# LEVERAGING TECHNOLOGY FOR BUSINESS FLEET APPLICATIONS: A CASE STUDY OF FLEET MANAGEMENT SYSTEM IMPLEMENTED IN KENYA POWER & LIGHTING COMPANY LIMITED

by

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# DECLARATION

Student number: 34147365

I declare that **LEVERAGING TECHNOLOGY FOR BUSINESS FLEET APPLICATIONS: A CASE STUDY OF A FLEET MANAGEMENT SYSTEM IMPLEMENTED IN KENYA POWER & LIGHTING COMPANY LIMITED** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE
(MR EC WAIYAKI)

13 September 2013

## APPRECIATION AND ACKNOWLEDGEMENTS

The successful preparation and completion of this study marks a fundamental milestone in my academic path. I feel humbled that God has accompanied me on this journey and made all things possible. I am well aware that such an undertaking is seldom an individual effort and, thus, the planning and execution of this study has included contributions from individuals other than me. While it is not possible to mention everyone who deserves recognition, I am especially indebted to my project supervisor (Prof. Anton Brits) for his invaluable academic guidance. I greatly appreciate his kindness, patience and insightful assistance throughout the research work and may he accept heartfelt gratitude for his outstanding mentorship.

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## ABSTRACT

This study aimed to evaluate the effectiveness of a modern fleet management system in improving the logistics of transporting staff, goods and materials in Kenya Power & Lighting Company, a utility firm in power distribution. In today's competitive marketplace which is characterised by rapidly changing business requirements, leveraging leading edge technologies and adopting best practices are essential in order to ensure sound logistical support that guarantees both effectiveness and efficiency in the transportation processes.

The sampling procedure of one-stage, cluster sampling and the use of the simple random sampling technique were used in this study to select a sample size which was sufficiently representative of the whole population. Both the descriptive study approach and the survey research strategy were adopted to enable the collection of data in a manner that allowed in-depth examination while gathering information that explained the relationships between constructs, in particular, cause and effect relationships.

The main purpose of this dissertation was therefore to establish that the use of information technology is feasible in transport industries, explain possible obstacles and also any major advantages of its implementation. Secondly, as regards the theoretical aspect, a broadened view on the use of online tracking for vehicles using a global positioning system is presented, together with practical examples, to illustrate its successful implementation in a fleet management system. The study concludes by offering suggestions and recommendations from the research results and the researcher's experiences for future studies.


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## Keywords

Global positioning system, information and communication technologies, fleet management system, Global System for Mobile Communications and Intelligent transport systems

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| | |
|---|---|
| **BCS:** | M/s Binary Computer Systems Ltd |
| **CBK:** | Central Bank of Kenya |
| **EDI:** | Electronic data interchange |
| **FMS:** | Fleet management system |
| **FTS:** | Fleet Tracking Solutions (Africa) Ltd |
| **GPRS:** | General packet radio service |
| **GPS:** | Global positioning system |
| **GSM:** | Global system for mobile communications |
| **ICT:** | Information and communication technologies |
| **IFLS:** | Integrated finance & logistics software |
| **IPPs:** | Independent power producers |
| **IT:** | Information technology |
| **ITS:** | Intelligent transport systems |
| **KENGEN:** | Kenya's Electricity Generation Company |
| **KPLC:** | Kenya Power & Lighting Company Limited |
| **KP&TC:** | Kenya Posts & Telecommunications Corporation |
| **LIT:** | Logistics information technologies |
| **MOE:** | Ministry of Energy |
| **PPA:** | Power purchase agreements |
| **RFS:** | Radio frequency system |
| **RVDS:** | Remote vehicle disabling system |
| **SMS:** | Short message service |
| **TMS:** | Transport management system |
| **UETCL:** | Uganda Electricity Transmission Company Limited |
| **URL:** | Uniform resource locator |
| **VHF:** | Very high frequency |

## DEFINITION OF KEY TERMS, CONCEPTS AND VARIABLES

**Global positioning system (GPS)** – A technology that uses the signals and data from multiple satellites to determine a location anywhere on earth. The GPS constellation consists of 24 orbiting satellites with four equally spaced around each of six different, orbiter planes.

**Electronic on-board computers (EOBC)** – An electric, electronic, electro-magnetic, or mechanical device capable of recording driver's [sic] duty status information accurately and automatically as required. The device must be integrally synchronised with the specific operations of the motor vehicle in which it is installed.

**Fleet management system** – A management tool that is also known as an intelligent fleet management system. It provides the manager with essential information through GPS technology which gives the accurate position, velocity and time data of the fleet. GPS provides this data free of direct user charge worldwide, continuously, and under all weather conditions.

**General packet radio system (GPRS) –** Packet switching technology where information is transmitted in short bursts of data over an IP-based network allowing continuous connection to data networks in support of many kinds of applications, including messaging and rapid data transfer.

**Fleet telematics –** A general term referring to emerging technologies in automotive communications, combining wireless voice and data capability for management information and safety applications.

**Global system for mobile communications (GSM) –** Originally short for 'Groupe Spécial Mobile' which is digital wireless communication.

**Satellite Tracking system –**The most expensive method of communicating, it is also the fastest. Typically, this option is reserved for over-the-road trucking companies and conglomerates with global fleets.

**Information technology (IT) –**The study, design, development, implementation and support for management of computer-based information systems, particularly software applications and computer hardware.

# CHAPTER ONE

**Stage in dissertation**

| | | |
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| **CHAPTER 1: Introduction** | 1.1 | Introduction to the Research Study |
| | 1.2 | Background to Research Study |
| | 1.3 | Statement of the Problem |
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|---|---|
| CHAPTER 2: Literature Review | Presents literature review examining the historical development of the fleet management systems |
| CHAPTER 3: Research Methodology | Describes the research design, sample and sampling procedure and the research instruments used for data collection and data analysis. |
| CHAPTER 4: Data Collection and Analysis | Describes the findings derived from the results of the data analysis carried out on the impact of the implementation of fleet management |
| CHAPTER 5: Discussion on Research Findings and Recommendations | Describes in detail the research output and presents recommendations derived from the results obtained. |
| CHAPTER 6: Research Summary and Conclusion | Presents a summary of the key research findings from the research work accomplished and draws conclusions in respect of the research questions. |

## 1. Introduction

### 1.1. Introduction to the Research Study

Transport and logistics are both key components of a successful economy. Governments worldwide seek to increase their competitiveness through new or replacement of infrastructure. The transport and logistics sector plays a major role in the world economy and is a significant contributor at both the national and local level in any country. This sector underpins the economy, enabling the efficient movement of goods, services and people. The increase in the concomitant management requirements of vehicle fleet operations has

outweighed the human mental capacity as advances in the technology of vehicular dynamics and design increase year after year. Over the past decade, firms have faced unprecedented change, namely, globalisation and internationalisation, the rapid advance of information technology (Chan & Peel, 1998:46), higher value of competition (Carr, 2002:447), increased availability and flexibility of products/services (Ahmad &Schroeder, 2001:16) as well as greater internal and external customer needs (Marjanovic, 2000:43).

Firms are, thus, no longer able to satisfy the various demands of their customers effectively with just product and price. They must also increase the performance of the product in terms of reaction speed, delivery policy, information services and flexibility. For this reason, firms are, in many instances, being forced to redesign their internal processes using different methods. Today, information technology (IT) is recognised as one of the most prevalent facilitators of such process changes (Chan & Land, 1999:311). IT not only enables firms to redesign their internal processes but it also helps them to improve their competitiveness in both local and international markets (Motwani & Kumar, 1998:964). The ability to track and control the movement of vehicles every minute may translate into hundreds of dollars as regards an organisation's bottom line. Necessary costs, such as fuel and employee overtime, may be closely monitored and verified to ensure that a company is operating at optimal efficiency. For example, excessive vehicle idling not only uses fuel, but also causes unnecessary engine wear and tear.

With real-time tracking and by accessing the appropriate reports, fuel use may be drastically reduced by as much as 20%. Some companies have even rewarded their employees for paying attention their fuel use; i.e. driving with the interests of the company in mind. Overtime costs are another significant expense that may be decreased with real-time monitoring, as timesheets may be compared to a report that lists a vehicle's location and movement throughout the day. Productivity is yet another benefit of real-time tracking accrued in planning and scheduling the best route to a job and discovering how long a particular job takes (Murphy, 2004:45). The implementation of information technology is becoming more and more essential in logistics, particularly in view of the fact that it may improve logistics efficiency, effectiveness and flexibility (Sanders & Premus, 2002:65).

In many advanced countries, there are several logistics projects taking place, with firms implementing new, advanced technologies such as global positioning system (GPS) and other wireless technologies (Shugan, 2004:4695). In the same vein, in the developing countries, and especially in the East African community, the use of wireless technology is

growing rapidly. For example, there are many such projects being undertaken in Kenya. While numerous studies concerning the technical aspects of GPS use have been conducted in developed countries in Europe and America (Adriansen & Nielsen, 2005; Bodamer, 2001; Stopher, FitzGerald & Xu, 2007), there is little information available on the use of the fleet management systems in Kenya and the only readily available information is on the marketing of different options of various equipment and software systems. There is, thus, little conclusive research evidence of the way in which the implementation of GPS fleet management system has changed internal processes in Kenyan firms.

For years, managers have relied on conventional manual systems using driver log sheets, service forms and other paper record-keeping systems to keep track of business fleet vehicle operations. To an extent, much of this process has been automated but, invariably, a fleet manager is required to sort through often incomplete sheets of paper in order to reconstruct vehicle records. However, there is GPS technology available now which is designed to track and records trip details that may be used to improve the transportation process.

