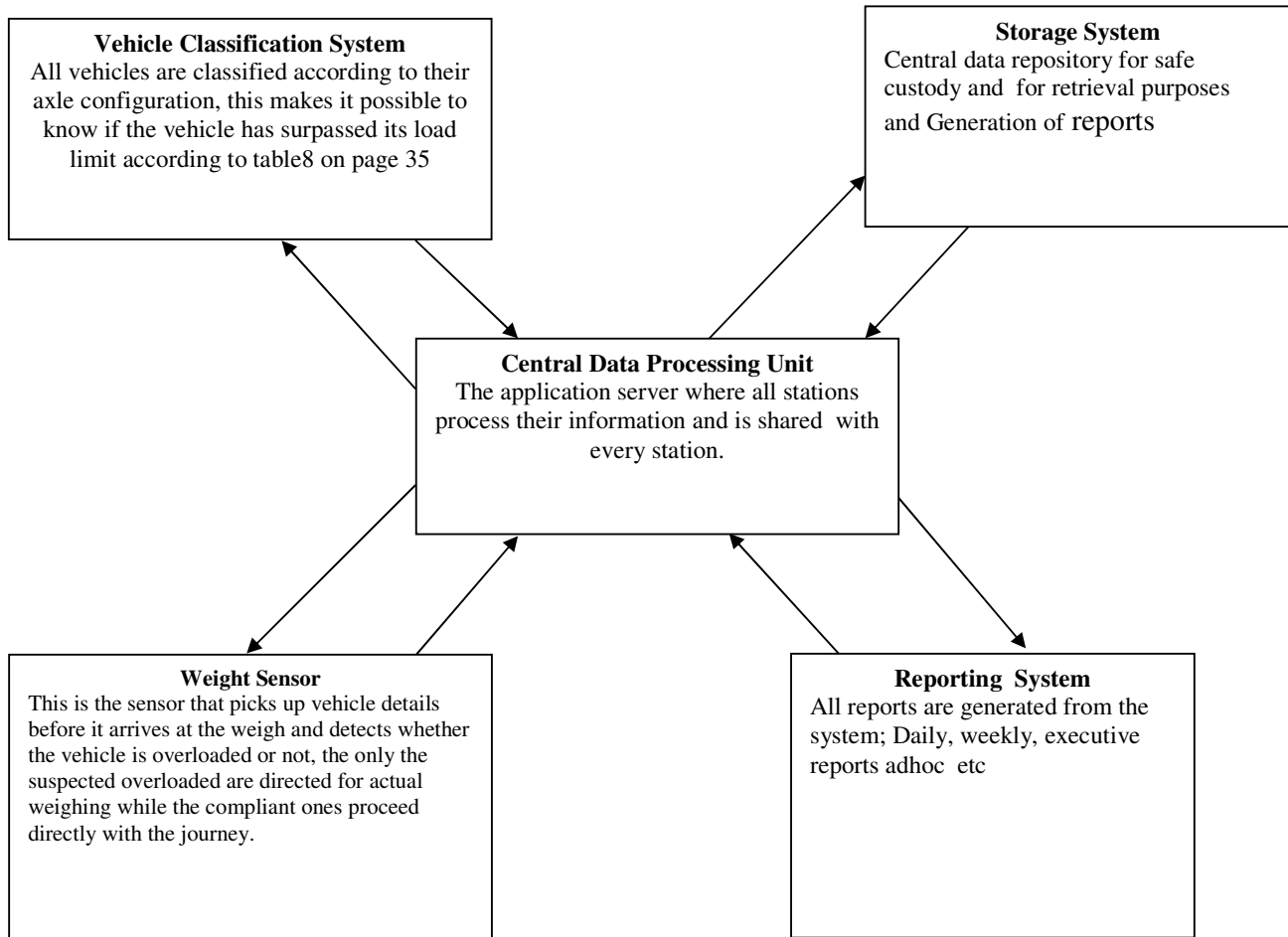
Depending on the application, multiple weighing sensor technologies can be used, including low-maintenance scale platforms with stainless steel load cells, or the Kistler Lineas Quartz sensor, for fast and minimally invasive installation.

There are around 800 WIM installations in the US used mostly for data collection. According to Peterson, authorities are realising that such information can be applied to help enforcement agencies. "In Minnesota, for example, there are 13 WIM sites collecting data for the state DOT, which is now researching on the benefits of combining visual identification technology with WIM and sharing that information with enforcement agencies," he says. "If vehicle detection, weight and other data is collected and shared through networks, a virtual system can be created for access by enforcement agencies which are beginning to realise a more cost effective solution."

2.5 Conceptual Model

This model allows development of a system with all variables taking into account at a high level and makes the process of understanding the system functionality more efficient.

Figure 1 The Conceptual framework



Source: Traffic data centre-UK

2.6 The current Kenyan Weighbridges

Kenya has 13 weighbridge stations located in various parts of the country all the stations are static (permanent) weighbridges, posing the danger already covered above besides being haven of corruption since many offender do not want to pay the heavy fines stipulated by the traffic act (see table 1 below).

Actual weights of the vehicles are measured at these weighbridges and compared to the maximum allowable weights as defined in the Legal Notice No. 118 on the Traffic (Amendment) Rules 2008. Any vehicle found to be in breach of the law in terms of overweight, is fined as per schedule defined in Table 1 - Minimum Fines for Excess Axle Load or Excess Gross Vehicle Weight below, and detained until the overload problem has been addressed and the court case is closed and any charges paid.

The ALWIM system would integrate with KRA system so that detailed records of new vehicles on the Road are automatically available to the users once they have registered with the Authority. Transit vehicles are weighed only once at Mariakani in case the cargo is from Mombasa port or at the first weighbridge for other entry points. These provisions are given to *'customs sealed containerized transit cargo under Police escort'*. KRA stands to benefit from the information of the system.

Police is very key in enforcement of the processes to be undertaken by the transporters and hence functionality of the prototype. All suspected overloaded vehicles must be directed to the scale, and if found overloaded they are appear in court to pay a fine. Notice to attend court is only given by Police who also ensures that overloaded trucks are reweighed after offloading excess weight before they proceed with the journey.

Table 1 - Minimum Fines for Excess Axle Load or Excess Gross Vehicle Weight

Minimum Fine (Kshs)		
DEGREE OF EACH AXLE OVERLOADING OR EXCESS	FINE ON FIRST CONVICTION (Kenya Shillings)	FINE ON SECOND OR SUBSEQUENT CONVICTION
Less than 1,000 kg	Kshs. 5,000	Kshs. 10,000
1,000 kg or more but less than 2,000 kg	Kshs. 10,000	Kshs. 20,000
2,000 kg or more but less than 3,000 kg	Kshs. 15,000	Kshs. 30,000
3,000 kg or more but less than 4,000 kg	Kshs. 20,000	Kshs. 40,000
4,000 kg or more but less than 5,000 kg	Kshs. 30,000	Kshs. 60,000
5,000 kg or more but less than 6,000 kg	Kshs. 50,000	Kshs. 100,000
6,000 kg or more but less than 7,000 kg	Kshs. 75,000	Kshs. 150,000
7,000 kg or more but less than 8,000 kg	Kshs. 100,000	Kshs. 200,000
8,000 kg or more but less than 9,000 kg	Kshs. 150,000	Kshs. 300,000
9,000 kg or more but less than 10,000 kg	Kshs. 175,000	Kshs. 350,000
10,000 kg or more	Kshs. 200,000	Kshs. 400,000

Source: Kenya Traffic act Cap 103

The ALWIM prototype framework is modelled around the United Kingdom's HI-TRAC 100+ systems due to its robustness, Accuracies to +/-1% are achievable providing the axle weigh bridge is installed in a concrete weigh lane constructed to TDC specifications, Besides normal highway speeds (20-120 Km/h) but was detect, count and classify vehicles from 5 Km/h to 200 Km/h

CHAPTER 3: METHODOLOGY

Introduction

The purpose of the research was to verify that data captured by a computer system is reliable than data obtained through manual system. Data from weighbridges across Kenya was used and analysed as proof of concept/evaluation validating the need of the framework in discussion.

3.1 Analysis

Different statistical methods can be used to make sense of collected data sets. According to Hair et al. (2007), two steps are involved in quantitative data analyses:

Descriptive statistics was used to obtain a descriptive overview of data in hand, and Using statistical tests for hypothesis testing. For this study, we shall have to conduct the following statistical analysis to make sense of the data.

3.1.2 Research Approach (overview)

The purpose of this research was to develop a model based on previous literature, and test the citizen adoption model in the area of axle load data capture; therefore, the quantitative approach was be used to test the developed research model empirically. This research process involves building up hypotheses based on theoretical statements. The quantitative approach was test the developed research model empirically since that approach is more useful for testing theory (Hair et al., 2007). In addition, it allows the researcher a greater variety of structured data collection techniques for use with a large representative sample, in order to achieve reliability and validity of the measures used.

3.1.2.1 Approach to Process Modelling

The research strategy was the general plan set by the researcher that outlines how the researcher plans to answer the research question(s). It specifies the source of data collection with consideration of issues such as access of data, time, location, money and ethical issues. To establish generalizability within the specific context of the proposed model with representative data, the survey was chosen as a suitable strategy for data collection. Empirical research via a survey research method is considered to be an appropriate approach to examine the citizens' awareness and adoption of Government Gateway adopters (Choudrie and Dwivedi, 2005)

3.1.2.2 Approach for design for proposed framework

The prototype was developed based on the processes currently practiced at the stations. Some of the processes are predetermined by law (CAP 403 laws of Kenya) since the forms/sheet to be used or filled in are already printed and availed to be used for information capturing. SSADM was used to develop the prototype.

The prototype include processes not currently in use at the bridges to strengthen the existing one and make it effective in axle control.

Using Kothari approach in sampling techniques, for a homogenous universe like ours a small sample size can serve the purpose and that is what was used. Kothari also suggests that for nature of the study; If the items are to be studied intensively and continuously, the sample size should be small.

Sampling technique plays an important role in determining the size of the sample, accuracy and acceptable confidence level. If the standard of accuracy or level of precision is to be kept high, then a relatively higher sample is required. This was the case for this research, a random sample was used and the number of sample was high.

Based upon these factors, Kothari suggests two alternative approaches for determining the sample size:

The first approach is to specify the precision of estimation desired and to determine the sample size necessary to ensure the study succeeds.

The second approach uses Bayesian statistics to weight the cost of additional information against the expected value of the additional information.

The formula for establishing the sample size for an infinite population where we are to estimate the proportion in the universe is

$$n = \frac{Z^2 * p * q}{e^2}$$

But in a finite population, the above standard formula changed as below:

$$n = \frac{Z^2 * p * q * N}{e^2 (N-1) + Z^2 * p * q} \quad \text{Note: } q=1-p$$

Where; **N**=Size of the Population; **n**=Sample Size; **e**=Acceptable Error (The Precision); **Z**=Standard Deviation at a given Confidence Level; **p**=Proportion of the Target Population Estimated to Have Characteristics Being Measured.

3.1.3 Sample size

Registered number of trucks from Kenya Revenue authority was 200,153 by January 2012. Out of this 40,030 which is about 20% are active weighbridge users. Based on this available information, it was possible to determine the following values in the formula: **N**=200,153; **p**=20%; **q**=1-0.2=80%

For determination of standard variant, precision refers usually to 95% confidence interval for the true value of effect. Using tables of normal probabilities, the Z score for 95% confidence level is 1.96. The precision for the research is estimate at plus or minus 4%. Using the above values, the estimated sample size is:

$$n = \frac{1.96^2 * 0.2 * 0.8 * 304,193}{0.04^2(304,193-1) + 1.96^2 * 0.2 * 0.8} = 383.7 = 384 \text{ respondents}$$

3.14 Data analysis

In order to get a descriptive overview of the data, descriptive statistics was used, and this statistical analysis summarizes the large set of data through a limited number of meaningful statistical indicators. Each variable is studied separately to compare average scores of variables among the different groups of respondents (Janssens et al., 2008). Usually, descriptive statistics contain three types of indicators: frequency distribution, central tendency measures, and dispersion measures. The use of frequency distribution indicates how the scores of individual respondents are distributed for each of the variables, and it examines the data one variable at a time (Janssens et al., 2008). “Typically, a frequency distribution shows the variable name and description, frequency counts for each value of the variable, and cumulative percentages for each value associated with a variable” (Hair et al., 2007, p. 308). The measure of central tendency helps a researcher summarize the characteristics of a variable in one statistical indicator to obtain a better understanding. The measures of central tendency are: mean, median, and mode. Mean—the average—is the most commonly used central tendency measure, the median is the middle value in the distribution, and mode identifies where the most value occurs in the distribution (Hair et al., 2007). In the research, all these descriptive statistics—frequency distribution, central tendency, and dispersion—was conducted, and the applicable details were included in the analysis portion.

3.1.5 Reliability test

To assess scale reliability in this research, Cronbach’s alpha and the calculation of composite reliability was used. Measures of internal consistency to test the reliability of the data in SPSS conducted. The method of internal consistency for estimating reliability was mainly focus on how consistently the examinees/subjects performed or desired across items or objects of items on this single test/scale form. The individual scales was subjected to Cronbach’s alpha test for internal consistency. Variables were used for analyses within acceptable scores if the alpha is greater than 0.70

3.1.6 Analysis Representations

The findings are presented by pie-charts, and bar charts for comparison and clarity purposes. Comments, reports, and conclusion is part of the analysis

3.1.7 Analysis of the product test

Table 2 Coding Key:

Variable Name	Code
Origin	1 = MOMBASA 2 = NAIROBI 3 = OTHERS
Destination	1 = NAIROBI 2 = UGANDA 3 = ATHI RIVER 4 = OTHERS
Cargo	1 = CLINKER 2 = CONTAINER 3 = WHEAT FLOUR 4 = FERTILIZER 5 = CEMENT 6 = C OIL 7 = CPO 8 = DIESEL 9 = FUEL OIL 10 = RICE 11 = SALT 12 = OTHERS
Status	1 = CAUTIONED 2 = Vehicles Over The Legal Weight Limit 3 = Vehicles Under The Legal Weight Limit 4 = Void

Source: Research

Table 3

Frequencies**Statistics**

	Origin	Destination	Cargo	Status	GVW Overload	Axle Overload
Valid	1723	1696	1692	1765	1765	1765
Missing	42	69	73	0	0	0
Mean	1.03	2.04	4.14	3.08	74.02	1374.76
Median	1.00	2.00	2.00	3.00	.00	770.00
Mode	1	1	2	3	0	0
Std. Deviation	.218	1.128	3.881	.980	540.921	1899.505
Variance	.047	1.272	15.064	.960	292595.147	3608117.587
Range	2	3	11	4	20000	16460
Minimum	1	1	1	1	0	0
Maximum	3	4	12	5	20000	16460

Source: Research

The output in the above table 3 gives the description of the data used in this study in terms of the mean, median, mode, standard deviation, variance, range, maximum and minimum.

Most of the tracks were originating from Mombasa and destined for Nairobi.

The cargo mostly carried was Containers and most the vehicles seem to go beyond the legal weight limit (mean and mode = 3).

The mean GVW overload was 74.02 tonnes with the maximum being 20,000 tonnes.

The mean axel overload was found to be 1,375 tonnes and it went up to a maximum of 16460 tonnes.

Frequency Table

Table 4 Cargo destination

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NAIROBI	763	43.2	45.0	45.0
	UGANDA	395	22.4	23.3	68.3
	ATHI RIVER	252	14.3	14.9	83.1
	OTHERS	286	16.2	16.9	100.0
	Total	1696	96.1	100.0	
Missing	System	69	3.9		
Total		1765	100.0		

Source: Research

45% of the vehicles were destined to Nairobi, 23.3% to Uganda 14.9% to Athi river and the remaining 16.9% to other places within and without Kenya.

Cargo origin

Table 5

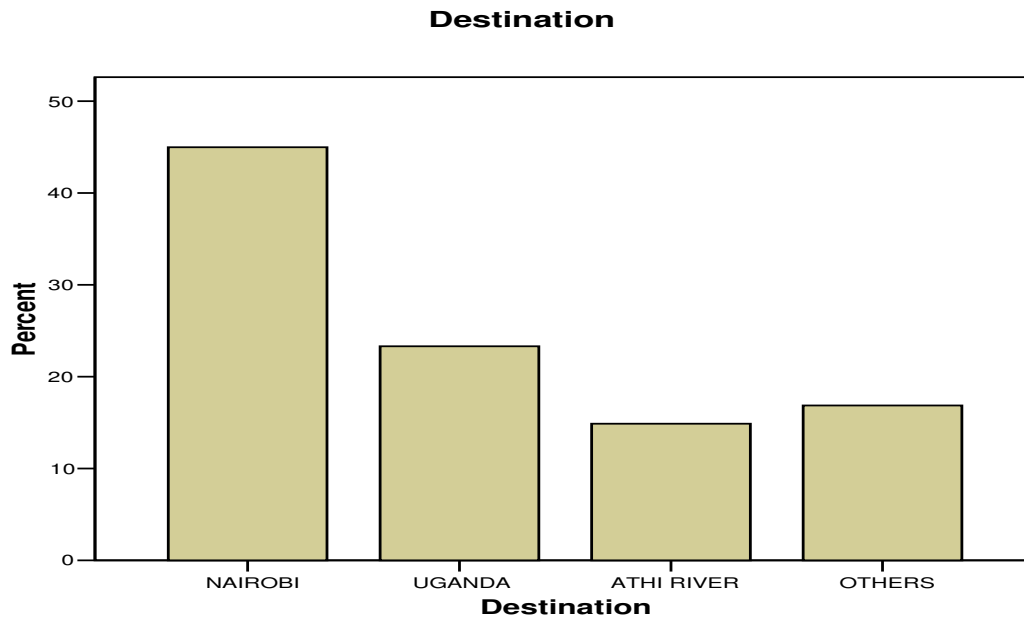
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MOMBASA	1694	96.0	98.3	98.3
	NAIROBI	11	.6	.6	99.0
	OTHERS	18	1.0	1.0	100.0
	Total	1723	97.6	100.0	
Missing	System	42	2.4		
Total		1765	100.0		

Source: Research

Almost all cargo that are major highways Originate from Mombasa (96%) confirming that Mombasa is the entry port to East and central African region and the need to control axle load. Transporters from the region is therefore a burden to Kenyan tax payers.

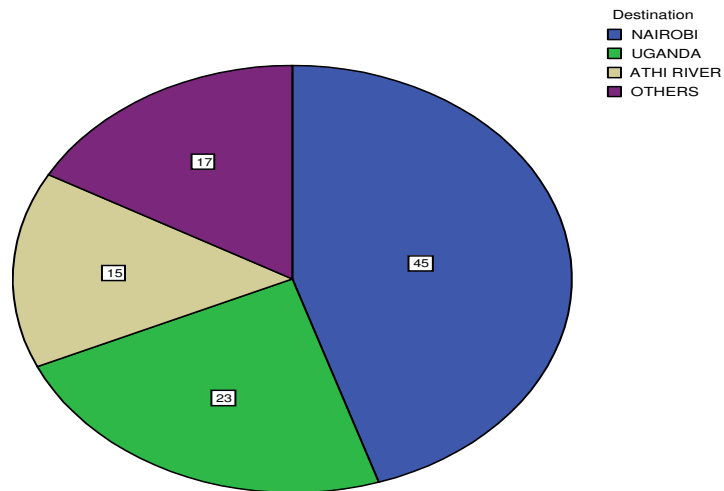
Figure 2

Bar Charts showing Volume of cargo to various destinations



Source: Research

The same information represented by Pie charts showing most cargo are destined to Nairobi



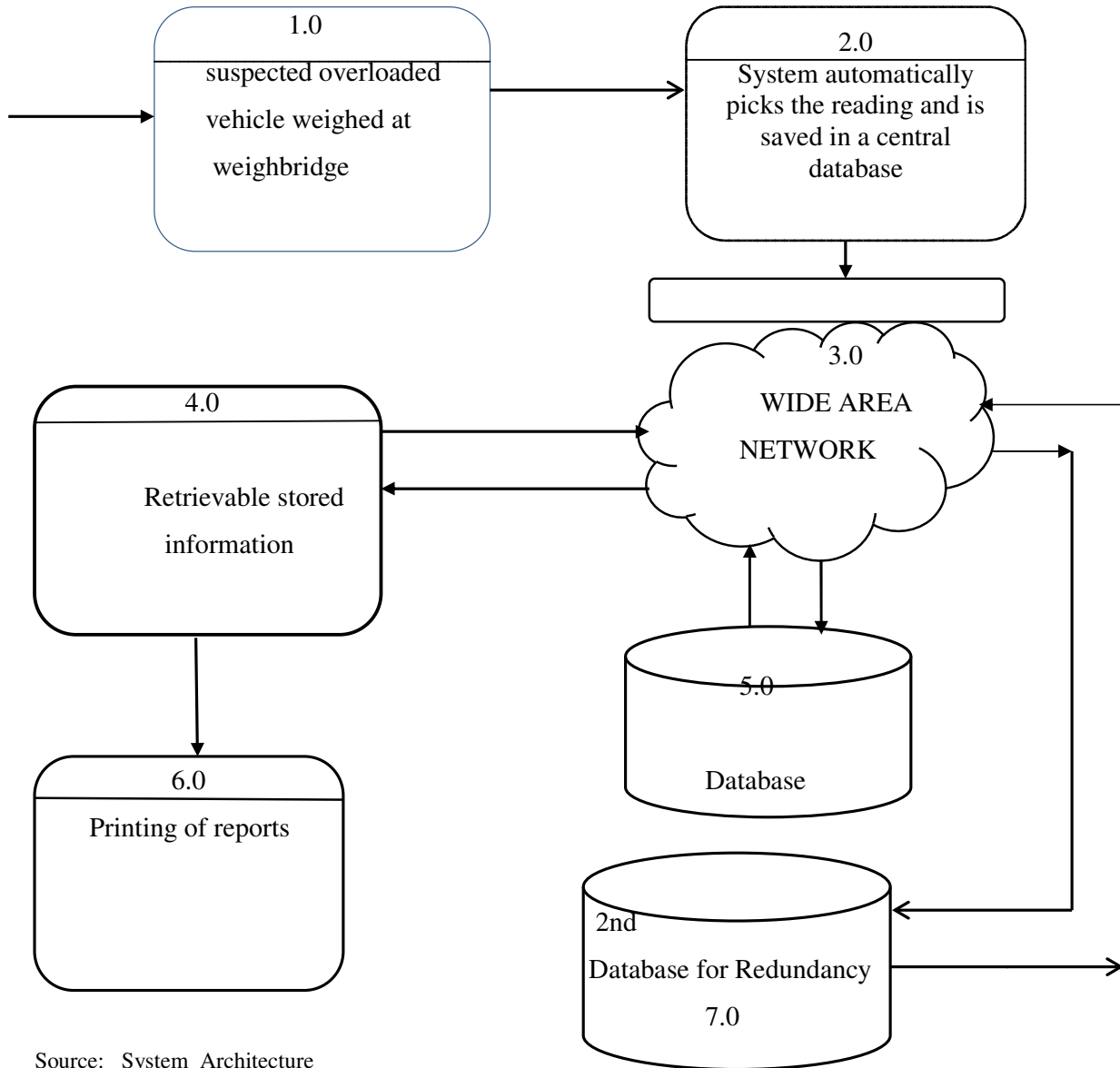
Source: Research

3.2 System design

The following process model describes activities at the type level used to develop the application. It is what the processes look like at system development.

Figure 3

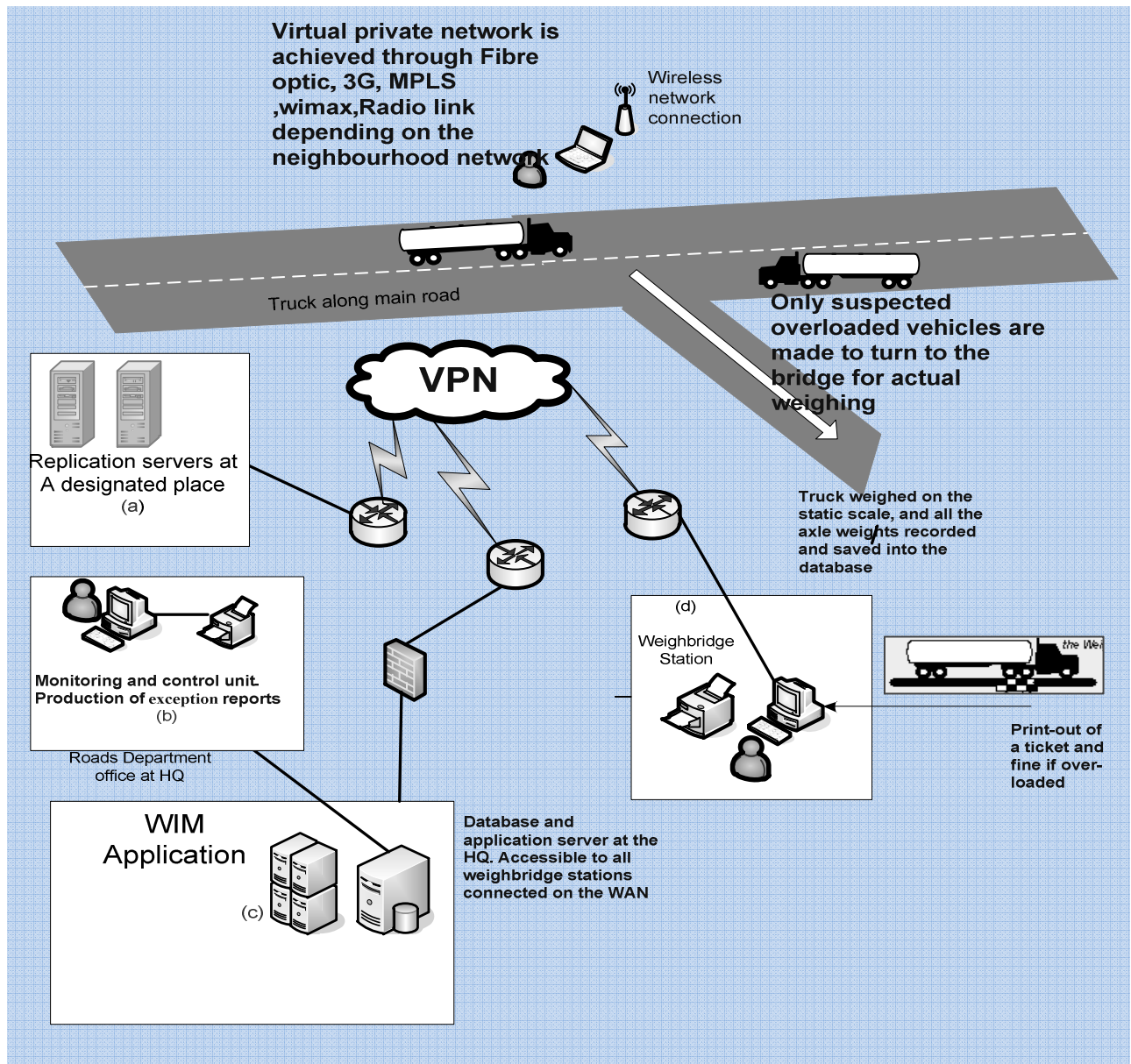
PROCESS MODELLING OF ALWIM



Source: System Architecture

System Architecture is the representation of a system, showing its structures, components, and visible properties the relationships between them, that works together to implement the overall system.

Figure 4: System Architecture of weigh in motion system at a weighbridge station.



Source: Customised from Botswana WIM system

System components:

- a) Redundancy site at a remote place for both the application and database servers;
This is to ensure business continuity in the even a disaster. Secret remote location is a security measure.
- b) Monitoring and control unit; where reports are generated. It is also an oversight Office to see the work is progressing well.
- c) Application and Database Servers; Real time servers that run application in all weigh bridge stations and stores in a repository for ease of information retrieval.
- d) Weighbridge station where ticketing is done, and compliance checked and necessary action taken .
- e) Approach to validation/evaluation

The following data was captured by the machine attendant prior to taking the weight readings of each axle e.g (COW0072) for the actual screen layout to be used by the machine attendant):

- i. Main Vehicle Registration Number
- ii. Country of Registration
- iii. Number of vehicles forming the vehicle combination (i.e. a count of the number plates for the horse and trailer(s))
- iv. Number of axles of the heavy commercial vehicle
- v. The axle configuration of the heavy commercial vehicle; the machine attendant should select the axle configuration from a list of pre-defined pictures or type in the code of the axle configuration in the Vehicle class code field.
- vi. Number of tyres on the vehicle
- vii. The type of cargo being transported
- viii. The transport operator code (this is maintained centrally at headquarters in order to avoid creation of multiple records for the same operator at weighbridge stations by machine attendants)
- ix. Previous Weighbridge Compliance number is optional but can be captured if available (new feature).
If a valid previous Weighbridge Compliance number is captured, the system was automatically display the weighbridge where that ticket was issued
- x. Exemption Permit number if such a permit has been issued to the transport operator
- xi. Trip details indicating the origin and destination; towns should be chosen from the pre- defined list

xii. Registration numbers of the trailers must be entered. The details of the main vehicle do not need to be re-entered since these have already been captured in the vehicle identification section. However in the event that Kenya should introduce the notion of Transport Permit as in other countries whereby Transport Operators are charged for using the road for commercial purposes, then a Transport Permit number would need to be captured for the horse. Vehicle details for the trailers need to be captured.

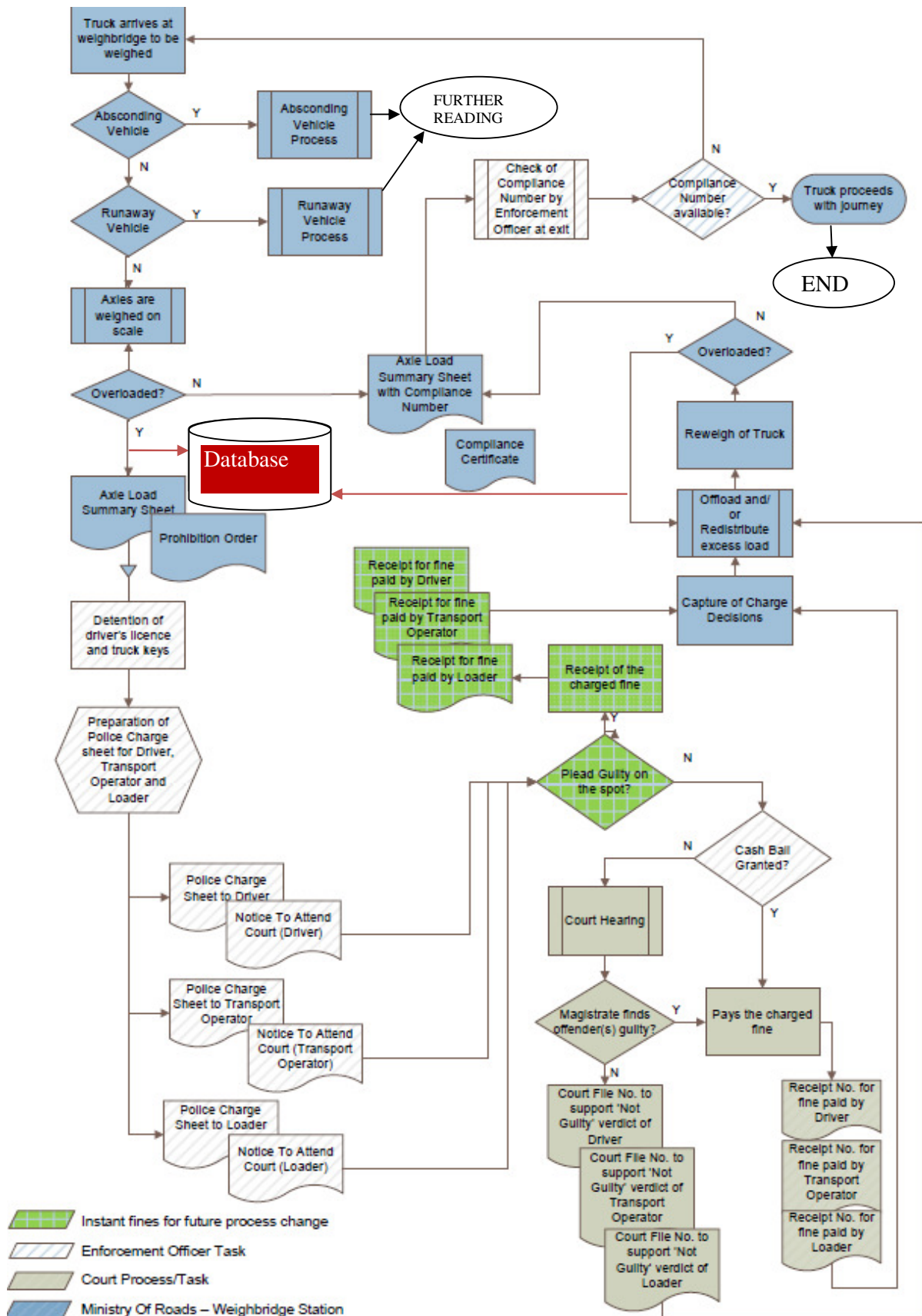
xiii. Driver's details from the Driver's license

The following checks was be performed by the system when capturing:

- a). Number of vehicles forming the vehicle combination – on the 'Vehicle Details' tab, the main vehicle registration number was be defaulted by the same number captured by the machine attendant and also, the number of expected vehicle trailer line details was also be determined by this value.
- b). Number of tyres on the vehicle – this was allow the system to verify if the axle configuration picked by the machine attendant corresponds to the number of tyres specified.
- c). Previous weighbridge compliance number – the main vehicle registration number as well as the transport operator specified by the machine attendant was be verified against the ones defined at the previous weighbridge where the compliance number was issued. If the data captured corresponds to the data of the previous compliance number, the location (From and To) of the vehicle was be defaulted by the application.
- d). Exemption permit number – the validity of the exemption permit was be verified as well as the vehicle main registration number and the trailer numbers against the information that was captured and approved for that particular exemption permit. The axle configuration of the exemption permit was also be verified against the axle configuration captured by the machine attendant.