This study intends to investigate this unexplored area. This will be done by evaluating the fleet planning and management systems problems experienced by Kenyan firms running a large fleet of more than 500 vehicles, while some of the solutions which have been implemented will also be explored. Furthermore, the viability of these solutions in addressing the root cause of the challenges identified will be discussed. For the purposes of this discourse, the application of information technology to vehicle fleet management will centre on fleet tracking systems, driver monitoring, fleet security and control through the global positioning system (GPS) in Kenya Power and Lighting Company (KPLC).

## 1.2. Background to the Research Study

Originally, the GPS was created to identify the precise location of any object on the earth, anytime, anywhere. Today, one of the fastest growing markets for GPS technology is vehicle tracking and location. In 2004, approximately 1 million fleet vehicles in the United States were equipped with tracking devices and companies of all sizes were taking advantage of this technology (Murphy, 2004).

There are many applications for the GPS fleet management systems with the most common GPS application being in the field of vehicle navigation. Vehicles installed with a GPS receiver coupled with a monitor are able to indicate to the user the shortest route, by

road, to his/her destination. A GPS may also be fitted in freight vehicles, including the trucks used for delivery and courier services, construction and aviation, so as to determine the safest and shortest route in order to save time and petrol. Construction companies may accurately mark the point at which a building or underground tunnel is located. Thus, the GPS is one way in which satellites have become part of everyday life (Egbert & King, 2003).

Fleet management systems provide the fleet manager with the tools required to meet tight deadlines, optimise deliveries and track the entire fleet. The basic elements of a fleet management system include the tracking devices in the vehicles and a central computer at the dispatching centre. For complete implementation of the system, the entire fleet is equipped with tracking units which integrate a position device (e.g. GPS) with communications mechanisms (e.g. global system for mobile communications [GSM]).

The possibility for an in-vehicle interface exists to permit the driver to access information and send messages. In addition, various sensors monitor the vehicle parameters, incusing, inter alia, whether the door is open/closed and unsafe temperatures in the trailer. Managers at the dispatch centre are able to visualise the entire fleet in real-time, usually on digital maps, thereby allowing them to obtain data on vehicle status and traffic updates. The integration of the system with automated company systems also provides statistical data on staff salaries, financial and accounting records (Bekiaris & Nakanishi, 2004).

### *1.2.1. Intelligent Fleet Management System Use in Kenya*

Technology is offering an answer to the business operation challenges being experienced in Kenya, including motor vehicle theft, fuel consumption or loss of goods in transit (Okuttah, 2009:1). Kenyan entrepreneurs have found these systems particularly useful for the purposes of fleet management in the wake of increasing fuel theft and fuel adulteration in the market. Three versions of technology-based tracking systems are available in East Africa; namely, those that rely on a mix of GPS and GSM systems, radio frequency systems and satellite-based platforms. In terms of the GPS/GSM system, satellite technology is used to monitor fleets with mobile telephones providing the end users with information. The mobile telephone enables the user to, for example, locate a motor car, or retrieve fuel consumption information (Okuttah, 2009:1). GPS tracking, also known as satellite tracking, has become popular in Kenya.

With the introduction of mobile, vehicle, laptop, wildlife and personal tracking, it is now easier than ever to recover stolen goods (Karen, 2010:1). Undoubtedly, car tracking has

become one of the most common gadgets used for vehicle location and monitoring due to the great number of car break-ins and thefts. For example, according to police records, more than 600 vehicles were stolen in 2008. This has resulted in many of the motor vehicle owners installing tracking devices in their vehicles (Karen, 2010:1). According to a fleet management consultancy in Kenya, the GPS/GSM system is cheaper than satellite-based technology because it requires that a single payment only be paid in order to gain access to all the information that is generated (Okuttah, 2009:1).

However, the main advantage of the satellite system is that the system is able to track a vehicle globally as it is not limited to any one local GSM receiver (Okuttah, 2009:1). The charges for a satellite system are approximately three times more than the conventional GSM system which is charged at approximately US$15 per month per unit (Klie, 2006:26). In Kenya, the Tramigo software is the most common GPS/GSM solution and is priced at approximately US$500 for the complete installation in a vehicle. The system offers detailed information, including the exact location of either motor cars or items. In view of the fact that the GSM modem incorporates a SIM card which is provided by the various mobile providers at a cost, its use is, therefore, limited to the network signal coverage and it is not able to deliver real-time information outside the network coverage area. The radio frequency system (RFS), on the other hand, runs on the masts mounted by the service provider.

These radio frequency systems may not work well in areas in which the provider concerned does not have such infrastructure in place. Nevertheless, its main advantage is that it is able to detect vehicles in buildings or even vehicles which are hidden underground. The satellite system, on the other hand, uses satellite phones, the price of which is beyond the reach of most potential users such as individual, public service vehicle operators. Nevertheless, its main benefit is in the fact that it is able to locate or track a vehicle in any part of the world (Okuttah, 2009:1). “Fleet companies running on tracking system have gained a reputation for reliability and predictability from their clients. Now, one can clearly see where the vehicle is, how fast it’s travelling and work out when exactly it should arrive at its destination” (Warungu, 2007:1).

### *1.2.2. Profile of Kenya Power & Lighting Company (KPLC)*

KPLC is a limited liability public company that is listed on the Nairobi Stock Exchange (NSE). It was created in 1954 and was known as the Kenya Power Company (KPC). It then changed its name to the East Africa Power & Lighting Company (EAP&L). In

1964, the EAP&L sold its Tanzanian shares to the government of Tanzania and, since then, its operations have been limited to Kenya only. This prompted a change of name to Kenya Power & Lighting Company Ltd (KPLC) in 1983. From 1983 to 1997, KPLC was responsible for the generation, transmission and distribution of power. However, in 1997 the power generation section was split off to form the Kenya Electricity Generating Company (KENGEN), leaving KPLC to transmit and distribute power. KPLC owns and operates the national transmission and distribution grid, and it retails to more than 1,463,639 customers throughout Kenya (KPLC Annual Report, 2009).

KPLC purchases bulk power through power purchase agreements (PPA) with Kenya Electricity Generating Company Limited (KenGen), independent power producers (IPPs) and the Uganda Electricity Transmission Company (UETCL). Kenya's power sector falls under the Ministry of Energy, which is responsible for the general oversight and policy direction. The corporate vision of KPLC is to achieve world-class status as a quality service business enterprise. This would enable the company to become the first supplier of choice of electrical energy within a competitive environment. In year 2008, at the start of the GPS fleet management system implementation, KPLC owned a fleet of 1 863 units which comprised 1 208 motor vehicles, 545 motor cycles and 110 items of plant/equipment with an annual, recurrent expenditure of 11 million US dollars (US1$ = Kshs 90.00 – Central Bank of Kenya (CBK) Forex rate (2011). In addition to this fleet, the company has financed 1278 cars under the private scheme operated by individual staff but with mileage compensation being offered if the motor cars are used for official duties. This scheme has an annual, recurrent expenditure of 5 million US dollars (1$=Kshs.90) as compared to the total transport expenditure of 16 million US dollars.

### *1.2.3. Requirement for a GPS Fleet Management System in KPLC*

Operating an efficient business is a priority for every business. As regards power distribution utilities, greater insight into their fleet movements and the location of their vehicles (and equipment inside of the vehicles) may provide a valuable indication of the efficiency of the business. A GPS-based fleet management system is a simple and effective way in which to gain this information (Shugan, 2004:469). KPLC used mechanical tachographs until 1994 when these were discontinued as a result of a lack of dealer support, spares and service. In addition, they required daily manual checking which is operationally cumbersome. Information on distance travelled, authorisation, road speed before accidents, start time and stop time was obtained from drivers either directly or from the documents that

they filled in for monitoring and control purposes. Thus, the monitoring and control of the fleet to reduce costs and improve on the accident rate was conducted manually with the help of historical data.

During the period 1995 to 2008, the company did not use either tachographs or any other vehicle on-board monitoring and control equipment. As a result, it was extremely difficult to monitor and control vehicle misuse, bad driving habits, accidents and costs on both an individual vehicle basis and for the entire fleet. During this period, the annual recurrent expenditure on pool vehicles escalated to a peak of $7 million annually. In addition, this period was dogged by a high accident rate of 20 accidents per million kilometres, as compared to the previous best average of 10 accidents per million kilometres recorded in 1995. In the five-year business plan (2004–2009), the installation of electronic tachographs (GPS) was identified as one of the strategies for improving the efficiency of the fleet.

Effective management of fleet operations is associated with enhanced productivity, operational efficiency and good customer service. The installation of modern tachographs was therefore expected to make it possible to establish the actual causes of accidents and to address those root causes. The locations of the vehicles are spread throughout the country. Therefore, the ability to collect data on-line ("hands free") and then consolidate the data into meaningful reports that can be used to optimally allocate transport vehicles and ensure accountability of the same from a central point would be a great advantage. The use of information from the modern tracking systems was envisaged to result in enhanced operational efficiency, improving driving behaviour, reduce costs, increased security and better customer service.

### 1.3. Statement of the Research Problem

The overall transport expenditure on pool vehicles at KPLC escalated to a peak of US$7 million at approximately 47 US cents per kilometre and a high rate of 20 accidents per million kilometres as compared to the previous best average of 10 accidents per million kilometres recorded in 1995. The implementation of the GPS fleet management system was intended to mitigate, among other things, the high fleet operating costs, high accident rates and low fleet availability. The system has been in place for the last two years since year 2009 and there is, thus, a need to investigate whether the system has worked for the company as was intended.

Consequently, this study intends to evaluate the impact of implementing a GPS fleet management system and to come up with facts and figures pertaining to any improvements in the transportation of staff, goods and materials at KPLC. Thus, the research to be conducted will evaluate the effectiveness of the GPS fleet management system as regards improving the logistics of transporting staff, goods and materials. It would appear that no local or international studies have conducted research into the effects of implementing information technology on the management of a corporate fleet in Kenya and, in particular, KPLC. In light of this fact, the researcher aims to fill the existing academic gap by carrying out the proposed research.

## 1.4. Objectives of the Study

The primary objective of this study is to investigate the effectiveness of the installation of a GPS fleet management system at KPLC. The study will carry out an evaluation of the functionality of the system and any improvements in the transportation of staff, goods and materials after the full implementation of the system in 2010.

The secondary objectives are:

- To analyze the effects of GPS in reducing the rate of accidents.
- To establish the effects of GPS in improving fleet availability.
- To determine whether fleet operations costs had reduced.
- To find out whether the average vehicle breakdowns had reduced.
- To find out whether there is any reduction on theft of vehicles

## 1.5. Research Questions

The study underscores the critical demand for information technology and its complex role within an organisation. The research questions will serve as the guideline for the study and are also important in meeting the objectives of the study.

- What has been the effect of the GPS in reducing the rate of accidents?
- What has been the effect of the GPS in improving fleet availability?
- How has the GPS assisted in reducing the fleet operations costs?
- How has the GPS assisted in reducing the number of vehicle breakdowns?
- What has been the effect of the GPS in minimising the theft of vehicles?
- What benefits have resulted from to using IT solutions in fleet management?

## 1.6. Scope of the Research

The study is limited to the company sub-regions (transport branches) in which some of the vehicles fitted with the GPS tracking units will be identified for sampling. These may be regarded as representative of the other regions as the company's fleet is divided into ten branches and the operations of these ten branches are homogenous. The data collection will be conducted in the three geographical areas that will be selected to represent a fleet population size of 1,200 units. The sample size will be subject to the given minimum according to the "Guide to minimum sample size" (Krejcie & Morgan, 1970). A comparative data analysis will be conducted for 2008, prior to fitting the GPS units, and the actual status at the end of 2010, after the completion of the implementation exercise for the 1,200 vehicles.

## 1.7. Research Methodology

The study will use primary data which will be collected from the sample population that operates the vehicle fleet countrywide. Structured questionnaires will be used in the data collection process. These will be administered through the use of the company's intranet communication system to all the fleet operators in the three areas selected and in which GPS units have been installed in the vehicles. The research questionnaire is designed to obtain specific information for each research question to ensure that adequate raw data is obtained for the purposes of data analysis and to enable the researcher to draw conclusions. This is crucial in examining the contribution of the GPS fleet management system to the organisation. In addition, secondary data will be obtained from recorded materials and system printouts. The company store records of all fuel transactions, distances travelled and accidents that have occurred over a period in a transport management system (TMS). Data downloads and computer printouts which are available in the system will provide further information for authenticating the responses to the questionnaires and providing collaborative information regarding the research problem. The descriptive technique and the content analysis methods will be used to enhance the researcher's understanding of the results obtained and to provide answers to the study questions.

## 1.8. Chapter Outline

**Chapter One**: An introduction to the dissertation is given in order to provide the general context for the research problem relating to the fleet management systems

implemented at KPLC. The chapter also briefly discusses the research objectives and the research methodology for the proposed study.

**Chapter Two**: The literature review discusses existing information on the research topic and examines the historical development of the intelligent fleet management tracking systems as well as some of the research concepts, principles and applications in GPS technology. The importance of intelligent fleet management systems and the benefits of real-time data for prompt decision making are included in this chapter.

**Chapter Three**: The research methodology includes a description of the research design, target population, sample and sampling procedure used in the study, as well as the research instruments, piloting of the research instruments, data collection and data analysis. The study approach to be adopted, the data collection methods and subsequent data analysis are discussed in depth in this chapter.

**Chapter Four**: The data collection and data analysis processes refer to the handling of the data collected and its analysis in such a way that is both clear and meaningful in enhancing the understanding of the research topic. The results obtained and the observations are presented accurately and concisely in a way that answers the study questions in the light of previous work conducted by other researchers.

**Chapter Five:** The discussion on the research findings and recommendations describes in detail the findings derived from the results obtained from the research study. In other words, the key results obtained from the research work are described in an attempt to highlight the significance of the results achieved and their relevance in direct applications.

**Chapter Six**: This chapter contains the research summary and conclusion. The purpose of the chapter is to present a summary of the study and to draw conclusions in the interests of both present and future research. The chapter describes, point by point, the major conclusions drawn from the findings of this research work in an attempt to provide recommendations for further studies.

# CHAPTER TWO

**Stage in dissertation**

| | | |
|---|---|---|
| CHAPTER 1:<br>Introduction | Provides an introduction to the general context of the research problem and briefly describes the research objectives and methodology for the proposed study. | |
| **CHAPTER 2:**<br>**Literature Review** | 2.1 | Introduction to the Literature Review |
| | 2.2 | Leveraging ICT in Transport Business Processes |
| | 2.3 | Insight into the Future of Technology From Top Industry Analysts |
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| | 2.6 | Real-time Fleet Management Technologies |
| | 2.7 | Challenges When Choosing and Implementing ICT |
| | 2.8 | Benefits of a GPS Fleet Management System |
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| | 2.10 | Summary of the Literature Review |

| | |
|---|---|
| CHAPTER 3:<br>Research Methodology | Describes the research design, sample and sampling procedure and the research instruments used for data collection and data analysis. |
| CHAPTER 4:<br>Data Collection and Analysis | Describes the findings derived from the results of the data analysis carried out on the impact of the implementation of fleet management. |
| CHAPTER 5:<br>Discussion on Research Findings and Recommendations | Describes in detail the research output and presents recommendations derived from the results obtained. |
| CHAPTER 6:<br>Research Summary and Conclusion | Presents a summary of the key research findings drawn from the research work and offers conclusions in respect of the research questions. |

# 2. Literature Review

## 2.1. Introduction to the Literature Review

This chapter contains a review of existing literature on fleet management systems. Specifically, the chapter describes the main characteristics of the various types of fleet management applications in use. The review accentuates the many challenges encountered in the modern transportation process, including the increase in congestion; lower costs; improved customer service; heightened terrorism/theft/security issues; information-sharing; regional multi-modal logistics growth; and the proliferation of new complex tools with which to optimise route scheduling. The chapter also critically examines both the historical development of the fleet management systems in transportation and also certain proven research concepts, principles and applications in GPS technology which are used in this study. These concepts, principles and applications provide an understanding and knowledge of the economics of the operations of a fleet as a result of the utilisation of the intelligent fleet tracking systems. The chapter also evaluates the accrued benefits of real-time data in prompt decision making, while the improvement in the various aspects of fleet operations underscores the need for transport and logistics service providers to implement real-time fleet management. Finally, the chapter ends with a brief, concluding summary.

## 2.2. Leveraging ICT in Transport Business Processes

Information and communication technology (ICT) may be defined as those technologies that enable the recording, processing, retrieval and the transmission of information or data. Herselman and Hay (2003:31) describe ICT as technologies that support the communication and co-operation of "human beings and their organizations" and the "creation and exchange of knowledge while Yu (2011:297) considers ICT to be a range of technologies that allow the gathering, exchange, retrieval, processing, analysis and transmission of information. In other words, ICT may be described as any tool that facilitates the communication, processing, transmission and sharing of information and knowledge through electronic means.

Rwashana and Williams (2008:144) maintain that ICT encompasses a range of electronic digital and analogue devices such as radio, television, telephones (fixed and mobile), computers, electronic-based media such as digital text and audio-video recording, and the internet, but excludes the non-electronic technologies. Selwyn (2002:49) refers to

ICT as “an umbrella term that includes computer hardware and software; digital broadcast and telecommunications technologies as well as electronic information repositories such as the World Wide Web or those found on CD ROMs”. Ssewanyana (2009:5) further describes ICT as a strategic tool that allows users to become more efficient and effective.

In recent times, there has been an increasing need for stronger cost control as well as a heightened demand for higher returns in businesses (Milis & Mercken, 2003:87). The use of ICT in order to gain competitive advantage has become a key strategic issue in organisations in a fast globalising environment (Kakabadse, Kakabadse & Kouzmin, 2005:55), particularly as a result of the fact that ICT plays a strategic role in the management of organisations. Rastrict and Corner (2010:311) and Lin and Lin (2006:246), among others, emphasise the positive relationship between ICT and its benefits. This implies that ICT may bring about organisational advantage. There are immense possibilities as regards ICT applications in transportation and logistics and various studies have noted several types of application, each one contributing to the transportation and logistics system in a unique way.

ICT, also known as logistics information technologies (LIT), may represent a major component of a organisation’s investment and includes the hardware and software expenditures associated with logistical activities such as ordering, warehousing, inventory and transportation management (Savitsikie, 2007). ICT applications emerged in the mid to late 1970s with electronic data interchange (EDI). This enabled a new form of chain management as a first step in the development of various e-commerce applications (Allen, 2001:29-30). E-commerce refers to any form of economic activity that is conducted by electronic means between two parties and includes the exchange of information (Hesse, 2002:211). However, the high price and non-standardisation of e-commerce applications meant that there was a limited degree of implementation as only large organisations were able to afford such technologies.