Once all the details of the vehicle and driver have been captured, the weighing of the vehicle was be initiated. The machine attendant guides the driver to position each axle on the scale sequentially. The machine attendant needs to ensure that each axle being weighed is properly positioned on the scale. For each axle weighed, the machine attendant was have to ensure that the reading displayed on the scale indicator matches the weight picked by the WIM application before moving on to weigh the next axle.

Figure 5. Flow diagram of the weighing module



Source: Research

Once all axle readings have been captured into the system and the machine attendant saves the record, three main checks are made by the application:

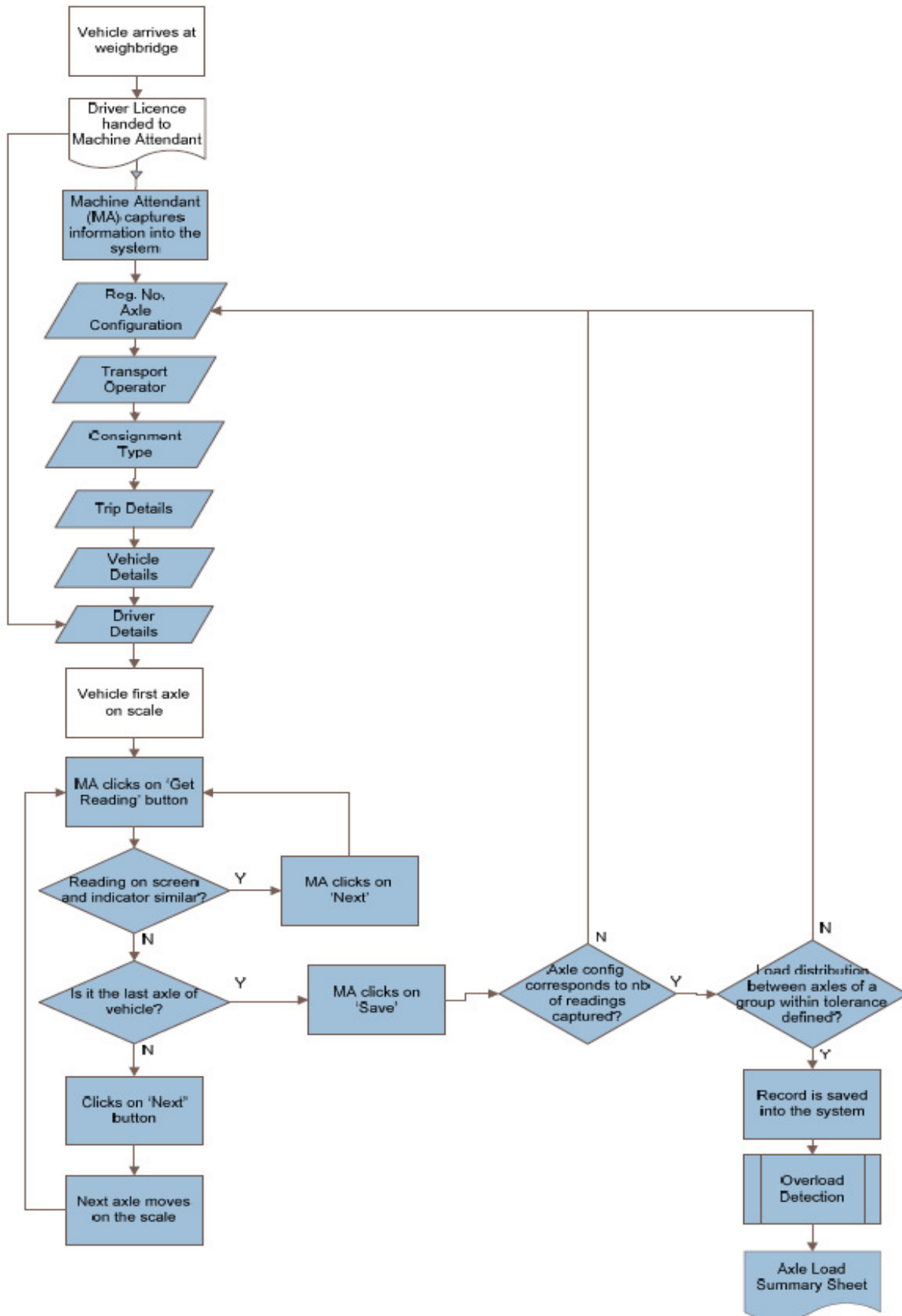
- (i) The number of axle readings must correspond to the number of axles defined for the axle configuration chosen by the machine attendant;
- (ii) The distribution of weight amongst the axles of a group are within the range that qualifies them as a group axle (refer to definition of tandem and tridem) .
- (iii) Axle groups address the problem of modification of vehicle configuration by heavy commercial vehicle owners by adding dummy axles in order to simulate axle groups. The variation in distribution depends on a percentage set in the application by the Axle Load Administrator.
- (iv) The number of axles of the vehicle combination does not exceed the maximum number of axles prescribed by the law unless there is an exemption permit that allows an axle configuration comprising more than the maximum allowed.

In case an exemption permit has been presented by the driver, the allowable GVW on the exemption permit was also be checked against the actual GVW of the vehicle after completion of the weighing of all its axles. If an excess from the allowable GVW on the exemption permit is detected on the actual GVW, the vehicle was treated as an overloaded vehicle and follow the process of overload charging (see Figure 7 - Overload Detection Process). However, load on axle or axle group was always be checked against the legal allowable limits, independent of the availability of an exemption permit or not.

If any of the above checks fail, i.e. number of axle readings, weight distribution within an axle group, number of axles of the vehicle and validity of exemption permit, the record is not be saved and the machine attendant was be requested to make the necessary correction before attempting to save the record again.

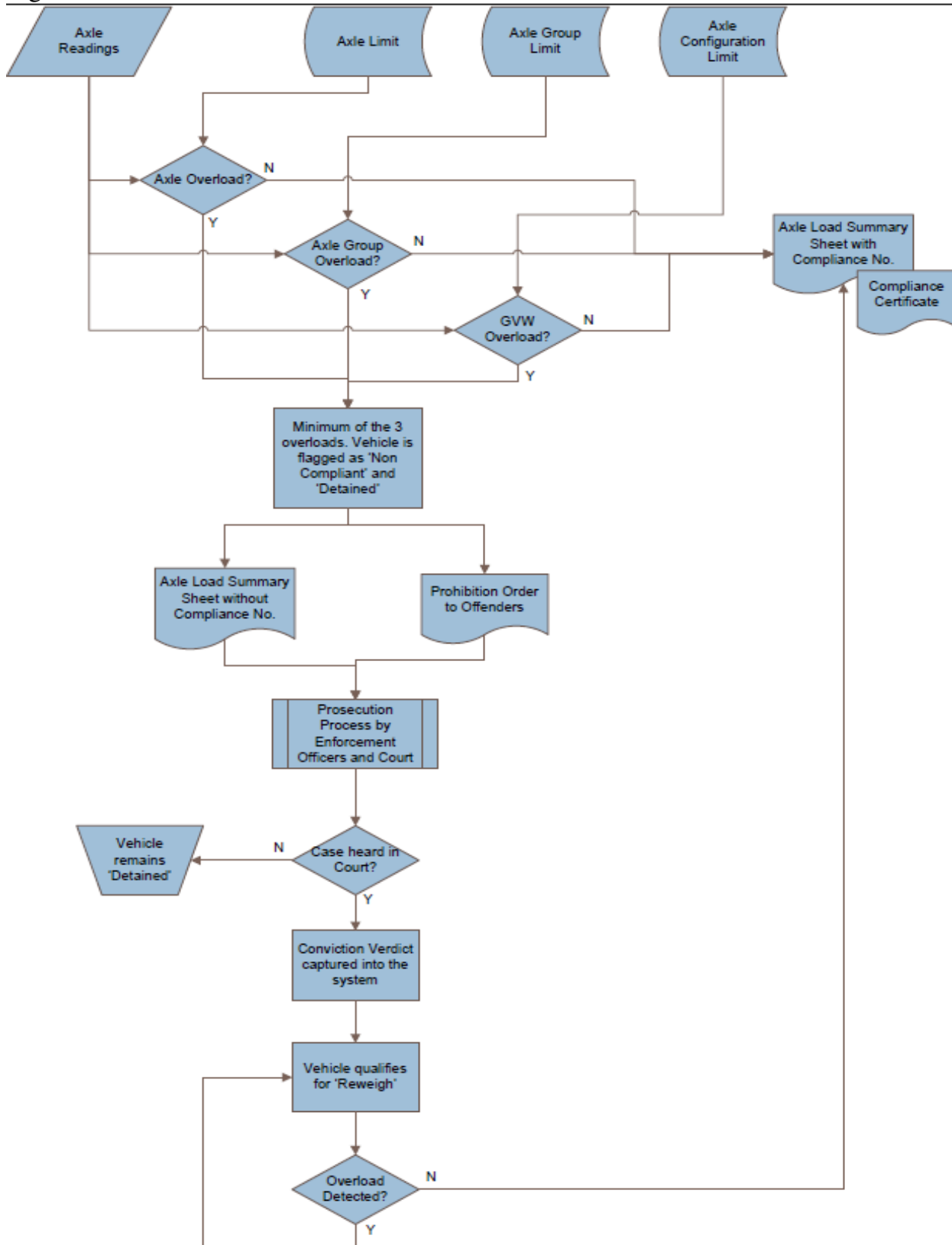
Once the record is saved successfully, the application automatically determine if there is any overload on axle, axle group and/or GVW weighed according to the limits defined in the Legal Notice No. 118 on the Traffic (Amendments) Rules, 2008 which has been set up in the system under different sections.

Figure. 6 - Axle Weighing Process



Source: Research

Figure 7. Overload Detection Process



Source: Research

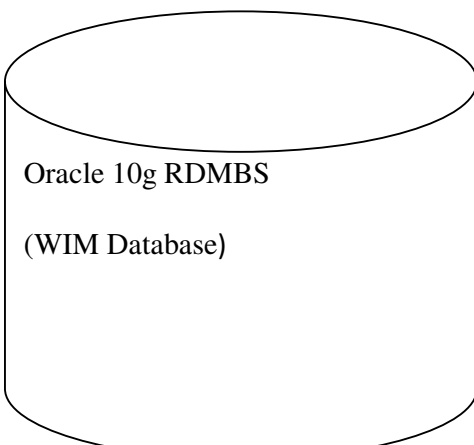
CHAPTER 4 : IMPLEMENTATION AND RESULTS

4.1 Introduction

This chapter is the outcome of the Analysis and Design phase of this study. The project mission is development and implementation of an accurate, computerized prototype, to demonstrate effectively the operations in all weighbridge stations across Kenya so that the data captured at each of the weighbridges was centrally stored and used for effective management and decision making purposes. This involves the installation of a WAN to link all weighbridge stations to the central database server with oracle relational database management system (RDBMS) running on SUSE Linux(OS), and another Oracle 10g Application Server on SUSE Linux (OS). This would be replicated in a remote location as backup.

4.2 Platform of implementation

Figure 8: below shows the Minimum Technical Specification for database and application servers at the headquarters and at the redundancy site.

Machine Name : Oracle Database Server	Machine Name: Oracle application Server			
Hardware : Dell PowerEdge R710 No. of Procs : 1 Quadcore Proc Type : Intel Xeon E5640 Processor Clock Frequency : 2.66Ghz	Hardware : Dell PowerEdge R710 No. of Procs : 1 Quadcore Proc Type : Intel Xeon E5640 Processor Clock Frequency : 2.66Ghz			
Backup Drive : 16X DVD+/-RW ROM Drive SATA	Backup Drive : 16X DVD+/-RW ROM Drive SATA			
Operating System: SUSE Linux Enterprise Server	Operating System: SUSE Linux Enterprise Server (SLES) 10 SP3			
 <p>Oracle 10g RDBMS (WIM Database)</p>	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Oracle 10g Application Server</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;"> Infrastructure (infra)Management Database HTTP Server </td> </tr> <tr> <td style="padding: 5px;"> Middle Tier Forms Services </td> </tr> <tr> <td style="padding: 5px;"> Report Services </td> </tr> </table> </div>	Infrastructure (infra)Management Database HTTP Server	Middle Tier Forms Services	Report Services
Infrastructure (infra)Management Database HTTP Server				
Middle Tier Forms Services				
Report Services				

4.3 Automatic counter

Definition: Automatic counter is a series of numbers automatically maintained by the system which is used to allocate to certain types of records, unique identifiers with a user-defined format.

Example: Scale Reading Number, Compliance number, Prohibition Order Number, Transport Operator Code

Purpose: Automatic counter is a system functionality that generates unique, serial numbers to identify different types of entities and transactions. These numbers are automatically assigned by the system whilst ensuring that no number is skipped even if there should be a network failure and also there is no duplication of use of the same number even if two users try to commit the same type of record at the same time.

Pre-requisite information/data:

The numbering generally starts with number 1 and continues to increase sequentially. The format of the counter is user-defined.

The following counters have been identified for the ALWIM application and details are given below:
 Table 6: Format of system data

Description	Start Counter	End Counter	Format	Remarks
Scale Reading Number	1	99,999,999	S99999999	With the proposed 9-digit scale reading number, this was allowed for the system to generate more than 13,000 unique numbers per day over the next 20 years.
Prohibition Order No		999,999	SYS999999	A SYS prefix can be added to identify prohibition order numbers that are generated from the ALWIM system.
Compliance Ticket Number	1	999,999		A reference number that is issued for each compliant vehicle weighed at a weighbridge.
Transport Operator	1			A unique reference number for each transport operator created in the
Code				application.
Exemption Permit Application Number	1			A unique reference number for each application of an exemption permit captured into the system.
Exemption Permit Number	1			A unique reference number for each exemption permit approved and issued to an applicant.

Source: Research

4.4 Single axles

Definition: A single axle is an axle that exists by itself. Single axles support load independently of other axles.

Example: Single Steering Axle (single tyres); Single Rear Axle (single tyres); Single Rear Axle (dual tyres)

Purpose: Single axles are defined in order to group them into different configurations of axle groups or in the axle configuration of vehicles or vehicle combinations.

4.5 Axle groups

Definition: Several axles may be grouped to form an indivisible unit that supports load as a single entity. The group may consist of two axles (known as Tandem axle group) or three axles, known as Tridem or Triple axle Group). Groups of four axles, called Quadrems, are not allowed in Kenya since December 2008. The definition of a tandem axle group and a triple axle group are: “Tandem axle group” means two axles suspended and interconnected in such a manner that any load imposed upon them was automatically be distributed to the two axles either equally or in proportions predetermined by the design of the suspension system, regardless of the road profile or road condition;

“Triple axle group” means three axles suspended and interconnected in such a manner that any load imposed upon them was automatically be distributed to the three axles either equally or in proportions predetermined by the design of the suspension system regardless of the road profiles or road condition

(Traffic Act CAP. 403, Twelfth Schedule, Section 1)

4.6 Axle configurations

Definition: The axle configuration of a vehicle combination is the set of axle(s) and/or axle group(s), the distance between them and, in the case of several vehicles, the way the individual vehicles connect to one another. The axle configuration determines the class of that vehicle combination and makes it easy to be classified through visual recognition.

Axle configurations applicable in Kenya are explicitly defined and they play a central role in vehicle or vehicle combination identification and classification and also in overload detection. Table 10 below depicts the images that was be linked to each axle configuration and used in the ALWIM application.

Table 7: The maximum allowable weight, GVW, of a heavy commercial which has been taken from the Legal Notice No. 118 on the Traffic (Amendment) Rules, 2008.

Vehicle & Axle Configuration	Maximum Gross
Vehicle with 2 axles	18,000kg
Vehicle with 3 axles	24,000kg
Vehicle and semi-trailer with total of 3 axles	28,000kg
Vehicle with 4 axles	28,000kg
Vehicle and semi-trailer with total of 4 axles	34,000kg
Vehicle and drawbar trailer with total of 4 axles	36,000kg
Vehicle and semi-trailer with total of 5 axles	42,000kg
Vehicle and drawbar trailer with total of 5 axles	42,000kg
Vehicle and semi-trailer with total of 6 axles	48,000kg
Vehicle and drawbar trailer with total of 6 axles	48,000kg

Source: Legal Notice No. 118 on the Traffic (Amendment) Rules, 2008.

4.7 Scale types

Definition:

A Weighbridge scale type is the make and model of the indicator used to display the weight of one or more vehicle axle(s) at a particular weighbridge. These are the common types available found in Kenyan weighbridges;

Avery Berkel 1310

Salter WI 125

Cas RW-2601P

Haenni EC100

Table 8: The information collected during site visits regarding which scales are available at which weighbridge stations as well as the status of each scale indicator

Scale Make and Model	Indicator	Type of scale	No. of Scales	Weighbridge Station	Status
Avery Berkel 1310		Static	1	Mariakani	Used and Working
			1	Gilgil	Back up and working
Salter WI 125 (interface inside the box)		Static	1	Mariakani	Used and Working
			1	Isebania	Used and working
XF-3190-A9		Static	1	Athi River	Used and working

Source: Research

4.8 Weighing Module

The weighing module is to verify compliance of axle weight of commercial vehicles carrying consignment on roads of Kenya. Information captured by machine attendants at each weighbridge scale is used for overload detection and results in the issue of the Axle Load Summary sheet which details the weight reading of each axle and axle group of the vehicle. In case of overload, the application determines the excess load to be charged according to the Traffic Act and the information provided on the Axle Load Summary Sheet is used by enforcement officers in the prosecution of offenders.

Pre-requisite information/data:

1. Three sets of records need to have been defined in the Automatic Counter screen
 - a). Scale Reading Number – previously known as Weighbridge Ticket number
 - b). Compliance Number – previously known as Compliance Ticket Number
 - c). Prohibition Order Number
2. Transport Operators data must have been captured into the system. The list must be as exhaustive as possible.
3. Axle configurations must have been defined in the system. The list must be as exhaustive as possible.
4. Consignment types must have been defined in the system. A maximum of around 20 consignment types to be created for it to be meaningful at all.
5. Locations of the significant towns must have been captured in the system. In case a specific town is not in the system, the user uses the nearest town available in the system.
6. There are up to four main authorities involved in the charging process of an overloaded heavy commercial vehicle: a). the weighbridge station, which is under Ministry of Roads. b) the enforcement officers, who are from the Kenya Police; c) the customs officers who are under the Kenya Revenue Authority; and d) the Court who is under the aegis of the Judiciary.

4.9 Weighing results – no overload detected

If no overload is detected, the application generates the Axle Load Summary sheet, giving the details of each axle weight, axle group weight as well as the actual GVW. Legal limits is NOT displayed. Currently, a weighbridge ticket is filled in manually by the machine attendant on serialized weighbridge tickets

4.10 Weighing results – overload detected

In case overload is detected (axle, axle group and/or GVW), the same information as for Axle Load Summary sheet with ‘No Overload Detected’ printed, except for the Compliance Number which is substituted by ‘NOT COMPLIANT’ on the Axle Load Summary sheet, and the following additional information is printed:

- i. Overload on axle (if any)
- ii. Overload on axle group (if any)
- iii. Overload on GVW (if any)
- iv. Chargeable overload on axle (if any), axle group (if any) and GVW (if any) as well as the chargeable weight (in kg)

4.11 Runaway vehicles

If a vehicle is found to be overloaded but somehow manages to leave the weighbridge station before any legal action has been taken against him and/or fails to come to the scale for a reweigh (i.e. the vehicle leaves the weighbridge station before the system has issued a compliance number for it), that vehicle is considered as a ‘runaway’ vehicle in the system. In such scenarios if the vehicle reports to another weighbridge station and when the machine attendant there captures the main vehicle number, the system informs the attendant that the vehicle has run away from a previous weighbridge. At this point the machine attendant should inform the enforcement officer who was then detain the driver and the vehicle. The offender is prosecuted at the Court near the weighbridge station from which it ran away.

4.12 Management of information and Reporting Module

- a) Operational Reports (Axle load summary sheet, certificate of compliance, Previous convictions, Overloaded vehicle by weighbridge station)
- b) Management Reports (Monthly reports, court fines, daily operational reports etc)
- c) Analytical Reports (Yearly reports, Consignment types, Top 10 overloaded transport operator etc)

4.13 Prototype of ALWIM application

This section provides details of the screen layouts of the ALWIM application is setup to satisfy all the requirements.

Figure 9: ALWIM prototype I

The screenshot shows a software window titled 'WINDOW1' with a date '28-JUN-2012' in the top right corner. The main area contains a form with the following fields:

- Main Vehicle Reg No
- Country Of Reg
- No Of Vehicles
- No Of Axes
- No Of Tyres
- Vehicle Class Code
- Postal Address
- Transport Operator
- Consignment

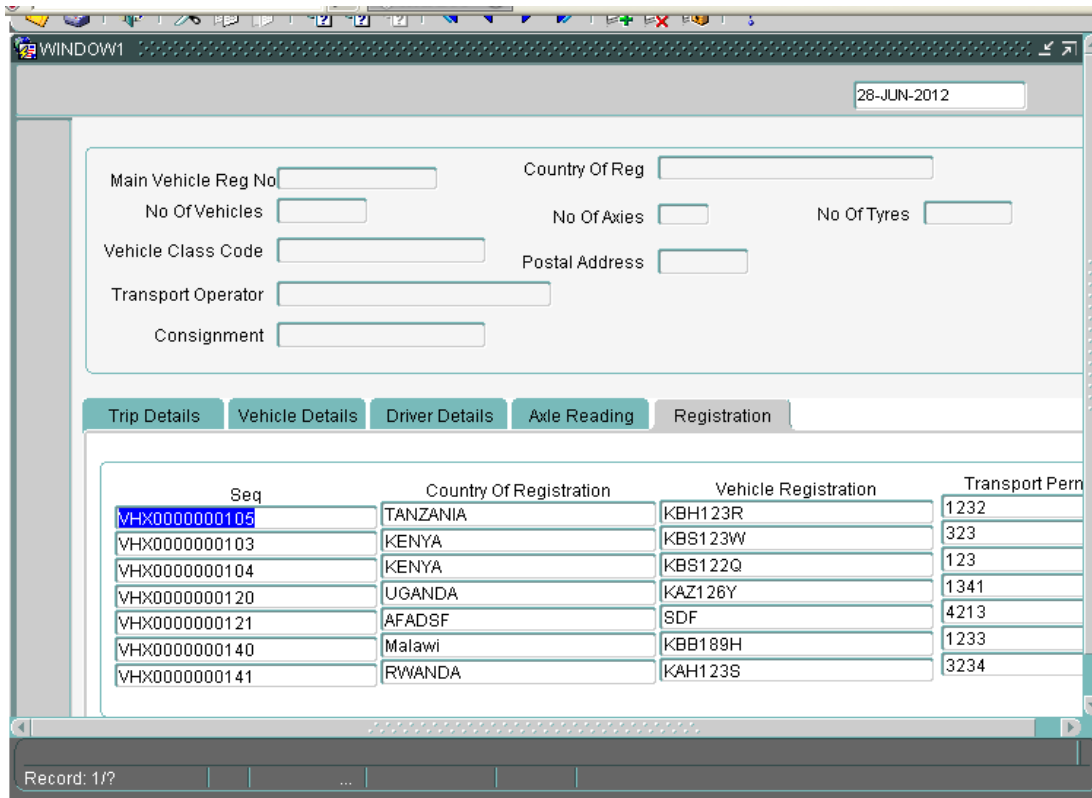
Below the form is a tabbed interface with five tabs: 'Trip Details', 'Vehicle Details', 'Driver Details', 'Axle Reading', and 'Registration'. The 'Trip Details' tab is active and contains a table with two columns: 'Origin' and 'Destination'.

Origin	Destination
MOMBASA	NAIROBI
MOMBASA	UGANDA
RWANDA	NAIROBI

To the right of the table is a vertical stack of three buttons: 'New', 'Save', and 'Query'.

Source: Research sample reports

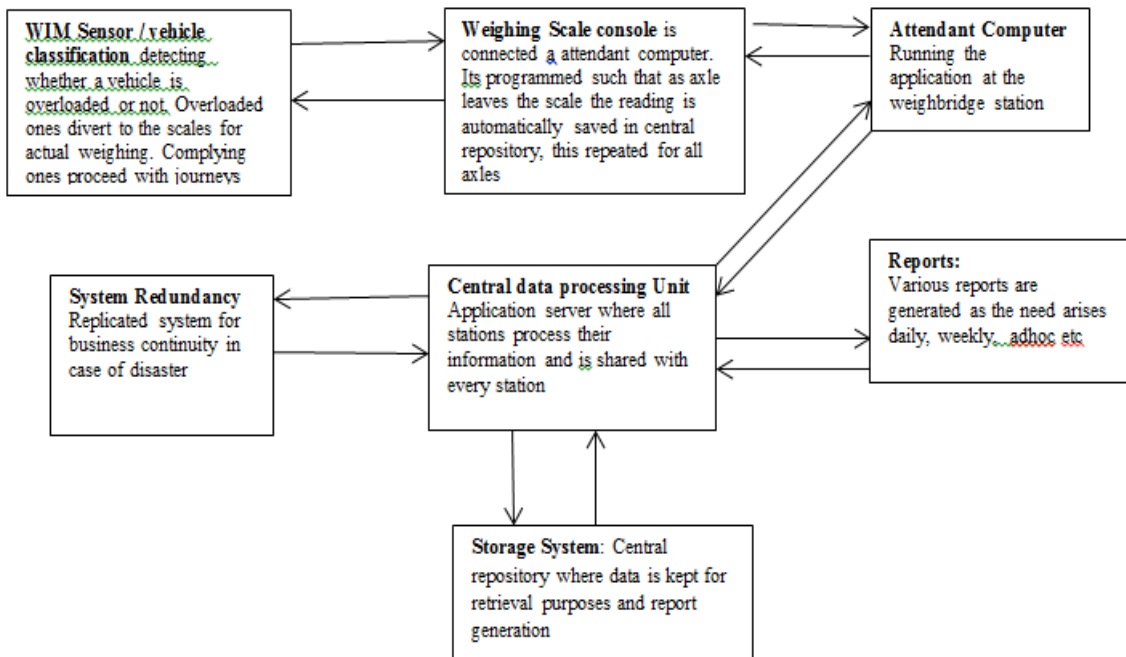
Figure 10: ALWIM prototype II



Source: Research sample reports

FINAL SYSTEM FRAMEWORK

All the components of the conceptual framework were relevant in the final system
Figure 11



CHAPTER 5 – DISCUSSIONS, CONCLUSION AND RECOMMENDATIONS

5.1 Results Analysis

This section outlines how the discusses how the objectives and research questions have been met; How the framework and prototype has contributed to improve the working of people involved, and also limitations and constraints experienced during the research, recommendations for further work is also included here.

5.2 Discussion

The main objectives during the study were;

a) **To design a framework for computer based axle load control system;**

During research a framework was developed (Fig. 1 on page 17) that would connect all the weigh bridges to a centralised application. One of the main controls lies in a centralised application and data storage. This fastens report generation data accuracy, prosecution and eliminates data manipulation.

A number of systems (from other countries) discussed in chapter 2 were found to suite the needs from those countries, but ALWIMS is unique to solving axle overload menace in Kenyan where transporters are very innovative to ensure that they overload.

b) **To create a repository of past offenders to assist in legal enforcement of the axle load;**

From the framework it was possible to create a repository for data storage and retrieval this is especially vital force law enforcement since the prosecution needs a reference like table I on page 19 to make a judgement. The repository is replicated for business continuity and availability as has been illustrated by Fig.3 and 4 on pages 27 and 28 respectively. The repository is not only for prosecution but also a provision of reporting and a source of any form information that may be needed from time to time.

c) **To design a prototype based on framework for axle load control at weighbridges.**

The third objective was met to show what the a complete system would look like when fully developed and implemented. Fig.9 and 10 on pages 42 and 43 respectively shows different fields that are populated during data capture and later used for reporting purposes.

The system framework was developed on oracle application 10g and database Server of oracle 10g RDBMS. Both application and Database servers are housed in a remote location accessible from weighbridge through the browser. All weighbridges simultaneously access the information from the servers which are also replicated for emergency reasons.

5.3 Benefits to be derived from the framework for axle load Management Information System for Kenya – researcher contribution.

- i) The authorities have easy access to records of road users and their detailed information for decision making and planning.
- ii) Time spent by transporters to reach destinations is reduced compared to the current system which is very slow. With long queues currently experienced especially in Mariakani Weighbridge.
- iii) Efficiency would be achieved as records are automatically picked by computer which is faster and accurate eliminating human mistakes and wrong data entries.
- iv) Prosecution process is fast and effective as the required reports (prohibition and Police charge sheets) are quickly generated by the system and not subject to alteration leaving no room for amendments. This ensures compliance by transporters.
- v) Transporters would have no alternative but to comply by having the right axle load since there is no room for records manipulation which was being shown in all weighbridges simultaneously plus the heavy fine involved. As a result lesser money would be required to maintain the roads which would last longer.

5.3 Limitations and Constraints

The entire framework and prototype is huge and a lot of time is needed to fully understand all its working processes.

More resources therefore are required to have an exhaustive framework i.e. the wide area network is quite wide touching distant places of the country Isebania, Webuye, Busia, Malaba, Eldoret Mombasa etc. to network all these places with different communication technologies is expensive let alone sustenance and maintenance.

The technical knowhow and appreciation of the system is lacking among the operators and the transporters as well. There is frustration of lack of support at some point even from very highly placed citizens, when reality to curb overloading occurs to them hence a tendency to fight back to beat the system.

5.4 Conclusion

The main objective of the system is to curb overloading which spoils the road leading to expensive repairs, loss in business and creation of unfavorable environment for business.

ALWIMS not only creates effective check in axle load but also eases the work for all stake holders in the axle weighing and recording. A centralized database repository is useful to police for prosecution purposes, valuable resource for transport sector for planning purposes, useful to road sector for generation of various reports. KRA would use the same for audit purposes to know if the transporters are paying the correct revenue for the kind of cargo they are carrying. The security department

5.3 Recommendations for further work

- (i) More work is required to fully integrate other modules like Oversized/ overload exemption permit, application for exemption permits. Other areas of study are unclassified axle configuration – when a foreign vehicle with usual axle configuration appears at the weighbridge.
- (ii) Undefined Transport operator; If a transport operator's details are not in the system when a vehicle arrives at the weighbridge, the machine attendant may have to improvise ways of how to register these operators.
- (iii) Vehicles that change axle configuration; Some transporters improvise dummy axles to give an impression that the vehicle can handle so much load capacity while in real sense it cannot because of fake – added axles hence overloading.
- (iv) Unavailable System; At times the system may not be available on the network perhaps due to hardware failure, power outage, network failure, failure between the indicator and the scale etc. There should be a precise way to deal with these occurrences.
- (i) Absconding vehicles; some vehicles avoid weighbridges all together. There should be a way to handle these unique cases.
- (ii) Runaway vehicles; Overloaded vehicles at times manages to leave the station before any legal action is taken against them or fails to reweigh there should be a way to contain them.