Meanwhile, various hardware and software applications were produced. According to Durr and Giannopoulos (2003:175), these applications were aimed at improving infrastructure and traffic and fleet management, facilitating the effective tracking of goods across the transport networks and also improved businesses and administrations connections. Radio frequency identification (RFID) has proven to be an efficient, automatic identification and data capture technology (Sarac, Absi & Dauzere-Peres, 2009:26). Marchet, Perego and Parotti (2006:785) proposed a categorisation of the main ICT applications available for freight transportation companies in terms of three application types: a) transportation fleet

and freight management, b) supply chain execution and c) field force automation. De Jong, Algers, Papola and Burg (2006:286) conducted a survey on the perceptions of users of the impacts of new technologies on urban distribution systems performance. The survey found that the use of ICT is expected to reduce the share of empty and not fully loaded vehicles.

When coupled with logistic innovations it is possible that developments in e-economy technology may bring about changes to the load factors. On the other hand, the use of technological tools may increase the number of small vehicle trips in the cities. De Jong et al. (2006:286) developed a "4 steps" freight transport model incorporating the impacts of ICT on the generation, attraction, modal shift or a change between transport modes and traffic assignment processes. Currently, there is rapid development in the use of ICT in organisations. ICT plays a crucial role in the present knowledge-based economy and, hence, organisations tend to rely heavily on ICT solutions in order to develop and grow their businesses (Asgarkhani & Young, 2010). The revolution in the use of ICT has profound implications for both economic and social development and has, in fact, pervaded every aspect of human life (Shanker, 2008:50). The application of ICT is widespread with ICT being regarded as an essential tool in the efficient administration of any organisation and the delivery of services to clients. Schware (2003:3–7) maintains that ICTs are being integrated into procedures, structures and products throughout businesses, governments and communities.

The use of ICT increases the supply of information as ICT plays a key role in information sharing and dissemination. According to Spanos, Prastacos and Poulymenakou (2002:659), ICT removes distance and time constraints in the accessing of required information flows. In addition, ICT reduces the cost of production as knowledge is produced, transmitted, accessed and shared at the minimum cost, while there is also a reduction in the degree of inefficiencies and uncertainty because it enables businesses to interact more efficiently (Buhalis, 2003:805). Shanker (2008:50) is of the opinion that the use of ICT in many organisations has assisted in reducing transactional costs and, overcoming the constraints of distance by cutting across geographic boundaries; it has also contributed to improving the coordination of activities within organisational boundaries. Spanos et al. (2002:50) maintain that ICT enables buyers and sellers to share information and transfer goods across national borders and this, in turn, helps to increase access to global supply chains.

ICT has also led to increased transparency in organisations as it enables the networking and information sharing that results in demands for greater openness and transparency (Shanker, 2008; Kollberg & Dreyer, 2006:84). Jiménez-Zarco, Martínez-Ruiz and Llamas-Alonso, (2006:84) further argue that ICT plays an important role in the acquisition, creation and management of knowledge as it enables the diffusion of the organisational data that may be crucial in effective decision making and control at all management levels. Similarly, ICT helps in organisational planning and improves organisational communication and flexibility. Currently, the extensive use of ICT is changing the way in which people and companies work. Researchers such as Hipp and Grupp (2005:517) and Castellacci (2006:841) refer to ICT as a vital tool for innovation in the present era. The benefits of ICT include the saving of inputs, general cost reductions, higher flexibility and improvement in product quality (Mouelhi, 2009:961).

Bloom, Garicano, Sadun and Reenen, (2009) ascertained that ICTs play a major role in networking and communication as firms use these technologies in order to facilitate communication among employees and reduce coordination costs. According to Hanna (2003), ICT enhances the production process in organisations as monitoring technologies may be used to reduce the number of supervisors required in the process. In addition, Arvanitis and Loukis (2009:43) maintain that the use of ICT has direct implications for firms, with ICT playing a role in areas such as information gathering and dissemination, inventory control and quality control. More specifically, ICT transportation fleet and freight management applications have been defined as decision support tools in transportation planning, optimisation and execution.

Applications help planners to choose transportation modes, manage freight consolidation operations and coordinate company shipments. In addition, they may be used as reporting tools by logistics managers who need to know vehicle travel times, service times and the delivery points that were visited. Supply chain management applications are designed to manage and automate the flow of products through the entire transportation process and all its phases. Specifically, they support functions related to information exchange. The field force automation applications, enabled by mobile technology provide a significant opportunity for both savings in operational costs and improvements in customer satisfaction as a result of the higher integration between remote workforces and the corporate business processes (Marchet et al., 2006:785).

## 2.3. Insight into the Future of Technology from Top Industry Analysts

This section discusses the insights of top industry analysts into the future of technology. Technology has become central to driving down transportation costs, and is indispensable in formulating global logistics plans (Levans, 2007:1).

According to Gonzalez (2006:9), freight payment is an area on which several organisations are now focusing in order to reduce cost. Many companies are seeking to implement a self-invoicing process whereby the shipper pays the carrier the rate in the transport management system, including known surcharges and accessories upon receiving the proof of delivery. This shifts the audit process to the carrier: a trade-off many carriers are happy to accept in return for getting paid thirty or more days earlier. It improves their cash flow, and the shipper eliminates all of the overheads involved in auditing and processing freight invoices (Gonzalez, 2006:11). Rising freight costs are clearly playing an important role in driving the renewed focus of companies on transportation, procurement and payment.

In 2007, freight rates started to soften for some transportation modes. This resulted in many companies reviewing their procurement freight audit, payment practices and technology. Companies believed they could save an average of 8.8% on their overall freight budget with more efficiency, and this was backed up by industry's best-in-class results. Companies are focusing on reducing manual payment processes and enhancing online collaboration with carriers for invoice exception handling. The savings come about as a result of avoiding overpayment on shipments as well as creating freight spend reports that may be used by procurement for both spend analysis and bid preparation activity. This, in turn, has helped United States-based freight companies to negotiate better rates and more favourable accessorial charges (Levans, 2007:1).

It is thus clear that automating payment procedures can assist in reducing transportation costs and many organisations are focusing on centralising transport procurement and payment in order to reduce costs. Such centralisation ensures that the correct transport modes and hauliers are chosen and that they are paid the correct amounts. A vital, but often overlooked, benefit is the fact that accurate cost allocation information from a freight payment system can prevent a ripple effect in the form of incorrect decisions in pricing, product investment strategies, distribution network design and sourcing strategies. In transportation, the most important action for companies to take is to centralise transportation procurement (Levans, 2007:2).

Olugbenga (2006:2) argues that ICTs are being used for strategic management, communication and collaboration, customer access, managerial decision making, data management and knowledge management. Thus, ICTs help to provide an effective means of organisational productivity and service delivery. According to Brynjolfsson and Hitt (2003:793), there is a substantial long-term productivity gain with the use of ICT in organisations. Buhalis (2003:805) also notes that the application of ICT in businesses results in fundamental changes that can provide powerful strategic and tactical tools for organisations if properly applied and used. This, in turn, may have a significant impact on promoting and strengthening organisational competitiveness.

Krishnaveni and Meenakumari (2010:282) assert that ICT has played a major role in reducing operational inefficiency and improving decision making in many areas of governance, while Cordella (2006) emphasises that the diffusion of ICT in the present era is associated with an increased amount of information becoming available. Hengst and Sol (2001:3-4) affirm that ICT enables organisations to decrease costs and increase organisational capabilities while also assisting in shaping inter-organisational coordination. Thus, the use of ICT may help in lowering coordination costs and increasing outsourcing in organisations. Similarly, in their report, Ramsey, Ibbotson, Bell and Gray (2003:250) mention that organisations generally stand to gain from ICT in areas such as reduced transaction costs. In other words, the use of ICT can assist both individuals and companies to access large markets at low cost. In addition, Irvine and Anderson (2008:200) comment that the use of ICT not only offers practical benefits for general management, but also enables companies to overcome the disadvantages of place and space utility in transportation.

Porter (1990:1189) defines competitive advantage as the heart of a company's performance. It reflects a company's ability to offer consumers greater value either by means of lowering prices or by providing increased benefits and services that justify higher prices. Alam and Noor (2009:112) argue that ICT offers enterprises the opportunity to compete on a global scale with improved efficiency and closer customer and supplier relationships. In other words, ICT should be regarded by businesses as an important strategy enabling them to remain competitive. Similarly, Melville, Kraemer and Gurbaxani (2004:283) highlight that the use of ICT enhances customer satisfaction by improving service quality, thus offering new opportunities to companies. Apulu and Latham (2010:23) claim that ICT enables customers to receive immediate feedback and this, in turn, enables companies to react quickly to customer demands and recognise new market niches. This implies that organisations that

are able to exploit the potential offered by ICT are enabled to handle various types of innovative processes in their businesses, as ICT influences the performance of an organisation in multifaceted ways. For these reasons, Kapurubandara and Lawson (2006:35) recommend that organisations adopt ICT in order to remain competitive in the present competitive global economy.

## 2.4. Impact of ICT on the Supply Chain Process in Transportation

It is possible to understand the true value of utilising the power of the computer in the logistics department only by understanding the large percentage of transport costs included in the supply chain. Transportation is the most expensive logistical activity, representing more than 40% of the expenses of most organisations. Transportation amounts to over US$400 billion in annual expenses in America alone, with global transportation expenditures exceeding US$2 trillion annually (Michigan State University, 2008). Banister and Stead (2004:611) proposes the classification of the possible impact of ICT on transport into the following three categories:

- The stimulation of more travel as new opportunities become available.
- The substitution for travel in view of the fact that activities will be carried out remotely rather than by means of travel.
- The modification of travel as the logistics and ICT processes combine to change the ways in which activities are carried out.