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USER MANUAL

i) **Setting up the database Server;**

Databases 10g or 11g can be used for this Research .The database installation is a straight forward wizard driven installation depending on the environment for installation i.e. windows, Linux, Novell, Sun systems etc. Oracle Corporation avails all types of CDs for any environment.

ii) **Setting up application server ;** With an existing Server Operating system (e.g. any flavour of linux)

Install forms then reports and weblogic. After weblogic installation is followed with jrocket then oracle portal CD for integration.

iii) **Linking the application and the Database Servers;**

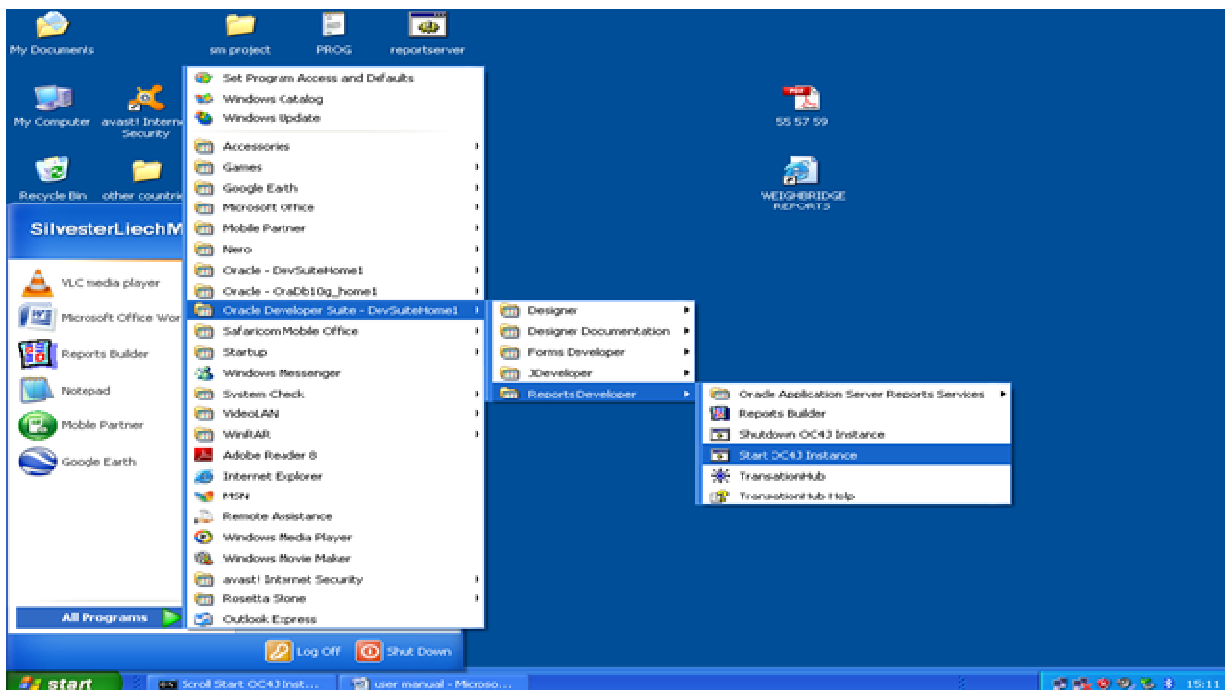
From the database server go to Net manager and set an IP address e.g. to 192.168.1.21(server IP) In the application Server – go to Net manager set the same IP address 192.168.1.21 as that of the database sever so that the application Server can “talk’ with database server. All these can be view from the “team viewer”.

Set the browser to the public IP e.g. 192.168.1.25 so that one would be able to assess the servers any where on the web.

iv) All workstations are installed with Oracle weblogic to access application and database servers for daily operations. This set up constitutes part of the platform found on page 31 of this booklet.

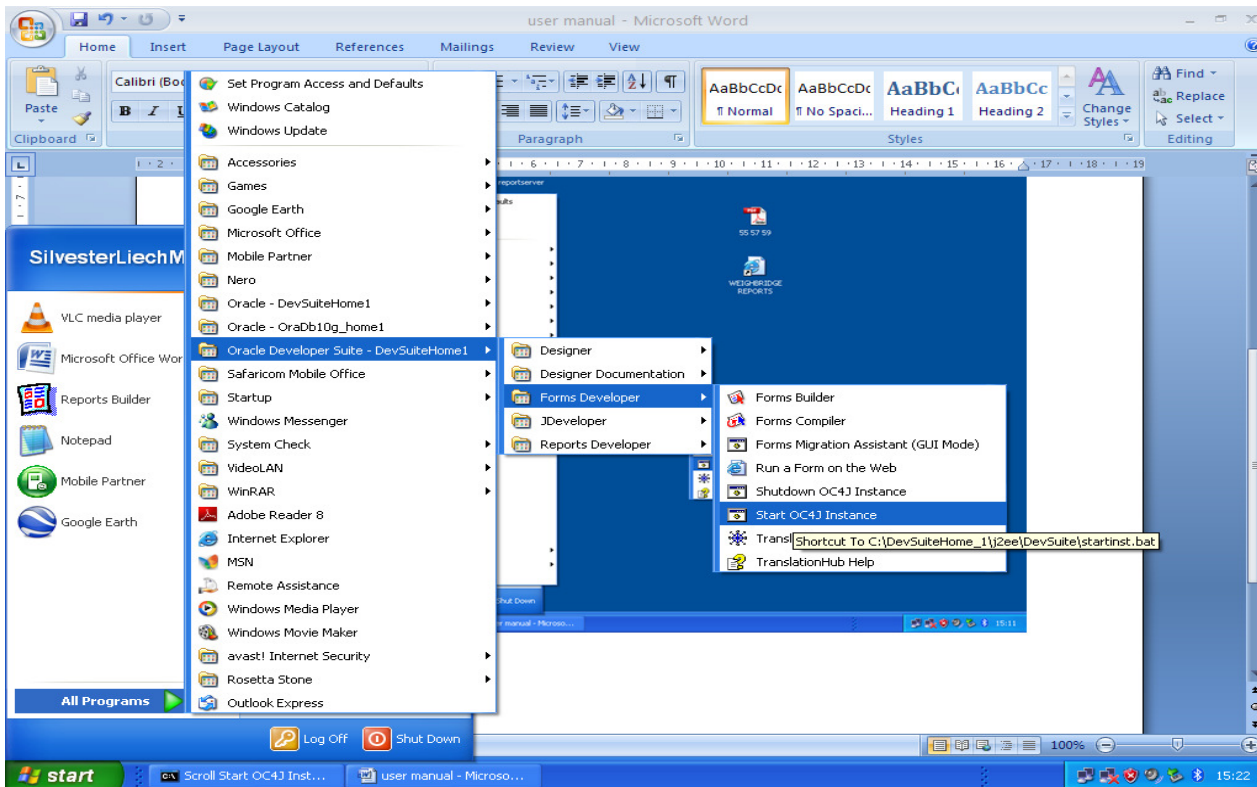
v) **Running the Application and Database**

The Oracle Servers are started by first starting the instance and the Listeners as follows; from the start button follow the path *Start/Oracle developer suite/Report developer/start OC4J instance* ←

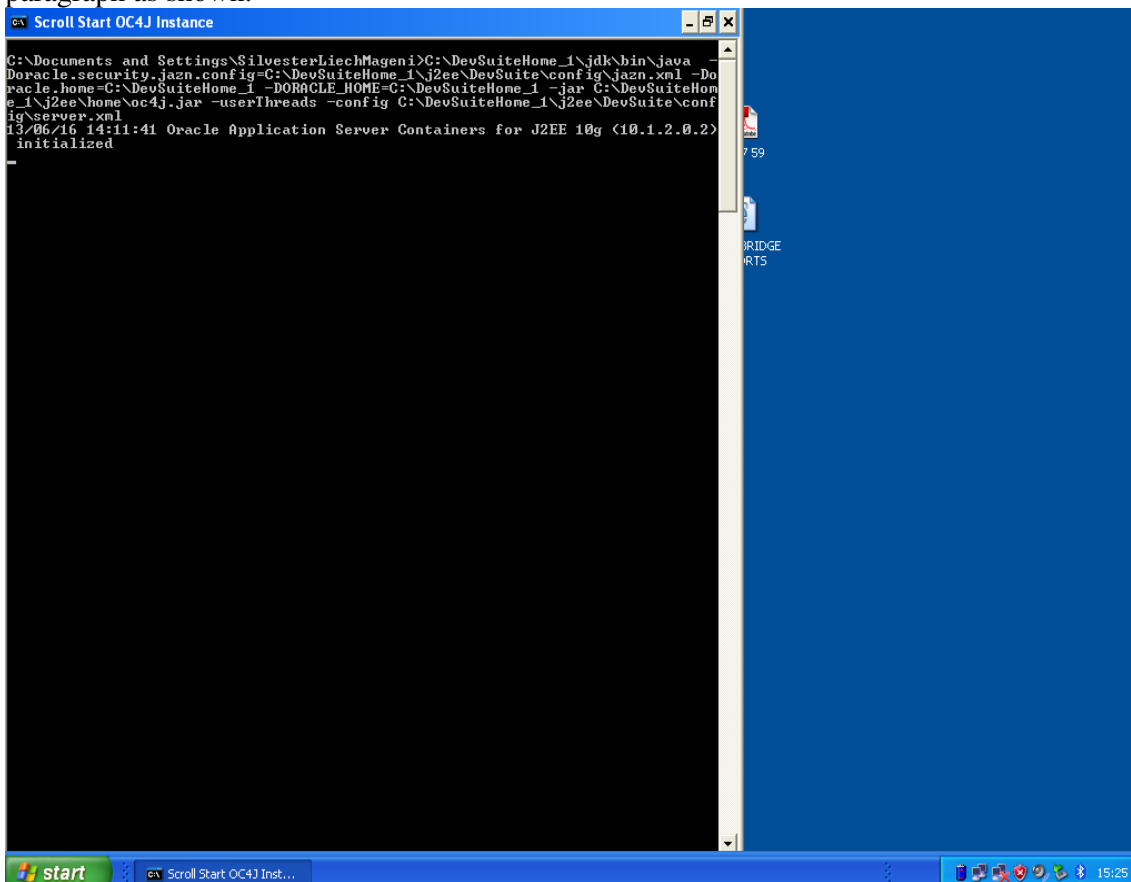


Alternatively the following path also initiates the instance;

Start/Oracle developer suite/Form builder/start OCJ4 instance ←



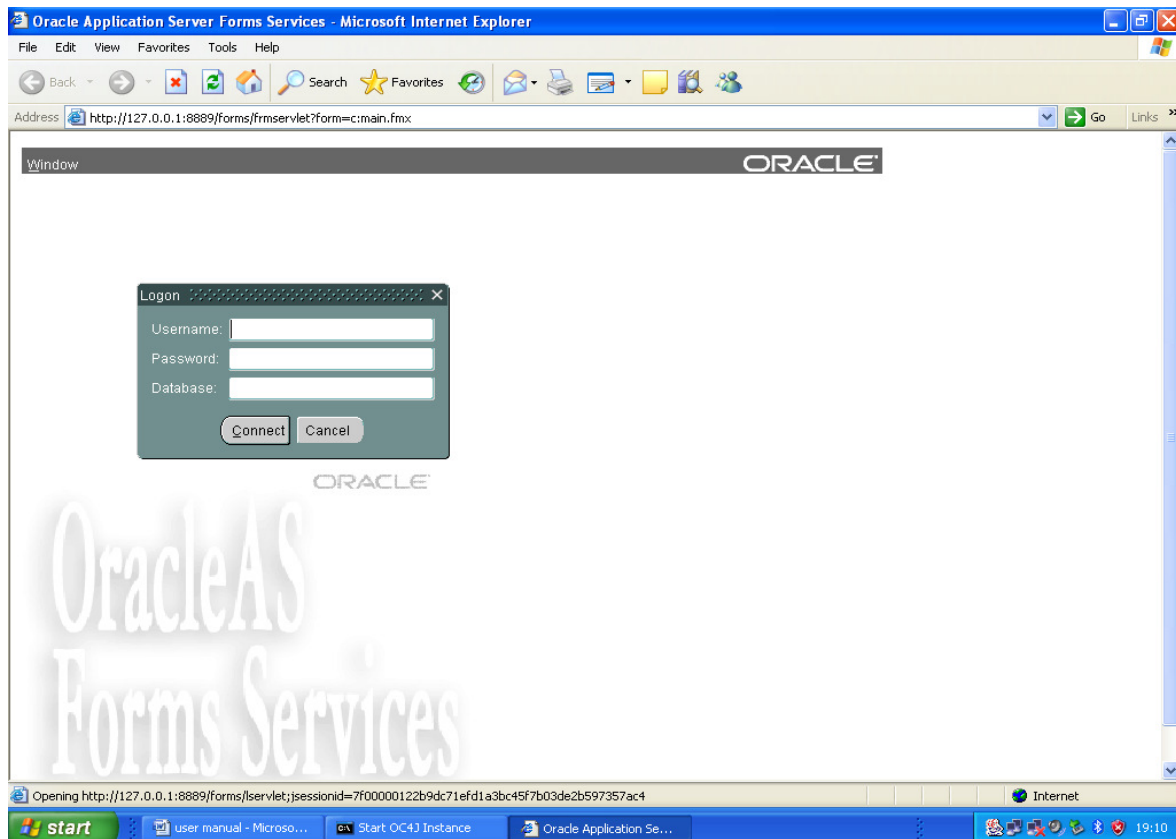
When the instance is up and running a black screen appears with word 'initialized' and the end of path paragraph as shown.



This is the path of an instance used in this study is shown below as it appears from the black screen above.

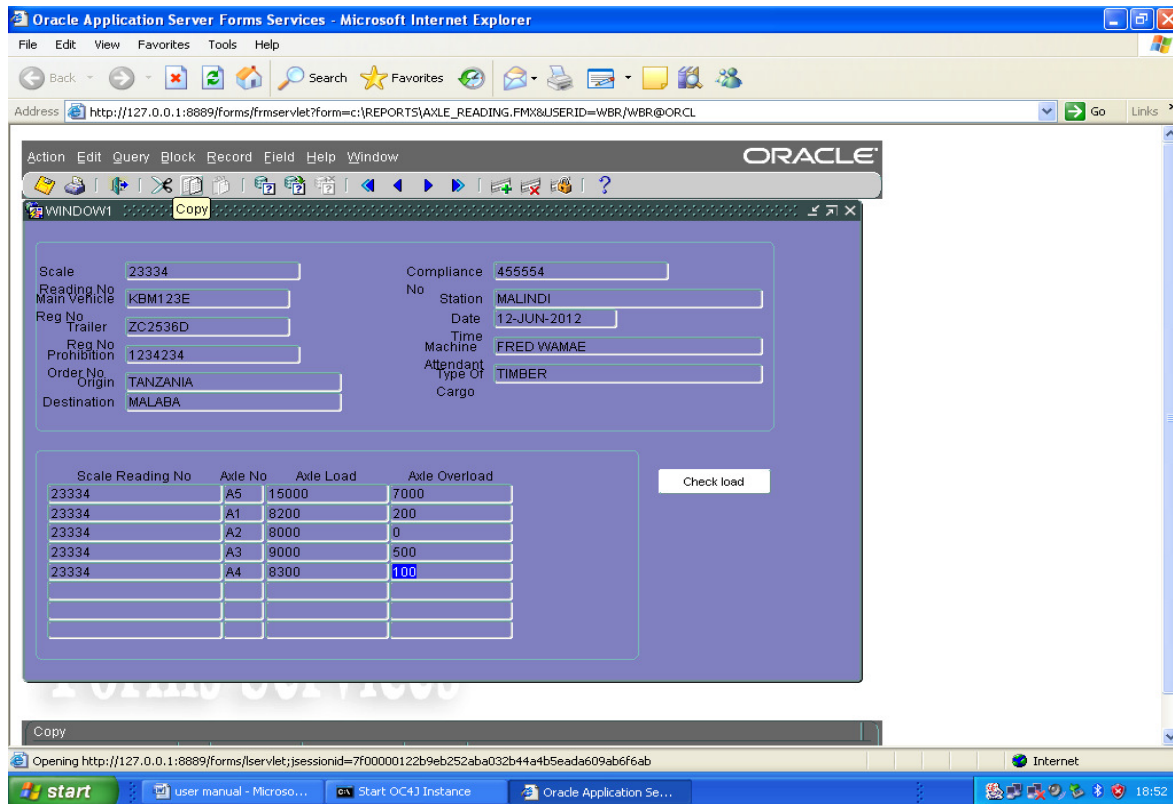
```
C:\Documents and Settings\SilvesterLiechMageni>C:\DevSuiteHome_1\jdk\bin\java -
Doracle.security.jazn.config=C:\DevSuiteHome_1\j2ee\DevSuite\config\jazn.xml -Do
racle.home=C:\DevSuiteHome_1 -DORACLE_HOME=C:\DevSuiteHome_1 -jar C:\DevSuiteHom
e_1\j2ee\home\oc4j.jar -userThreads -config C:\DevSuiteHome_1\j2ee\DevSuite\conf
ig\server.xml13/06/16 14:11:41 Oracle Application Server Containers for J2EE 0g (10.1.2.0.2)
initialized.
```

With servers running, only authenticated users are given access through a web enabled browser to the server from their workstations by providing **username** and **password**. The authentication is by a screen as one shown below;

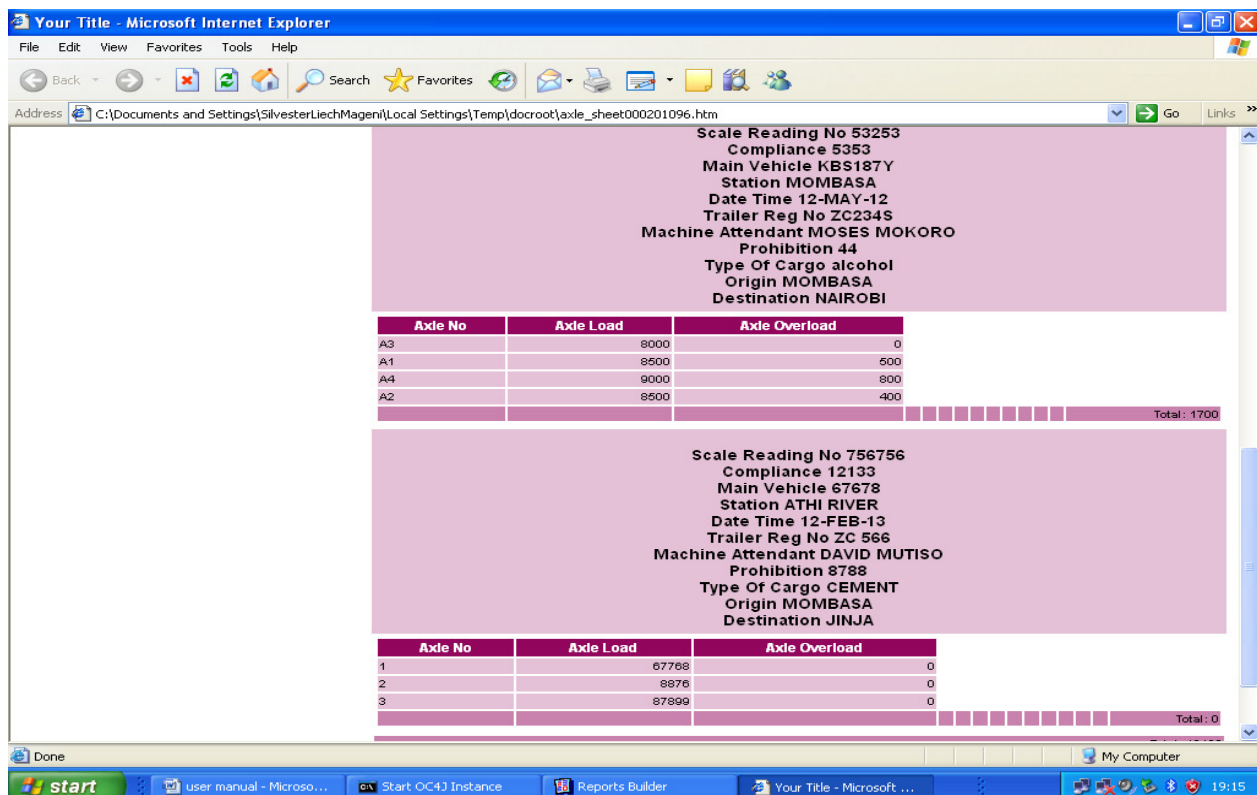


Once a user is in the system axle weighing continues and capturing continues from the weighing scale connected to the attendant computer. The weighing interface is programmed such that as the axle vehicle Wheels (axle) passes over the scale, reading are automatically reflected on the attendant computer as he captures them by clicking return key or the mouse button. These readings are automatically saved to the server (wherever it is located) and the attendant cannot change them.

A Sample of a capture screen is shown below.



The information captured is used to produce various reports and documents which is used at different Stages of the entire process in a weighbridge. Sample of report is shown here below;



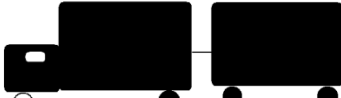




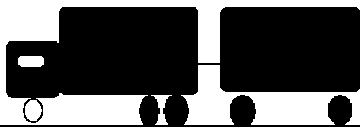


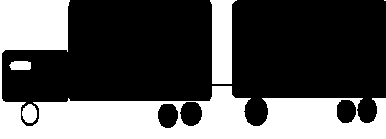
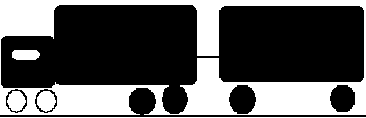

Appendix I I

KEY:-

- Single Tyre
- Double Tyre

Table 9 - Axle Configuration Pictures

Axle Configuration	No. of Axles	Picture
2A	2	
3A	3	
4A	4	
4B	4	
4C	4	
4D	4	
5A	5	

5B	5	
5C	5	
5D	5	
6A	6	
6B	6	
6C	6	

Source: Research

Table 10 APPENDIX III Sample of data captured in the field

Reg. No.	Transporter	Origin	Destination	Axle	Date In	Time In	Date Out	Time Out	Cargo	Status	GVW Overload	Axle Overload
KAZ580M	PANAL	MOMBASA	SUDAN	6C	09-May-2012	0:27	09-May-2012	0:27	CONT	Vehicle Over The Legal Weight Limit	460	2580
KBM155V	AGILITY	MOMBASA	NAIROBI	6C	09-May-2012	0:29	09-May-2012	0:29	CONT	Vehicle Under The Legal Weight Limit	0	0
KBQ348Y	PANAL	MOMBASA	NRB	6C	09-May-2012	0:30	09-May-2012	0:31	CONT	Vehicle Over The Legal Weight Limit	0	3480
KBR257R	VOLCAN	MOMBASA	NAIROBI	6C	09-May-2012	0:34			CONTAINER	Void	0	0
KBR257R	VOLCAN	MOMBASA	NAIROBI	6C	09-May-2012	0:40	09-May-2012	0:41	CONTAINER	Vehicle Under The Legal Weight Limit	0	0
KBP543A	dhl excel supply chain k ltd	MOMBASA	NRB	6G	09-May-2012	0:42	09-May-2012	0:42	EMPTY CRATES	Vehicle Under The Legal Weight Limit	0	0
KBJ316T	SWIFTROYAL	MOMBASA	NAIROBI	6G	09-May-2012	0:43	09-May-2012	0:44	CONTAINER	Cautioned	0	0
KAU316N	SWIFT ROYAL CONVEYORS	MOMBASA	NAIROBI	6G	09-May-2012	0:45	09-May-2012	0:45	CONTAINER	Vehicle Over The Legal Weight Limit	0	1280
KBA165C	RENAISSANCE	MOMBASA	THIKA	6G	09-May-2012	0:48	09-May-2012	0:49	CONT	Cautioned	0	0
KBF358A	RENAISSANCE	MOMBASA	NAIROBI	6G	09-May-2012	0:50	09-May-2012	0:50	CONTAINER	Cautioned	0	0
KBP732Z	Anthony	MOMBASA	UGANDA	6G	09-May-2012	0:51	09-May-2012	0:52	SALT	Vehicle Over The Legal Weight Limit	0	3560
KAN961E	T.H	MOMBASA	UGANDA	5D	09-May-2012	0:54	09-May-2012	0:54	SALT	Vehicle Over The Legal Weight Limit	0	2840
KBJ894B	CKLN LTD	MOMBASA	BUSIA	5D	09-May-2012	0:55	09-May-2012	0:56	CALCIUM	Cautioned	0	0

Source: KeNHA

KBJ135C	SIGINON	MOMBASA	NAIROBI	6G	09-May-2012	0:57	09-May-2012	0:57	CONT	Vehicle Under The Legal Weight Limit	0	0
KAW814L	SIGNON	MOMBASA	NAIROBI	6G	09-May-2012	0:58	09-May-2012	0:59	CONT	Vehicle Under The Legal Weight Limit	0	0
KAN666W	BAJABAR	MOMBASA	NAIROBI	6C	09-May-2012	1:00	09-May-2012	1:00	WHEAT	Vehicle Over The Legal Weight Limit	0	2020
KBQ894M	horizon cargo	MOMBASA	NAIROBI	6G	09-May-2012	1:01	09-May-2012	1:02	CONTAINER	Vehicle Under The Legal Weight Limit	0	0
KAW665E	TRANSNICK	MOMBASA	ATHI RIVER	6C	09-May-2012	1:04	09-May-2012	1:04	CLINKER	Vehicle Over The Legal Weight Limit	0	5900
KBQ273U	JAMES	MOMBASA	NRB	6C	09-May-2012	1:05	09-May-2012	1:06	CONT	Vehicle Under The Legal Weight Limit	0	0
KBB365T	M C M LTD	MOMBASA	Uganda	6C	09-May-2012	1:12	09-May-2012	1:13	CONT6C	Vehicle Under The Legal Weight Limit	0	0
KBN269B	MAXPOWER	MOMBASA	KSM	6C	09-May-2012	1:20	09-May-2012	1:21	CONT	Vehicle Under The Legal Weight Limit	0	0
KBH648L	A K N	MOMBASA	NAIROBI	6G	09-May-2012	1:44	09-May-2012	1:44	CONT	Vehicle Over The Legal Weight Limit	0	920
UAN947A	TRANSTRAC	MOMBASA	UGANDA	6C	09-May-2012	3:00	09-May-2012	3:00	CONT	Vehicle Under The Legal Weight Limit	0	0
KBK956B	mwanzo mpya	MOMBASA	BUSIA	6G	09-May-2012	3:13	09-May-2012	3:14	EMPTY	Vehicle Over The Legal Weight Limit	1400	2940

Source: KeNHA

UAN553F	HILABO	MOMBASA	UGABA	5D	09-May-2012	4:06	09-May-2012	4:06	CNT	Vehicle Under The Legal Weight Limit	0	0
KAE285G	D.F.MWAURA	NAIROBI	MOMBASA	0.125	09-May-2012	4:52	09-May-2012	4:52	STEEL	Cautioned	0	0
KBN123A	ANDY FORWARDES SERVICES LTD	MOMBASA	NAIROBI	6C	09-May-2012	4:58	09-May-2012	4:58	CONTAINER	Cautioned	0	0
KBJ106C	Kenuga enterprises	MOMBASA	TANZANIA	6C	09-May-2012	5:09	09-May-2012	5:11	CONT	Vehicle Over The Legal Weight Limit	0	6360
KAS061A	YALFA CARGO	MOMBASA	UGANDA	6C	09-May-2012	5:21	09-May-2012	5:21	CONTAINER	Vehicle Under The Legal Weight Limit	0	0
KBJ792M	BASH HAULIERS	MOMBASA	NAIROBI	6C	09-May-2012	5:32	09-May-2012	5:33	CONTAINER	Vehicle Over The Legal Weight Limit	0	1560
KAZ552X	BASH	MOMBASA	NBI	6C	09-May-2012	5:34	09-May-2012	5:34	CNT	Cautioned	0	0
KBM960J	SHREEJI	MOMBASA	ATHI RIVER	6G	09-May-2012	5:36	09-May-2012	5:36	CLINKER	Vehicle Over The Legal Weight Limit	0	6120
KBM540K	SHREEJI	MOMBASA	ATHIR	6G	09-May-2012	5:37	09-May-2012	5:38	CLINCKER	Vehicle Over The Legal Weight Limit	0	7560
KBR234K	MODERN COAST B C LTD	MOMBASA	LODWAR	6C	09-May-2012	5:38	09-May-2012	5:39	WFP	Vehicle Over The Legal Weight Limit	0	1520
KBR403V	TAITA ESTATE	VOI	MOMBASA	6G	09-May-2012	5:40	09-May-2012	5:40	SISAL	Vehicle Over The Legal Weight Limit	0	1680
KAW386Q	TSS	MOMBASA	NAIROBI	6C	09-May-2012	5:45	09-May-2012	5:45	FERTILIZER	Cautioned	0	0

Source: KeNHA

KBP685F	INTEX	MOMBASA	NRB	6G	09-May-2012	6:23	09-May-2012	6:24	CONT	Vehicle Under The Legal Weight Limit	0	0
KAY930H	BACCHU GROCERS LTD	MOMBASA	NAIROBI	6G	09-May-2012	6:25	09-May-2012	6:25	CONT	Vehicle Under The Legal Weight Limit	0	0
KAT133B	MULTIPLE HAULIERS	MOMBASA	ISIOLO	6C	09-May-2012	6:27	09-May-2012	6:27	CEMENT	Vehicle Over The Legal Weight Limit	0	2060
KBL119F	PASTA	MOMBASA	UGANDA	6C	09-May-2012	6:28	09-May-2012	6:29	DIESEL	Vehicle Over The Legal Weight Limit	0	2260
KAS393W	SANGHANI	MOMBASA	NRBI	6G	09-May-2012	6:45	09-May-2012	6:45	CLINCKER	Vehicle Over The Legal Weight Limit	0	3980
KBJ750N	PELICAN HAULAGE	MOMBASA	NRB	6G	09-May-2012	6:47			FERT	Void	0	0
KBJ750N	PELICAN HAULAGE	MOMBASA	NRB	6G	09-May-2012	6:48			FERT	Void	0	0
KBJ750N	PELICAN HAULAGE	MOMBASA	NRB	6G	09-May-2012	6:50			FERT	Void	0	0
KBJ750N	PELICAN HAULAGE	MOMBASA	NRB	6G	09-May-2012	6:54	09-May-2012	6:54	FERT	Vehicle Under The Legal Weight Limit	0	0
KBK108J	SWAN	MOMBASA	UGANDA	6C	09-May-2012	6:55	09-May-2012	6:56	CLINKER	Vehicle Over The Legal Weight Limit	0	6580
KAX124K	AO BAYUSUF	MOMBASA	NAIROBI	6G	09-May-2012	7:00	09-May-2012	7:01	OIL	Vehicle Under The Legal Weight Limit	0	0

Source: KeNHA

KBM590H	MULTIPLE HAULIERS LTD	MOMBASA	ATHI RIVER	6C	09-May-2012	7:02	09-May-2012	7:04	CLINKER	Vehicle Over The Legal Weight Limit	340	16320
KBQ274R	TRAILINK	MOMBASA	NAIROBI	6G	09-May-2012	7:17	09-May-2012	7:21	CEMENT	Vehicle Over The Legal Weight Limit	0	2220
KBN940A	SHREEJI	MOMBASA	NAIROBI	6G	09-May-2012	7:22	09-May-2012	7:22	STEEL	Vehicle Over The Legal Weight Limit	0	3080
KAS408W	RAPID KATE	MOMBASA	NRB	6C	09-May-2012	7:23	09-May-2012	7:23	CONTAINER	Cautioned	0	0
KAX603C	SANGHANI	MOMBASA	ATHIRIVER	6C	09-May-2012	7:25	09-May-2012	7:25	CLK	Vehicle Over The Legal Weight Limit	20	4060
KBL730N	GENERAL CARGO	NRB	MSA	6C	09-May-2012	7:26	09-May-2012	7:26	CONTAINER	Cautioned	0	0
KAW495G	NANAK TRUCKING	MOMBASA	NBI	6G	09-May-2012	7:39	09-May-2012	7:40	CONT	Cautioned	0	0
KBA196F	RELIABLE FEIGHT LTD	MOMBASA	UGANDA	6C	09-May-2012	7:42	09-May-2012	7:42	CONT	Vehicle Over The Legal Weight Limit	0	3120
KBE569U	MOTRE X	MOMBASA	ATHI RIVER	6C	09-May-2012	7:44	09-May-2012	7:44	CLINKER	Vehicle Over The Legal Weight Limit	540	8260
KBP430M	MOTREX	MOMBASA	ATHI RIVER	6C	09-May-2012	7:45	09-May-2012	7:45	CLINCKER	Vehicle Over The Legal Weight Limit	0	8640
KBR950Q	MOTREX	MOMBASA	NRB	5D	09-May-2012	7:46	09-May-2012	7:47	CLINCER	Vehicle Over The Legal Weight Limit	940	16460
KBQ665P	KB SANGHANI	MOMBASA	NRBN	6C	09-May-2012	7:49	09-May-2012	7:49	CLNCR	Vehicle Over The Legal Weight Limit	0	9120

Source: KeNHA

KBG073L	saris agencies	MOMBASA	NAIROBI	6G	09-May-2012	7:50	09-May-2012	7:50	IRON SHEETS	Vehicle Over The Legal Weight Limit	420	5480
KBJ173B	Damco logistics	MOMBASA	UGANDA	6G	09-May-2012	7:54	09-May-2012	7:54	CONT	Cautioned	0	0
KAP617K	WHITESKY	MOMBASA	ELDORET	6C	09-May-2012	7:55	09-May-2012	7:55	RICE	Cautioned	0	0
KBR591H	AINI SHAMZI	MOMBASA	NRB	6G	09-May-2012	7:56	09-May-2012	7:57	CLINKER	Vehicle Over The Legal Weight Limit	0	8660
KBK975F	R K SANGAHANI	MOMBASA	ATHI RIVER	6C	09-May-2012	7:58	09-May-2012	7:58	CLINKER	Vehicle Over The Legal Weight Limit	0	5500
KBK577R	MURABI	MOMBASA	RWANDA	6G	09-May-2012	8:00	09-May-2012	8:01	CONT	Vehicle Over The Legal Weight Limit	20	3240
KBP435M	MOTREX	MOMBASA	A RIVER	6C	09-May-2012	8:01	09-May-2012	8:02	CLINKER	Vehicle Over The Legal Weight Limit	160	9020
KAQ382K	MOTREX	MOMBASA	UGANDA	6C	09-May-2012	8:14	09-May-2012	8:15	WHEAT	Vehicle Over The Legal Weight Limit	120	2560
KBB761P	DAKAWOU TRANSPORT	MOMBASA	NRB	5D	09-May-2012	8:29	09-May-2012	8:29	GAS	Vehicle Over The Legal Weight Limit	0	900
KBM387P	JANES TRANSPORTERS	MSA	Uganda	6G	09-May-2012	8:32	09-May-2012	8:32	SALT	Vehicle Under The Legal Weight Limit	0	0
KAW770J	RELIABLE	MOMBASA	Uganda	6C	09-May-2012	8:46	09-May-2012	8:46	CONT	Vehicle Under The Legal Weight Limit	0	0
KBP507B	JANES TRANSPORTERS	MOMBASA	NAIROBI	6F	09-May-2012	8:52			SALT	Void	0	0