The use of ICT has been identified as possible way in which to reduce the cost of travel (Mokhtarian, 2004:257), while ICT may also be an enabler for both front-end and back-end processing in a supply chain. Access to information by all of the parties in a supply chain may serve to ensure that logistical services are more accurate, swift and less costly according to Piplani, Pokharel and Tan (2004:136). In view of the fact that the supply chain involves several steps, the impact of ICTs may save costs at every step and at every interface between the supply chain partners according to Jayaraman and Agarwal (2008:409).

According to the European Commission DG Energy and Transport (2009), some software and information systems can improve both mobility and transportation management. These systems provide innovative services and create favourable technical conditions for enhancing quality and efficiency while maintaining safety standards. A document on freight distribution management identifies the innovative e-logistics as best practice for improvement

in transportation management. A number of ITS applications (e.g. web-enabled information and booking services, delivery notification and information through mobile telephones, trip planning and resource optimisation, GPS-based vehicle location systems, long range, wireless communications, and others) enable the user to manage his/her logistical resources in such a way as to realise flexible, demand-driven freight distribution schemes.

Davies, Mason and Lalwani (2006:12) conducted a field survey focusing on the United Kingdom and examined the extent to which internet freight exchanges and the use of ICT processes are affecting general haulage. They found that 85% of their respondents considered ICT important for their companies, while there was a positive association between fleet size and the importance of ICT. It emerged that 56% of the respondents were using ICT for vehicle routing and planning, 33% for vehicle tracking and 13% for vehicle telematics. According to the opinion of 69% of the respondents, the freight exchanges were helpful only in the area of less empty running. However, in all the other areas, including choice of loads, reducing the time required to find backloads, reducing the cost of finding loads and the accuracy of information, the usability was not confirmed. They concluded that, when the industry structure is characterised by an extremely large number of smaller operators, there is a well-developed adoption of ICT and also a widespread reliance on the traditional means of operation.

Bertolini, Bottani, Rizzi and Bevilacqua (2007:198) analysed the impact of ICT on supply chain processes in the specific case of the Italian footwear industry. The main aim of the study was to quantify the current supply chain lead time (the entire process from manufacturing the product until the product reaches the final customer) of the industry and to simulate the impact of the adoption of ICT tools as a viable way in which to reduce the supply chain lead time. They found that advanced ICT tools have the potential to significantly reduce the lead time of most of the logistical processes while also resulting in substantial improvements in the integration of firms and their suppliers.

The findings of Sarac et al. (2009:26) on the impact of ICT show that RFID technologies may offer several advantages to supply chain management through enhanced traceability, as well as the improved visibility of products and processes all along the supply chains. Other advantages include an increase in the efficiency and speed of processes, improvements in the accuracy of information and a reduction in inventory losses. Wang, Lin and Lin (2007:377) also focused on the way in which RFID can improve the information flow of a construction supply chain. Through the analysis of a dynamic model and the real-

time demonstration of RFID, they concluded that this type of software technology can significantly improve supply chain control and construction project management by improving the efficiency of operations and providing dynamic control.

According to Ustundag and Tanyas (2009), RFID is regarded as a promising technology for the optimisation of supply chain processes. This is as a result of the fact that RFID improves manufacturing and retail operations, including forecasting demand, planning, managing inventory and distribution. A model was developed to measure how the product value, lead time and demand uncertainty may influence the performance of integrated supply chain using RFID in terms of the cost factors at the echelon level. The cost savings arising out of the enhanced performance of the supply chain were analysed using simulation techniques and the expected benefits were calculated taking into account the factors of lost sales, theft, inventory, order and labour costs. The results showed that an increase in product value increases the total supply chain cost savings, while increased demand uncertainty decreases the supply chain cost savings. In addition, it was found that each member of the supply chain did not benefit equally from the RFID integration and that increasing lead time decreases the total supply chain cost savings for the retailer.

According to Frazelle (2002:169), transportation expenses are increasing disproportionately as compared to other logistical costs. This is as a result of smaller, more frequent orders, increasing international trade and global logistics, rising fuel costs, labour shortages, decreased carrier competition as a result of tier mergers and acquisitions, and increased union penetration in the labour market. "Reducing transport costs while maintaining and improving customer service levels and levering private and third-party transportation systems caused the need for some serious technology to be developed in the supply chain" (Frazelle, 2002: 169).

As indicated above, there is a clear move towards improving the supply chain in an organisation. The following include some of the many advantages to using technology in supply chain operations:

- Technology allows for paperless operations. This reduces the cost of paper and printing and ensures that all transactions are properly recorded, archived and reported on (Finn, 2002: 2).
- Technology allows for real-time communications through devices such as the global positioning system (GPS), short message service (SMS), electronic mail as

well as the World Wide Web (www.). This helps organisations to address issues when they occur, and not after they have occurred.

- Technology allows for system-driven activities as opposed to human-driven activities. This results in a decrease in human-error related incidents and better adherence to business rules.
- Technology allows for more accurate and comprehensive data as it enables the more efficient management and utilisation of data through the use of the appropriate systems.
- Technology allows for the support of value-added services.
- Technology allows for greater visibility and control over an organisation as a result of real-time information and user accountability.
- "Some companies are surprised to discover what they overlook due to lack of visibility into their processes. One Pivotal customer found out that the company had shipped a number of orders for which it had not yet invoiced customers, meaning money was being left on the table. The company only realized this after automating its order capture, order processing, and order fulfilment systems" (Pivotal Corporation, 2006:5).
- Technology leads to more efficient operations by reducing costs and allowing for more efficient processes.
- As a result of the ability to provide information in real time, technology allows for improved customer responsiveness.
- Technology allows for enhanced compliance with the organisation's planned trip schedules so as to ensure cost control.

Business management technology gives small and medium enterprises an advantage by automating the flow of information between departments and reducing the mistakes associated with the double entry of information across systems. This, in turn, creates a more efficient supply chain. The main objective in creating an efficient supply chain is to reduce costs while meeting customer requirements and needs is another essential objective of successful supply chain management. Today's customers expect the same level of experience and efficiency, irrespective of whether they are dealing with a small, medium or large organisation. "The Internet has made customers less patient and forgiving about problems with transactions, deliveries, orders and customer service" (Jani, 2006:3). It is, thus, crucial

that small and medium-sized organisations develop a flowing and efficient supply chain in order to provide improved quality and customer responsiveness.

Business management software allows small and medium enterprises to better serve their customers by having instant access to information regarding their order, status of shipping and payment information. Business management software provides small and medium enterprises with real-time information, which reduces response time to customers, and ensures faster order fulfilment and extended service (Jani, 2006:3).

## 2.5. Fleet Management Systems in the Transport Industry

In today's competitive marketplace, it is imperative that businesses operate at peak efficiency, provide timely customer service and still make a profit. Thus, in view of these realities, it is often crucial for business owners to discover those areas in terms of which cost effectiveness may be improved.

Azevedo, Ferreira and LeitÃˇco (2007) support the idea that ICT systems affect competition in the logistics sector in three distinct ways. Firstly, ICT systems may change the structure of the logistics industry, and even modify the rules of competition. This is due to the fact that ICT systems offer new value-added services that previous paper-based administration could not. Moreover, the ICT systems lead to higher efficiency and effectiveness, which affect their competitiveness. Secondly, ICT may be used to create sustainable competitive advantage and provide firms with new competitive instruments. Thirdly, ICT systems do not necessarily need to change existing processes, but rather facilitate their execution within the current business model.

Technology is usually the driving force behind such discoveries. Organisations that manage fleets or a mobile sales force as well as field service organisations are facing many challenges. These challenges include improving compliance and organisational communications, reducing costs, and improving customer satisfaction. As a result, fleet management systems are perceived in terms of how they are able to benefit companies by realising efficiency and profitability. In the knowledge-based economy of today, the rapidly changing and uncertain environment means that transport firms are facing their biggest challenge in how to address the current situation and capture a competitive advantage. The increasing competence in the market is an important factor that drives the adoption of new technologies and innovation, as companies search for new opportunities to cut costs by improving process efficiency or by developing new products (Hidalgo & Lopez, 2009).

Below is a list of some of the past and current organisational issues identified by various researchers and which the use of technology may improve and even solve:

- **Customer satisfaction**. Without the use of technology, the level of customer satisfaction is often extremely low as manual planning systems often fail to meet customer requirements, including delivery windows, timeous delivery, delivering the product in good condition and efficient returns. Melville et al. (2004:283) maintain that the use of ICT brings about customer satisfaction by improving service quality and, thereby, offering new opportunities for companies. Apulu and Latham (2010:23) claim that ICT enables customers to receive immediate feedback and this, in turn, enables companies to react speedily customer demands and to recognise new market niches.
- **Eroding profit margins**. With profit margins becoming smaller, producers are constantly looking for new ways in which to reduce costs in order to increase the overall profit and ensure the continuity of their organisations. Hengst and Sol (2001:3) affirm that ICT enables organisations to decrease costs and increase organisational capabilities and that it assists in the shaping of inter-organisational coordination.
- **High cost of logistics**. Instead of being a support service the logistics department was becoming expensive. In order to reduce this expense, technology was needed. Nixon (2001:62) reinforces the need for improving compliance and organisational communications by suggesting that firms utilise ICT to enhance their service capability within an e-business context.
- **Failure to achieve optimal results**. Organisations have realised that only the streamlining of their business processes and systems would enable them to maximise their profits and sales. According to Mason-Jones and Towill (1999:13) and Sauvage (2003:236), firms improve their operational efficiency through the ongoing implementation of information or automation technologies in accordance with their business characteristics.
- **Existing (old) technology could not support growth**. Although many organisations had been using technology in the past, it became evident that existing technology was not capable of supporting the growth that was both desired and needed. Irvine and Anderson (2008:200) comment that the use of modern ICT not only offers practical benefits for general management, but also

enables companies to overcome the disadvantages of place and space utility in transportation.

- **Improved reporting**. The need for improved reporting arose in order to enable management to understand and respond to what was happening in their organisations. It is essential that organisations be able to manage information effectively. In addition, they need integrate several logistical activities by including inbound and outbound transportation, distribution, warehousing, and fleet management in order to streamline the physical product flows of their customer firms (Lai, Kee-Hung, Ngai & Cheng, 2000:1).
- **Continual investment in computer software and hardware**. It became clear that there was an increase in technology costs, but with fewer benefits accruing from the technology that was being deployed. The investment in state-of-the-art ICT could be the main differentiator between leading edge logistics firms and average firms (Bowersox, Daugherty, Droge, Rogers & Wardlow1989:133).
- **Need for transparency**. The structured framework for alignment which is described by Chaharbaghi, Feurer, Wargin and Weber (2002:219) has been implemented by companies such as Hewlett and Packard in order to increase the level of transparency and to help reduce the redundancies.
- **Inefficient and inaccurate reporting**. The manual systems were extremely complicated and only a handful of selected employees were able to understand fully and utilise the relevant systems placing the organisations vulnerable to manipulation on the part of these employees. According to Evangelista and Sweeney (2006) and Hidalgo and Lopez (2009), ICTs are important for logistics in terms of cost reduction, business control and error reduction for logistics providers.
- **Globalisation**. Globalisation and the development and growth of major organisations called for systems that would be able to handle more complex and larger orders. Thus, the use of ICT could help both in lowering coordination costs and increasing outsourcing in organisations. In their report Ramsey et al. (2003:250) mentioned that, in general, organisations stand to benefit from ICT in areas such as reduced transaction costs. In other words, the use of ICT may assist both individuals and companies to access large markets at a low cost.

- **Competition**. By utilising technology, an organisation may increase its competitiveness through the reduction of its costs and the improvement of its service levels. Several researchers have found that ICT integration enables a firm to improve its supply chain flexibility, resulting in higher levels of agility and ultimately a higher competitive business performance (Mondragon Coronado, Lalwani, Mondragon Coronado & Mondragon Coronado, 2009).

Pokharel (2009) summarises the benefits of ICT systems adoption from the literature. It performs a supportive role for human activities, enhances organisational (or personal) efficiency and effectiveness, helps to execute activities faster, supports autonomous decision-making processes, enables distributive operations, achieves higher logistics efficiency, adds transparency to the stakeholders, leads to the adoption of better business practices to meet the customer service levels, increases organisational capability to respond to a dynamic environment and reduces the cost of operation by as much as 50% over traditional business practices. In this sense, we can look at the benefits of a lower level system in the ICT system hierarchy.

The following section discusses the main characteristics of real-time fleet management systems that are able to cope with information revealed in a dynamic manner and that are also able to manage unexpected events.

## 2.6. Real-time Fleet Management Technologies

Current real-time fleet management systems may be categorised according to the type of real-time information which they process. Available work addresses cases where a new customer request appears and must be fulfilled in a specific time period. The systems that existed in the previous decade were able to cope with new customer requests although they either assumed that travel times were constant throughout the day or they used simple procedures to adjust such travel times, including multiplier factors that were associated with different periods of the day. However, these assumptions were weak approximations of the real-world conditions in which travel times are subject to more subtle variations over time (Goetschalckx, 1988:34; Powel, 1990:28; Savelsbergh, 1991::474; Slater, 2002; Ganz & Ryzin, 1999:675). These variations may result either from predictable events such as congestion during peak hours or from unpredictable events such as accidents, mechanical failures, and so forth. Accordingly, the optimal solution to the formulation of an urban freight

delivery problem that assumes constant travel times may be suboptimal or even infeasible (Ichoua, Gendreau & Potvin, 2003:379).

Kim, Lewis and White (2003) were the first to introduce real-time traffic information into such a system. They examined its value to optimal vehicle routing in a non-stationary, stochastic network by developing a systemic approach for determining driver attendance times, optimal departure times and optimal routing policies under a stochastically changing traffic flow. Ichoua et al. (2003:380) presented a real-time fleet management model based on time-dependent travel speeds. An experimental evaluation of the proposed model was performed in both a static and a dynamic setting, using a parallel tab, search heuristic. The results showed that the time-dependent model provides substantial improvements as compared to a model based on fixed travel times.

Fleischmann, Gnutzmann and Sandvoss, (2004b:420) presented a dynamic routing system that dispatches a fleet of vehicles according to customer orders arriving at random during the planning period. The system disposes of online information of travel times from a traffic management centre. Taniguchi and Shimamoto (2004:235) also presented an intelligent transportation system based on dynamic vehicle routing and scheduling with variable travel times. Results indicated that the total cost decreased by implementing the dynamic vehicle routing and scheduling model. The real-time information was based on variable travel times compared with those of the forecast model (i.e. the latter provides forecast travel times based on historical data).

Finally, Haghani and Jung (2004:2959) suggested a systemic approach to addressing the dynamic vehicle routing problem with time-dependent travel times. They also presented a genetic algorithm with which to solve the problem. The latter is a pick-up or delivery vehicle routing problem with soft time windows in which they consider multiple vehicles with different capacities, real-time service requests and real-time variations in travel times between demand nodes. Dynamic travel times are obtained by on-board terminals. However, recorded vehicle incidences may also include travel time and service time delays and vehicle breakdowns that have not been addressed by any of the systems mentioned above. This research gap emphasised the need for real-time incident handling systems.

The world of fleet management has, in recent years, been revolutionised by the introduction of various tracking technologies. ICTs have become well established in transportation as the pivotal enablers of the integration and alignment of dispersed suppliers,

manufacturers and logistics providers (Manecke & Schoensleben, 2004:213). Coupled with the embeddedness of ICTs, a proliferation of mobile technologies has been witnessed recently, thus adding to the sophistication of the technology solutions available to complex supply chains.

### *2.6.1. Mobile Emerging Technologies*

Mobile technologies such as global positioning systems (GPS), general packet radio service (GPRS) and geography information systems (GIS), coupled with advanced Internet solutions, provide both transparency and more specific information to supply chain collaborators in terms of the instant localisation and traceability of shipments and also delivery status. Tsai (2006:526), Durr and Giannopoulos (2003:175) and Skinner, Bryant and Richey (2008) have all concluded that tracking physical goods in real time greatly improves logistical performance, cost efficiency and customer satisfaction.

GPS are space-based, radio positioning systems that provide 24-hour three-dimensional position, velocity and time information to suitably equipped users anywhere on the surface of the earth (Malladi & Agrawal, 2002:10). The impact of these mobile technologies is all the more marked on contemporary, sophisticated logistics which include multi-tiered suppliers and manufacturers that are globally dispersed. It is, thus, apparent that, with the increase in global integration and complex business networks, it imperative to develop network options beyond the boundaries of internal logistics. This brings with it both new opportunities and also the risks inherent in implementing new logistics. According to Turner (1996:51), other emerging techniques include the following:

**Automatic Vehicle Identification (AVI)**

Automatic vehicle identification (AVI) is a technology that has emerged recently in various traffic management and toll collection applications. An AVI system consists of an in-vehicle transponder (tag), a roadside reading unit and a central computer system (Boyce, Hicks & Sen, 1991). When a vehicle containing a transponder passes a roadside reader unit, the information on the transponder is transferred to the reader unit. The transferable information may range from a simple vehicle identification number to toll account balances or trip information. For the purposes of computing travel times, the central computer monitors several consecutive reader units and matches them to the transponder identification numbers created in the central computer system (Hallenbeck, Boyle & Ring, 1992:273).

**Automatic Vehicle Location (AVL)**

Automatic vehicle location (AVL) is another technology that is found in several applications in transportation management. AVL permits the location of a vehicle to be known automatically. This is made possible by the use of transmitters that are carried in a vehicle (on-board telematic devices). The transmitters enable the location of a vehicle to be determined at frequent intervals, if not continuously. The location of each vehicle is projected onto a vector map. Travel times can be calculated by using data such as a vehicle's mean velocity and variance in real-time mode (Perkinson, 1994:35). AVL systems have become common in freight fleets, as well as in emergency and rescue vehicles. There are several different technologies (ground based and satellite) that can be categorised as AVL. GPS is the most common satellite technology utilising orbiting satellites for continuous location determination.

**Electronic Distance Measuring Instruments**

The integration of an electronic distance measuring instrument (DMI) with the floating car technique provides an easier and safer way in which to collect detailed travel time information. The sensor of the electronic DMI is attached to the test vehicle's transmission with the DMI being able to provide instantaneous speeds up to every 0.5 seconds (Thurgood, 1994). This detailed travel time information can be automatically downloaded to a portable computer in an easy-to-use data format. An electronic DMI coupled with a portable computer enables travel time runs to be performed with a driver only. This technique provides detailed travel time and delay information that is particularly valuable for the purposes of bottleneck identification and intersection evaluation.