Source: KenHA

KBP507	JANES TRANSPORTERS	MOMBASA	NAIROBI	6F	09-May-2012	8:53			SALT	Void	0	0		
B														
KBP507B	JANES TRANSPORTERS	MOMBASA	NAIROBI	6F	09-May-2012	8:57	09-May-2012	8:57	BOXES	Vehicle Over The Legal Weight Limit	20000	11180		
KBQ369C	GLOBAL	MOMBASA	UGANDA	6G	09-May-2012	9:23	09-May-2012	9:23	CONT	Vehicle Over The Legal Weight Limit	0	1520		
KBK632X	ISAWAKA	MOMBASA	THIKA	6C	09-May-2012	9:28	09-May-2012	9:29	CONT	Vehicle Under The Legal Weight Limit	0	0		
KBR471M	NORTHWEST	MOMBASA	NAIROBI	6G	09-May-2012	9:30	09-May-2012	9:31	CONTAINER	Vehicle Under The Legal Weight Limit	0	0		
KBR219L	SWA CARRIERS	NRB	MOMBASA	6C	09-May-2012	9:47	09-May-2012	9:48	LOOSE CARCO	Vehicle Over The Legal Weight Limit	40	2260		
KBQ340H	DAKAWAOU	MOMBASA	NBI	6C	09-May-2012	10:05	09-May-2012	10:05	DIESEL	Cautioned	0	0		
KBQ124G	MANCO	MOMBASA	KAMPALA	5D	09-May-2012	10:06	09-May-2012	10:06	RICE	Vehicle Under The Legal Weight Limit	0	0		
KBQ850G	P N MASHRU	MOMBASA	NRB	6G	09-May-2012	10:09			CLINKER	Void	0	0		
KBQ850G	P N MASHRU	MOMBASA	NRB	6C	09-May-2012	10:10	09-May-2012	10:10	CLINKER	Vehicle Over The Legal Weight Limit	0	1220		
KBN124Q	P N MANSHRU	MOMBASA	ATHI R	6G	09-May-2012	10:16	09-May-2012	10:17	SUPER	Vehicle Under The Legal Weight Limit	0	0		
KAV204T	ANWAR ALI BROTHERS	MOMBASA	UGANDA	6C	09-May-2012	10:27	09-May-2012	10:28	CLINKER	Vehicle Over The Legal Weight Limit	500	8260		

Source: KeNHA

Table 11
Frequency Table

		Transporter			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		68	3.9	3.9	3.9
	dhl exel supply chain ltd	3	.2	.2	4.0
	FREIGHT world logistics	6	.3	.3	4.4
	k m barre	1	.1	.1	4.4
	ME LTD	1	.1	.1	4.5
	w f logisit	1	.1	.1	4.5
	O.A.C	1	.1	.1	4.6
	1	1	.1	.1	4.6
	122	2	.1	.1	4.8
	A O BASID	1	.1	.1	4.8
	a &a hauliers	2	.1	.1	4.9
	a l kenya ltd	1	.1	.1	5.0
	A A A	1	.1	.1	5.0
	A ALI	1	.1	.1	5.1
	A B ABDILE	5	.3	.3	5.4
	A D WACHE	2	.1	.1	5.5
	A ENTERPRISES	1	.1	.1	5.6
	A K ABDULGHANI	1	.1	.1	5.6
	A K N	1	.1	.1	5.7
	a m z bajaber	1	.1	.1	5.7
	a o bayusuf	1	.1	.1	5.8
	A TO Z	8	.5	.5	6.2
	a to z transporters	1	.1	.1	6.3
	A W MUGO	1	.1	.1	6.3
	A.A HASHI	1	.1	.1	6.4
	A.A SALAD	1	.1	.1	6.5
	A.B.ABDILE	1	.1	.1	6.5
	A.M.ENT	1	.1	.1	6.6
	A.O BAYUSUF	1	.1	.1	6.6
	A.O. BAYUSUF	1	.1	.1	6.7
	A.S ALI	3	.2	.2	6.9
	AA	1	.1	.1	6.9
	AA TRANSPORTERRS	1	.1	.1	7.0
	aaa	1	.1	.1	7.0
	AB A ABDILE	1	.1	.1	7.1
	ab washe	1	.1	.1	7.1
	abdulsalam	1	.1	.1	7.2
	ABI ALMI TRANSPORTERS	1	.1	.1	7.3
	ABL	14	.8	.8	8.0
	abosi transporters	1	.1	.1	8.1
	ABUSAL	1	.1	.1	8.2
	aden	1	.1	.1	8.2
	AFRICAN LINE	2	.1	.1	8.3

	AGILITY LOG LTD	16	.9	.9	9.2
	agrovalue	1	.1	.1	9.3
	AHAMED	1	.1	.1	9.3
	AINI SHAMZI	2	.1	.1	9.5
	AINU SHAMSHI	2	.1	.1	9.6
	AINU SHAMSI	1	.1	.1	9.6
	AINUSHAMSI	1	.1	.1	9.7
	AK ABDUL GANI	2	.1	.1	9.8
	AL AMIN	3	.2	.2	10.0
	al kamaar ltd	1	.1	.1	10.0
	AL KAMAR	1	.1	.1	10.1
	AL KAMAR TRADING CO	1	.1	.1	10.1
	ALCASON	1	.1	.1	10.2
	ALFALAH WHOLESELLERS	9	.5	.5	10.7
	ALI AMIN	2	.1	.1	10.8
	ali elmi	1	.1	.1	10.9

Source: Research

Above displays the names of transport companies involved in cargo transportation

Origin

Table 12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MOMBASA	1694	96.0	98.3	98.3
	NAIROBI	11	.6	.6	99.0
	OTHERS	18	1.0	1.0	100.0
	Total	1723	97.6	100.0	
Missing	System	42	2.4		
Total		1765	100.0		

Source: Research

It is illustrated that 98% of the cargo originates from Mombasa with remaining 2% of cargo originating from Nairobi and other places. The table also gives an illustration that the origin of 42 vehicles were not entered.

Destination

Table 13

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NAIROBI	763	43.2	45.0	45.0
	UGANDA	395	22.4	23.3	68.3
	ATHI RIVER	252	14.3	14.9	83.1
	OTHERS	286	16.2	16.9	100.0
	Total	1696	96.1	100.0	
Missing	System	69	3.9		
Total		1765	100.0		

Source: Research

Most of the vehicles at 45% were destined for Nairobi and 23.35 were headed for Uganda. 14.9% of the vehicles were headed for Athi-river with the remaining 16.9% going to other destinations within Kenya and outside Kenya.

Axle

Table 14

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0.0833333	2	.1	.1	.1
	0.125	84	4.8	4.8	4.9
	0.208333	8	.5	.5	5.3
	0.25	8	.5	.5	5.8
	3B	1	.1	.1	5.8
	4C	1	.1	.1	5.9
	4D	6	.3	.3	6.2
	5C	4	.2	.2	6.5
	5D	78	4.4	4.4	10.9
	6C	1033	58.5	58.5	69.4
	6F	43	2.4	2.4	71.8
	6G	493	27.9	27.9	99.8
	6I	4	.2	.2	100.0
Total	1765	100.0	100.0		

Source: Research

The leading axel type used by most vehicles was 6C at 58.5% followed by 6G at 27.9%.

Table 15 Date In

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	09-MAY-2012	1765	100.0	100.0	100.0

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	09-MAY-2012	1641	93.0	97.0	97.0
	10-MAY-2012	50	2.8	3.0	100.0
	Total	1691	95.8	100.0	
Missing	System	74	4.2		
Total		1765	100.0		

Source: Research

All the vehicles sampled in this study came in on the same date of 09 May 2012. Most Vehicles were cleared on the same day at 97% with only 3% being cleared the next day.

Table 16 Cargo The cargo transported was mostly containers at 43.7% followed by Clinker 20%. 73 vehicles never indicated the cargo they were carried

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CLINKER	339	19.2	20.0	20.0
	CONTAINER	740	41.9	43.7	63.8
	WHEAT FLOUR	72	4.1	4.3	68.0
	FERTILIZER	56	3.2	3.3	71.3
	CEMENT	36	2.0	2.1	73.5
	C OIL	39	2.2	2.3	75.8
	CPO	50	2.8	3.0	78.7
	DIESEL	38	2.2	2.2	81.0
	FUEL OIL	41	2.3	2.4	83.4
	RICE	18	1.0	1.1	84.5
	SALT	22	1.2	1.3	85.8
	OTHER CARGO	241	13.7	14.2	100.0
Total	1692	95.9	100.0		
Missing	System	73	4.1		
Total		1765	100.0		

Source: Research

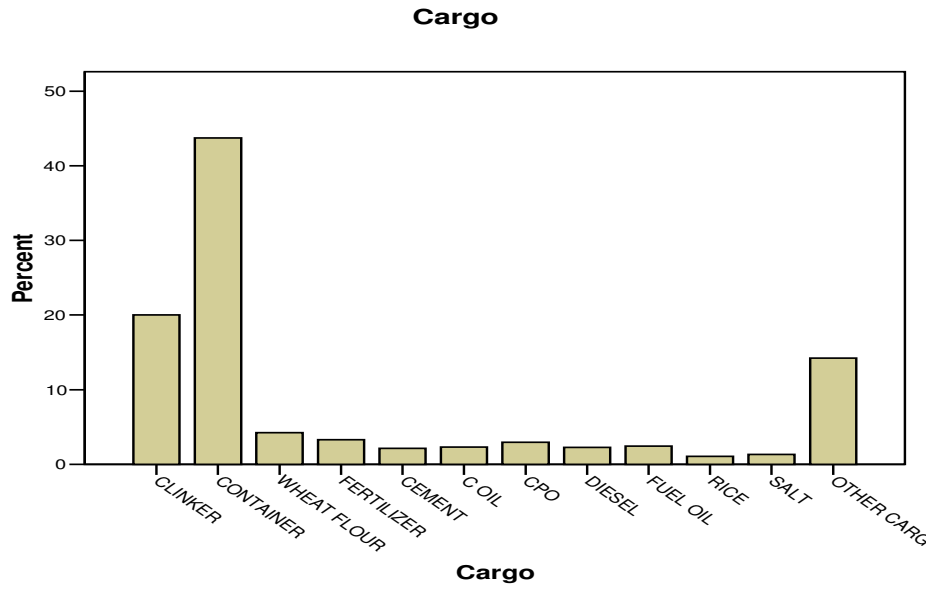
Table 17 Statistics

		Cargo	Status	Destinatio n	Origin
N	Valid	1692	1765	1696	1723
	Missing	73	0	69	42
Mean		4.14	3.08	2.04	1.03
Median		2.00	3.00	2.00	1.00
Mode		2	3	1	1
Std. Deviation		3.881	.980	1.128	.218
Variance		15.064	.960	1.272	.047
Range		11	4	3	2
Minimum		1	1	1	1
Maximum		12	5	4	3

Source: Research

Figure 12

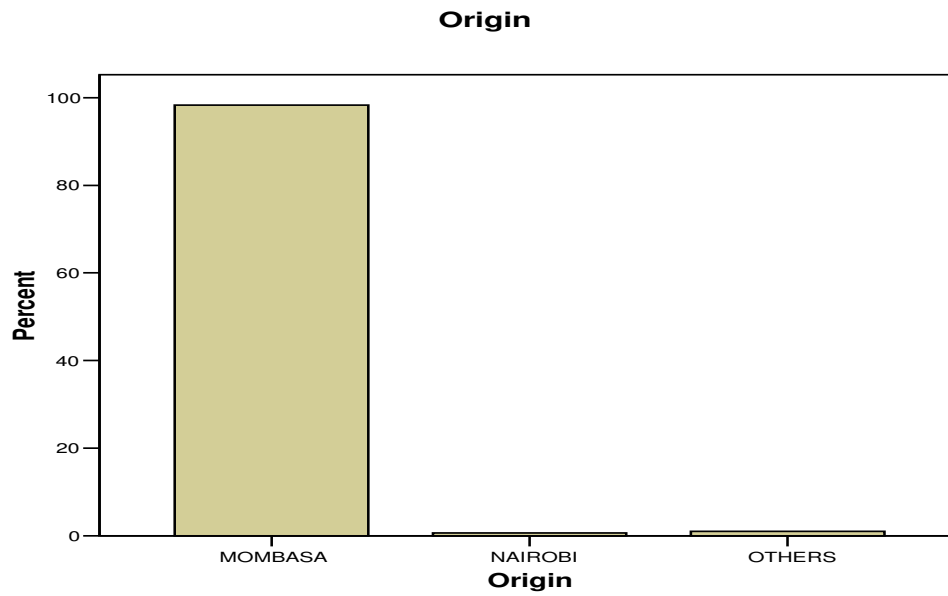
Bar Charts



Source: Research

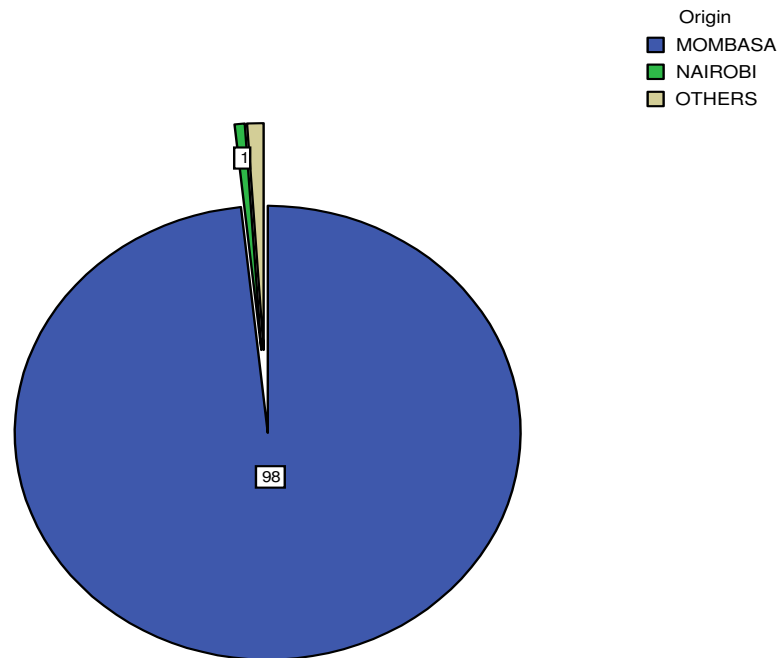
Figure. 13

Bar Charts



Source: Research

PIE CHAT ON ORIGIN



Source: Research

Table 18 Status

	Valid	1765
	Missing	0
Mean		3.09
Median		3.00
Mode		3
Std. Deviation		.971
Variance		.942
Skewness		-.755
Std. Error of Skewness		.058
Kurtosis		.627
Std. Error of Kurtosis		.116
Minimum		1
Maximum		5

Source: Research

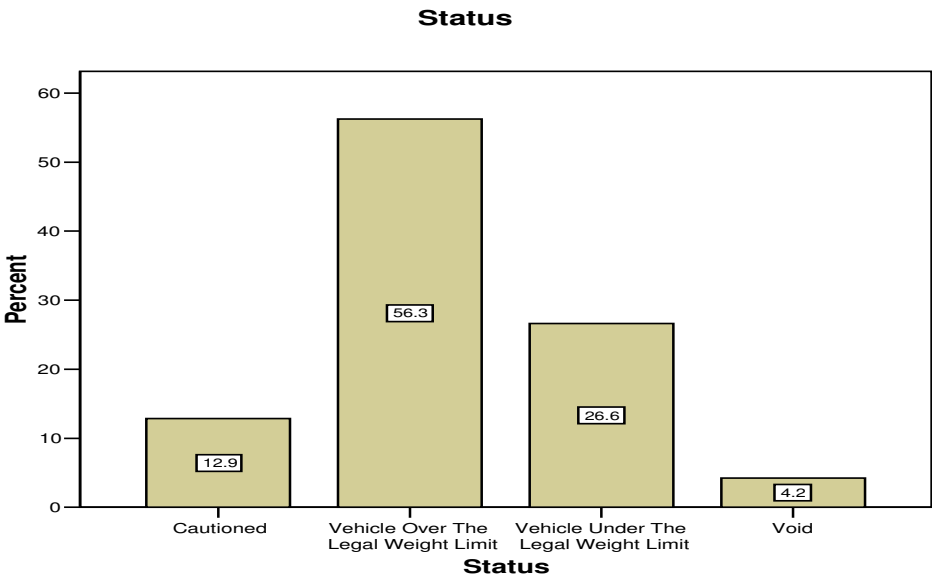
Table 19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cautioned	227	12.9	12.9	12.9
	Vehicle Over The Legal Weight Limit	993	56.3	56.3	69.1
	Vehicle Under The Legal Weight Limit	470	26.6	26.6	95.8
	Void	75	4.2	4.2	100.0
	Total	1765	100.0	100.0	