**Licence Plate Matching (Via Portable Computer or Video)**

Licence plate matching was used as early as the 1950s for the purposes of travel time studies, but it has been used more commonly for tracking or identifying vehicles in origin-destination surveys (Turner, 1996:51). Early methods relied on observers to note both the licence plates of passing vehicles and the corresponding times on either paper or into a tape recorder. Licence plates were manually matched later in the office, and travel times computed. However, recent advances have greatly improved the ease and accuracy of this technique (Liu, 1994) and portable computers can now be used to record and match licence plates, significantly decreasing the data reduction time. Video cameras are also used to record licence plates with image processing and computer algorithms being used for the automatic reading of the licence plates.

**Cellular Phone Tracking**

The increasing popularity of cellular phones has enabled their widespread utilisation for the purposes of traffic monitoring and travel time prediction (Robinson, Ewald, Gravely & Carter, 1993). In some areas there are dedicated numbers for cellular phone users to report either emergencies or accidents. Cellular phones can also be used by motorists to report their positions at designated checkpoints, thus allowing a traffic operations centre to estimate travel times based on several cellular phone reports (Leveine, McCasland & Smalley, 1993:26). According to Mondragon et al., (2009:229), mobile systems for vehicle tracking, also known as telematics, constitutes an industry in the United States of America that will be worth US$41 billion by the end of the first decade of the 21st century (Bisdikian et al., 2002:15).

The objective of this research is to align operational and mobile information system models in a manner that will meet the demands of transport companies. Road transport logistics is the primary transport mode in Europe with a market share of 45% of the total freight transport. In addition, road transport logistics exceeds other modes such as sea (41%), rail (8%), inland waterways (4%) and pipeline (3%) (Mondragon et al., 2009:229; Brown et al., 2006:353). The implementation of GPS fleet management system incorporates several value-added processes including delivery controls such as updated, estimated time of arrival (ETA) and the issue of late running; statistical reporting such as vehicle and job histories; digital imaging for damaged goods; vehicle defect reporting; driver time reporting; and highways agency data/warnings.

McKinnon and Ge (2004:219) conducted the 2002 transport KPI survey into the United Kingdom food supply chain, and deduced that about 29% of the 15,600 journey legs monitored suffered delays averaging approximately 45 minutes, while, under one-third of these delays only had been caused by traffic congestion on the road network. Most of the delays had occurred at distribution centres (DCs), reception bays of factories, and shops. This finding indicated that “backdoor congestion” increases the average length and variability of both loading and off-loading times (McKinnon, 2006). In an effort to overcome the challenges posed by unreliable delivery schedules, ICT and vehicle tracking systems are ensuring the increased optimisation and competitiveness of transport operations in the market. Mobile tracking systems are able to provide both shippers and carriers with greater confidence in delivery schedules, thus helping to overcome one of the traditional obstacles to backloading (Department for Transport, 2003).

Advances in IT enable vehicle schedules and routes to be re-planned in real time while the vehicle in question is on the road. Operators are then able to exploit both backloading and the load consolidation opportunities that arise at short notice (Waters, Richmond, Parkes & Wright, 2006). The GPS devices used in logistics to track shipments and storage of products are one example of vehicle tracking technologies (Mintsis, Basbas, Papaioannou, Taxiltaris & Tziavos, 2004:399; Devlin, Mcdonnell & Ward, 2007:273). Currently, the commercial use of the GPS tends to involve combining the GPS system with geographic information systems (GIS) in order to locate an object on a graphical map or a more meaningful location name (e.g. an address). Vehicle tracking is now used in more than a quarter of the vehicle fleets in the United Kingdom. Adoption of vehicle tracking is at its highest in both commercial vehicle fleets (30%) and large fleet operators with more than 100 vehicles (31%). An interesting phenomenon is the fact that uptake is particularly high in the utilities (86%), logistics and road transport (40%) and service management (38%) according to survey conducted by telematics and tracking specialist Digicore (m.logistics, 2008:34).

A recent survey of the users of tracking systems, published in m.logistics (2008:34), reported benefits such as increased productivity, reduced costs and enhanced fleet performance. Other benefits mentioned include reductions in overtime claims, insurance premiums, fuel usage, communications costs and administration (m.logistics, 2008:34). Transport practices are influenced by the regulatory and global economic environments, company infrastructure available and competition with other supply chains (Srivastava, 2006:3). The sharing of information such as container location through real-time vehicle tracking has enabled the haulier company as well as the shipping lines to identify job status quickly as well as establish appropriate control measures to overcome the uncertainty of the last mile. Increasing delivery visibility and reducing delays and errors helps the organisations along a particular supply chain to share the same objective which was identified by Waters et al. (2006) as satisfied end-customers. Meanwhile, in addition to the direct operational benefits of “quicker response” integration between the carriers and the haulier company, the Internet-based container tracking system could generate considerable macro opportunities as a result of improved physical flows and trade security.

### *2.6.2. How GPS Fleet Management Systems Work*

Effective management may be a daunting task, especially for those businesses that deal with employees or assets in transit. Fleet management uses GPS technology to track vehicles, employees and assets effectively. In addition, the use of GPS tracking brings with it

several benefits for traffic planning. For example, vehicles equipped with a GPS device may provide speed data to the Traffic Management Centre which, in turn, disseminates congestion information and forecasts to wireless information service providers (Thill, 2000:3). GPSs were originally designed for military use and arose from the need for submarines to locate their position accurately before launching missiles (Egbert & King, 2003). All GPS receivers make use of orbiting satellites to determine their location. As the technology has advanced, there has been an upsurge in the use of GPS. Handheld GPS units may be used for outdoor sports such as hiking, boating, fishing and navigating at sea. For instance, a GPS receiver can be used to guide the user on his/her current position when lost and then to help the user to navigate his/her way out of woods or at sea. A GPS receiver can also be used to measure the distance of a ball from the hole for golfers and to assist cyclists in keeping to the correct path.

The GPRS-based GPS-GSM vehicle tracking system communicates between the hardware and software through the GSM modem via the Internet to a server, which can be accessed by a local computer on which the software has been installed. While there many GPS applications the most common GPS application is vehicle navigation where most vehicles are installed with a GPS receiver with a monitor to indicate to the user the shortest route to the user's destination by road. Currently, cellular phones are equipped with an integrated GPS receiver. In addition, a GPS may be used as an emergency locator and security feature to track vehicle locations. The GPS is one way in which satellites have become part of everyday life (Egbert & King, 2003:68).

There are three main segments in a GPS, namely; space, control and user (Wells, 1987).

- **Space segment**. There are 24 GPS satellites which orbit the earth. The nominal orbit height is approximately 20,200 kilometres covered in a 24 hour operation. Each GPS satellite transmits a signal to the GPS receiver on the ground. The GPS receiver then calculates the distance to the satellites. Eventually, information such as the coordination of current location, time and speed can be retrieved from the receiver (Ahmed El-Rabbany, 2006:3).

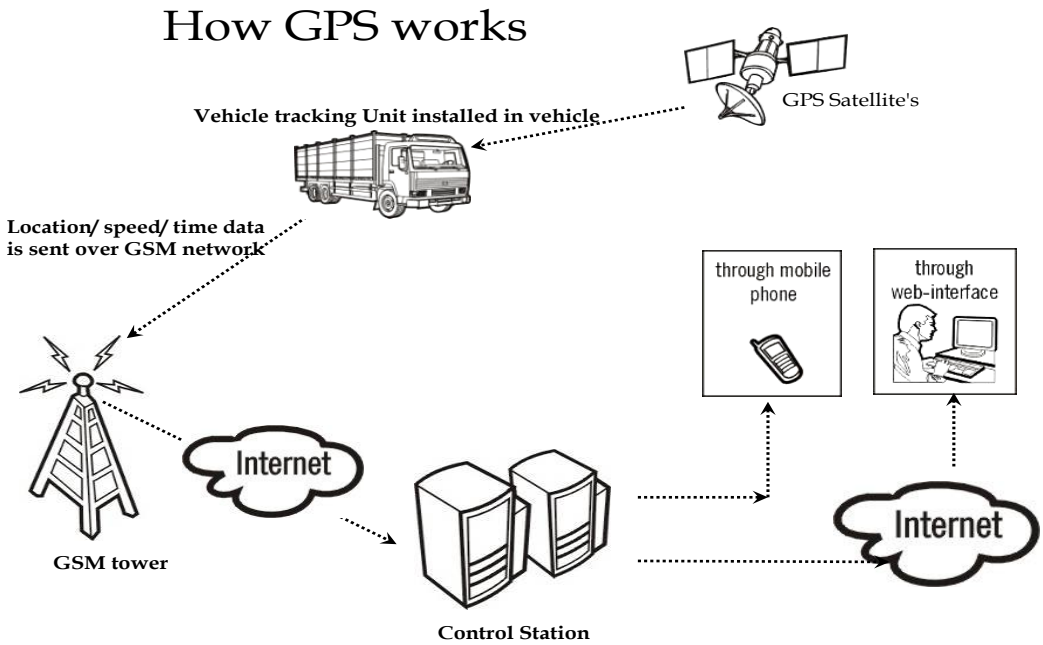



Figure 2.1: A typical GPS fleet management system architecture

- **Control segment**. The control segment comprises a master control station which has five ground stations located around the world to ensure that the satellites are functioning properly. The main control station (MCS) is located in the United States. GPS satellites use the ground stations to determine, among other things, the location of the satellites and the status of atomic clocks (Langley, 1991:38).
- **User segment**. The user segment comprises GPS receivers that are designed to decode the signals from the satellites in order to determine the position, velocity and time of the receiver. There are two types of service available to GPS users, namely, the civilian (SPS) and the military (PPS). GPS is free to all users all over the world (Ahmed El-Rabbany, 2006:3).