Source: Research

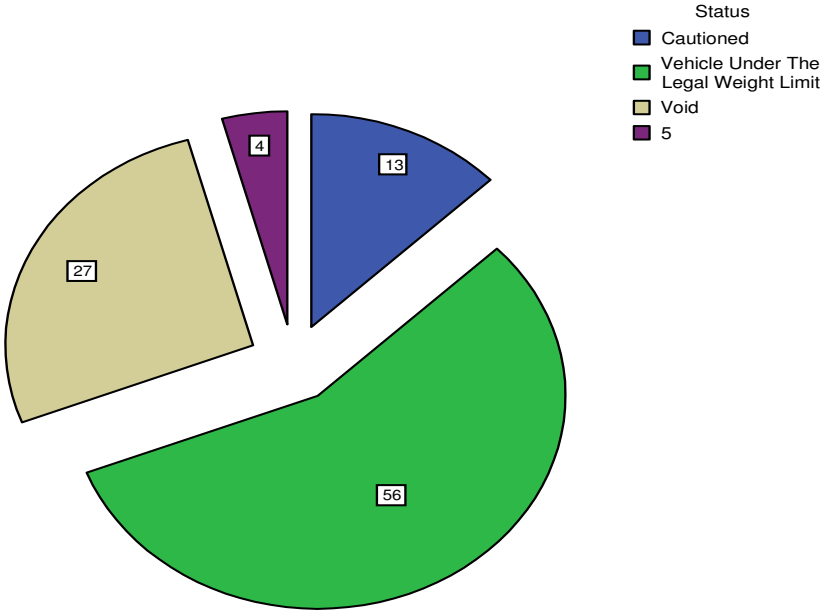
Majority of the vehicles sampled for the study were over the legal weight limit at 56.3% while only 26.6% were under the legal weight limit. 12% of these vehicles had been cautioned and 4.2% were void

Figure14 Bar Graph



Source: Research

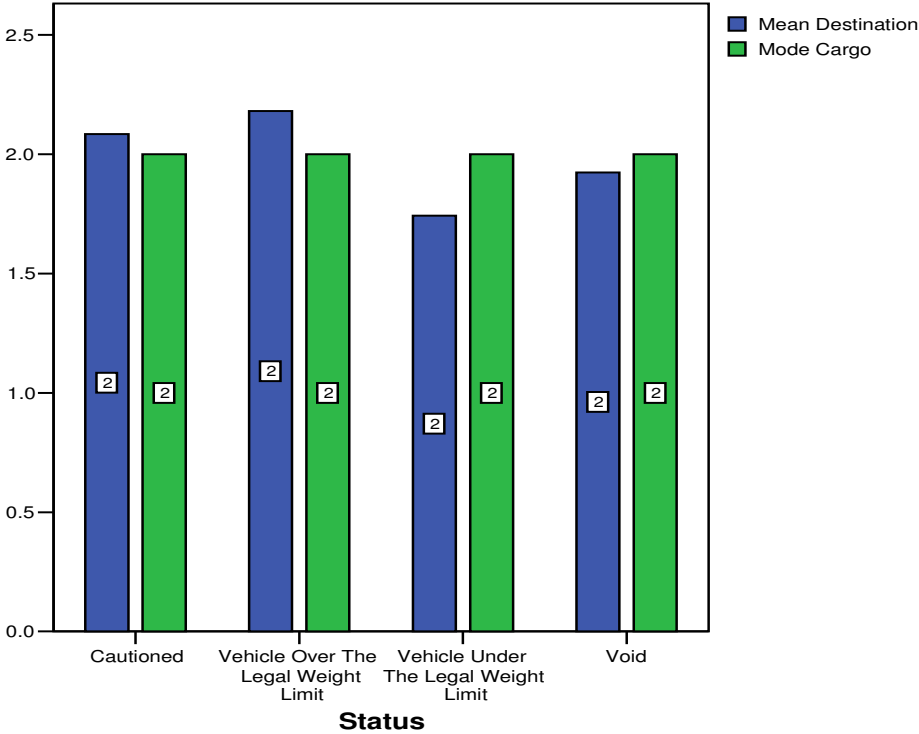
PIE CHARTS ON STATUS



Source: Research

Figure 15

Bar Charts on Status

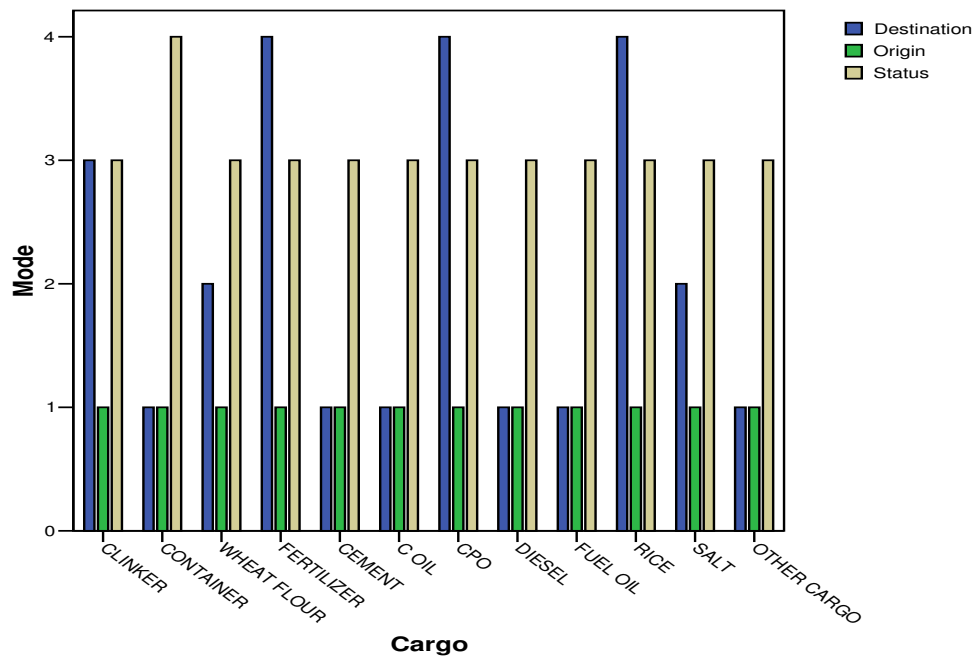


Source: Research

This bar graph compares the status of the vehicles against the mean destination and mode cargo transported. The overloaded vehicles were mostly containers and were destined for Uganda. Vehicles carrying Containers seemed to dominate all the categories of the status.

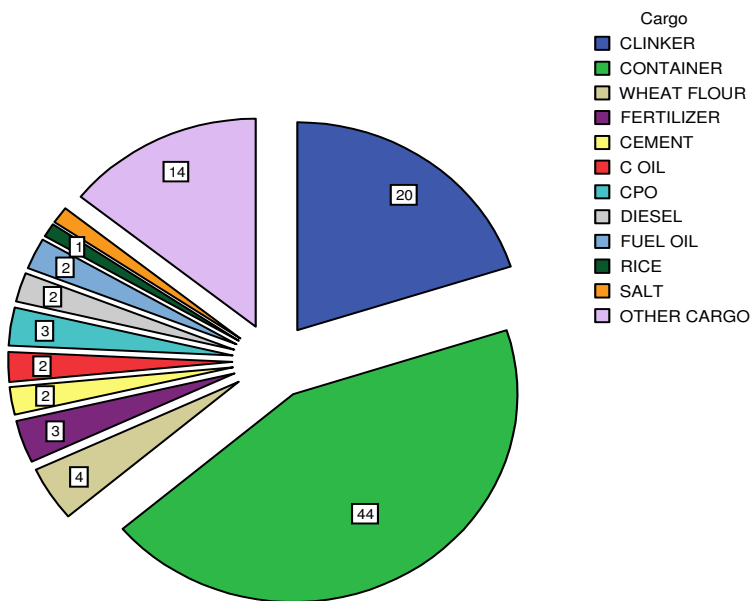
Figure 16

Bar Charts



Source: Research

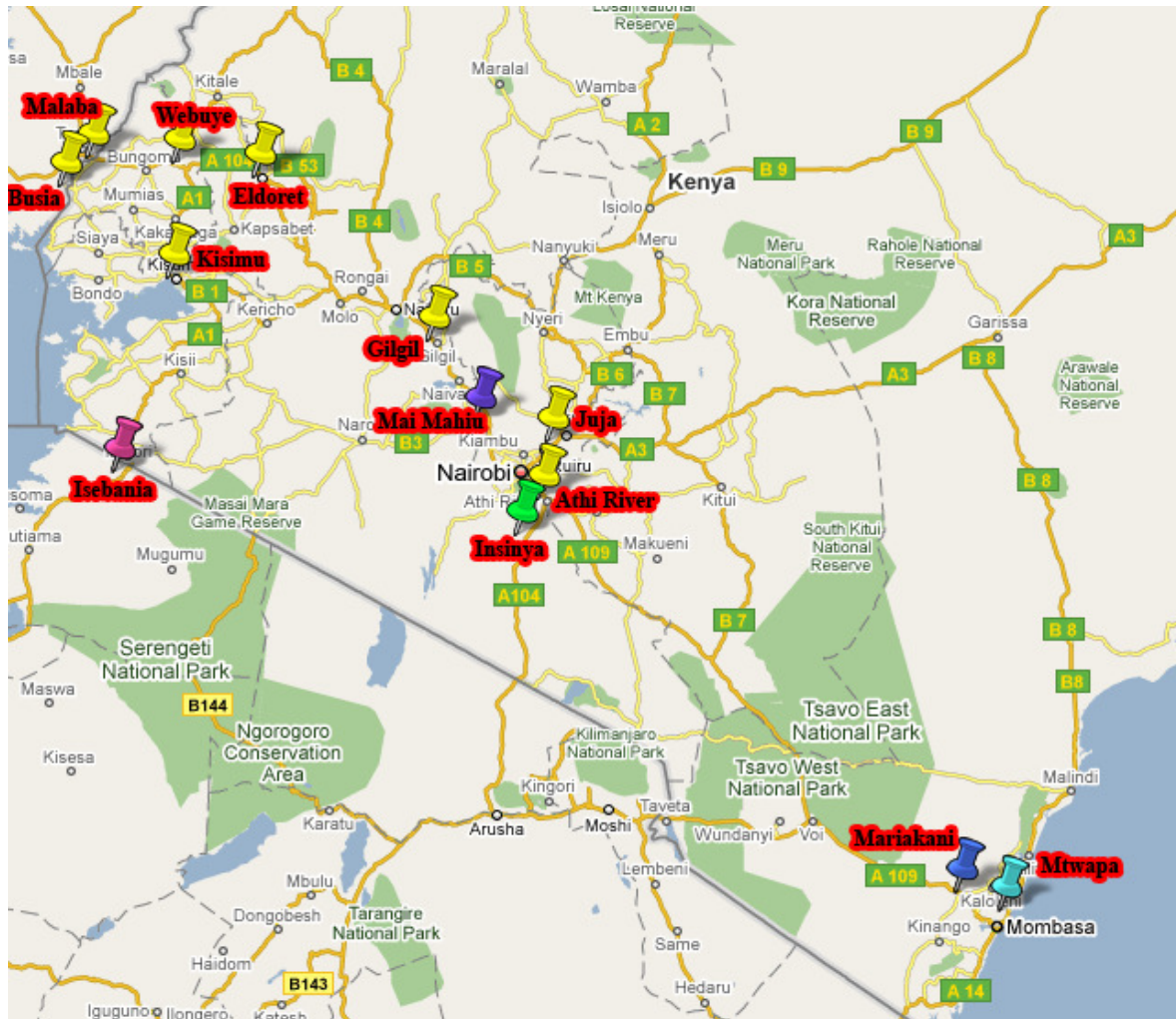
PIE CHART ON CARGO



Source: Research

APPENDIX IV

Figure 17 Map showing current locations of weighbridges in Kenya



Source: MOR (2011)

APPENDIX V

SAMPLE SOURCE CODES

Oracle Instance

```
C:\Documents and Settings\SilvesterLiechMageni>C:\DevSuiteHome_1\jdk\bin\java -
Doracle.security.jazn.config=C:\DevSuiteHome_1\j2ee\DevSuite\config\jazn.xml -Do
racle.home=C:\DevSuiteHome_1 -DORACLE_HOME=C:\DevSuiteHome_1 -jar
C:\DevSuiteHom
e_1\j2ee\home\oc4j.jar -userThreads -config C:\DevSuiteHome_1\j2ee\DevSuite\conf
ig\server.xml
```

12/06/27 11:58:43 Oracle Application Server Containers for J2EE 10g (10.1.2.0.2)
initialized

Tables

```
create table vehicle(main_vehicle_reg_no varchar2(20),
country_of_reg varchar2(20),no_of_vehicles number(5),
no_of_axies number(2),no_of_tyres number(5),
vehicle_class_code varchar2(15),
transport_operator varchar2(20),
postal_address number(5),consignment varchar2(15));
create table trip_details(from varchar2(20),to varchar2(20));
create table vehicle_details(seq number(10),
country_of_registration varchar2(20),
vehicle_registration varchar2(20),
transport_permit_no varchar2(15));
create table driver_details(driving_lisence_number number(15),
country_of_issue varchar2(15),driver first_name varchar2(15),
```

```

driver_surname varchar2(15));
create table axle_reading(axle_no number(10),axle_code number(10),
axle_decription varchar2(20),time_read varchar2(10),
weight_reading number(10));
create table min_fines_on_axle_load(degree varchar2(70),
fine_on_first_c number(6),fine_on_second_c number(6));
conn /as sysdba
drop user demo cascade;
grant connect,resource,unlimited tablespace to demo
identified by demo;
alter user demo temporary tablespace temp;
alter user demo default tablespace users;
conn demo/demo
create table vehicle(main_vehicle_reg_no varchar2(20),
country_of_reg varchar2(20),no_of_vehicles number(5),
no_of_axies number(2),no_of_tyres number(5),
vehicle_class_code varchar2(15),
transport_operator varchar2(20),
postal_address number(5),consignment varchar2(15));
create table trip_details(origin varchar2(20),
destination varchar2(20));
create table vehicle_details(seq number(10),
country_of_registration varchar2(20),
vehicle_registration varchar2(20),
transport_permit_no varchar2(15));
create table driver_details(driving_lisence_number number(15),

```

```

country_of_issue varchar2(15),first_name varchar2(15),
surname varchar2(15));
create table axle_reading(axle_no number(10),axle_code number(10),
axle_decription varchar2(20),time_read varchar2(10),
weight_reading number(10));
create table min_fines_on_axle_load(degree varchar2(70),
fine_on_first_c number(6),fine_on_second_c number(6));
create sequence vehicle_d_seq
start with 100
increment by 1
nocycle
nomaxvalue
/
create trigger vh_id_trigg
before insert on vehicle_details
for each row
begin
select 'VHX' ||lpad(vehicle_d_seq.nextval,10,'0')
into :new.seq
from dual;
end;
/

```

STEPS

Startup the report server, this server enables calling of reports from form applications

Edit the following.

C:\DevSuiteHome_1\reports\conf\rwnetwork.conf

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPEdiscoveryService SYSTEM
"file:C:\DevSuiteHome_1\reports\dtd\rwnetworkconf.dtd">
<discoveryService>
<!--multicast channel="228.5.6.7" port="14021" timeout="1000" retry="3"/-->
<namingService name="Cos" host="localhost" port="5501"/>
</discoveryService>
```

Create a batch file

The batch file contains a list of commands.

Steps

Open notepad and type the following

Start C:\DevSuiteHome_1\bin\namingService 5501

Start C:\DevSuiteHome_1\bin\rwserver server=Cos

Save the file as reportserver.bat

Open oracle forms 10g and create a form

Add a report to the form and edit the properties of the form as follows, in the property palette of the added report.