### *2.6.3. Global Positioning Systems and Telematics*

The basis of the GPS is a constellation of satellites that are constantly orbiting the earth. These satellites, which are equipped with atomic clocks, transmit radio signals that indicate the exact location of the satellites, the time and other information. The radio signals from the satellites, which are monitored and corrected by control stations, are picked up by the GPS receiver.

*2.6.4. The Main Characteristics of Fleet Management Systems*

Fleet management systems enable the real-time monitoring of various parameters, such as vehicle location and velocity and field data (e.g. load temperature), in order to detect bottlenecks in delivery execution and minimise operational costs. These systems comprise specialised software packages that are aimed specifically at fleet operations (Laporte & Crainic, 2000). The architecture of such a system is depicted in figure 2.2 and comprises three main components:

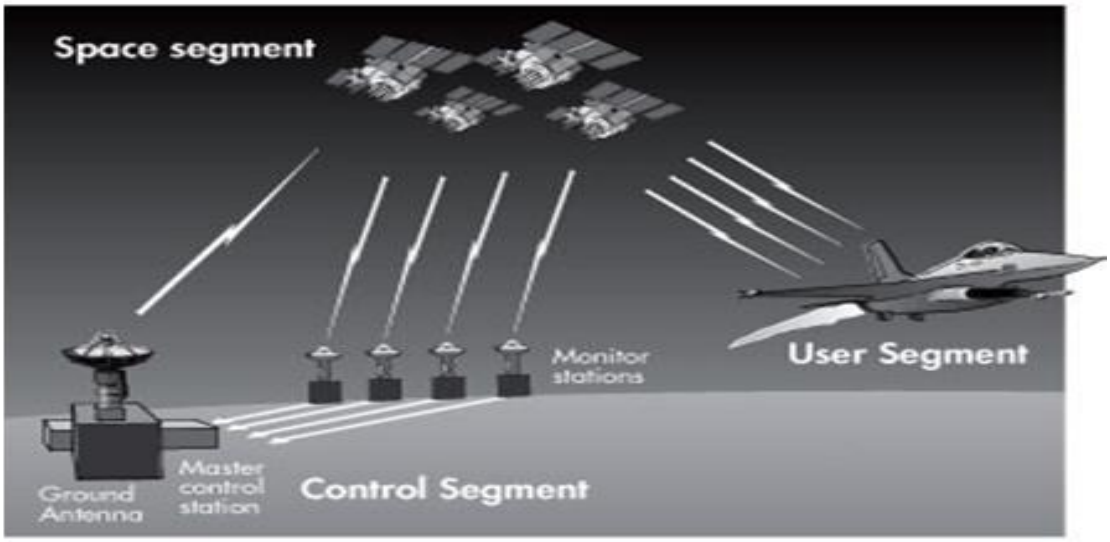



Figure 2.2: The three components of the elements of GPS
Source: Illustration from The Aerospace Corporation

**On-board Telematic Equipment**

This consists of a set of microelectronic devices that are responsible for processing all the data received either by the positioning satellites or by the on-board sensors and then transmitting the data through a mobile network at the control centre.

**Control Centre**

The control centre consists of an application that manages all the data which is transmitted by the on-board equipment. The route planner is able to know, in real-time, the position of each vehicle and collect all necessary information concerning the execution of each delivery schedule.

**Mobile and Satellite Communication Systems**

Communications consist of two parts. Firstly, the mobile access terrestrial network (e.g. GSM), which is responsible for the wireless interconnection of the control centre with the on-board devices, and secondly, the positioning system (e.g. GPS), which is responsible

for vehicle tracking. Today, GPS-based navigation systems may be found in motor vehicles, farming and mining equipment, and in a variety of other land-based vehicles (golf carts and mobile robots) (Abbott, Powell, Signal & Redmond, 1999:145). In view of the fact that GPS is available globally and is free of charge (Zeimpekis & Giaglis, 2006:367), it would appear that GPS provides the best vehicle navigation system and, thus, GPS frequently comprises part of the existing vehicle infrastructure for many firms (Zeimpekis & Giaglis, 2006:367). For this reason, GPS represents a broader use of IT in the transport industry (See, 2007:876). GPS is a satellite-based navigation and time transfer system which was developed by the United States Department of Defense. It serves marine, airborne, and terrestrial users, both military and civilian. Specifically, GPS includes the standard positioning service (SPS), which provides civilian users with 100 metre accuracy, and the precise positioning service (PPS), which provides military users with 20 metre accuracy. Both of these services are available worldwide with no requirements for a local reference station.

In contrast, the differential operation of GPS makes available two to ten metre accuracy to users within 1000 kilometres of a fixed GPS reference receiver (Enge, 1994:83). GPS is essentially a passive mechanism in that it does not involve any intrinsic disclosure by the GPS receiver to any other device. However, it can be combined with transmitters and transponders to produce devices that disclose location to another party (Clarke, 2001:206). Primarily designed as a land, marine and aviation navigation system, GPS applications have expanded to include surveying, space navigation, automatic vehicle monitoring, emergency services dispatching, mapping, and geographic information system geo-referencing (Dana, 1997:9). In view of the fact that the dissemination of precise time, time interval and frequency standard are integral aspects of the GPS, a wide community of users has come to depend on the GPS as a primary source of control (Dana, 1997:9).

Mobile geographic information systems which integrate the GPS with hand-held computers and special software make appropriate information available to the personnel working with them (Connolly, 2007). For example, fire-fighters are able to use these systems to locate the nearest fire hydrant while game park rangers may access the appropriate map and record changes in the natural habitat whilst they are in the field (Connolly, 2007). In addition, the GPS equipment is able to capture data that it would not be possible to obtain using traditional methods, such as travel speed and the specific routes or paths taken by a driver. This information is necessary to enable transportation planners to analyse GPS-recorded travel (Murakami & Wagner, 1999:149).

### *2.6.5. Types of GPS Navigation Systems*

There are different types of GPS systems categorised on the basis of their use. According Mohinder, Grewal, Angus and Bartone (2013), modern technology has improved the way we navigate, from the traditional compass and maps to the modern global positioning satellite, or GPS, systems. With GPS, travellers do not have to depend on stars, landmarks or even constellations. GPS systems use satellites that can send out signals back to earth.

Mohinder et al. (2013) state that the atomic clock in the satellite sends information about your current location and time to your GPS system. This information assists the GPS in pinpointing your location on the map. The basic GPS system has the essential functions of a GPS without a lot of features. The system can report the location in terms of the latitude and longitude laid out in a high-quality map that details highways, landmarks and streets. This type of GPS is ideal for those who have a low budget but need the basic functionalities of a GPS.

According to Admiral (2013:1) there are three types of car navigation systems. These systems consist of navigation techniques that are designed to stand alone, handheld techniques which suit multiple reasons, and systems that are designed in order to use laptops, PCs, pocket PCs, and also PDA systems. Each of the types of auto navigation systems and devices provides different benefits and drawbacks. The stand-alone techniques tend to be often the most well-known choice and offer a steady power supply and turn-by-turn direction (Admiral (2013:2).

There are several ways in which users may use GPS navigation systems. For example, handwriting devices, voice recognition devices, and GPS systems enable users (especially the disabled and the elderly) to input their location parameters in a convenient way in different situations. In addition, with the help of eye-tracking devices, such systems may also be of benefit to those individuals with disabilities since they help to automatically choose a target device from a device set (Admiral, 2013:2).

Three types of GPS antenna are used in transportation navigation systems. GPS receivers also offer a fast and convenient method for obtaining position information that may be collected in real time. GPS technologies enable transportation engineers to collect data on, inter alia, vehicle trajectory, travel time and travel speed (Mohinder et al., 2013). These GPS systems are as follows:

**Passive System**

Passive systems, either wireless or module, are the easiest and most economical way in which to manage information. In the main, no communication service contract is required. This system is also known as a "stored data" system. A more recent development is a wireless transmitter that automatically downloads GPS information to the office computer. However, one drawback is the fact that passive systems are not able to track a driver's progress as this happens in "real" time or "near real" time (Arunkumar & Sivanandam, 2007:116).

**Active (real-time) System**

An active (real-time) system requires a GPS-mounted wireless receiver that automatically downloads information. These systems are Internet-based systems with real-time components that are able either to transmit data on demand or conduct polling at various intervals, that is, every 2, 5, 10 or 15 minutes. In addition, the system may require more staff and Internet storage data may be both limited and short-term. This makes it difficult to perform trend analysis over long periods of time. (Arunkumar & Sivanandam, 2007:112).

**Hybrid System**

The hybrid system combines features of both the passive and the active systems. It provides real-time vehicle data, as well as comprehensive information storage. Hybrid systems provide the most adaptability to business needs. However, one drawback is the facts that hybrids, like the active systems, require an Internet connection and would probably also require a dedicated computer. Connectivity and transmission charges would apply when using hybrid system (Arunkumar and Sivanandam , 2007:116).

## 2.7. Challenges when Choosing and Implementing Technology

Accordingly, the GPS is becoming the most popular (Zeimpekis & Giaglis, 2006:367) and the most widely used information system in logistics, especially in the transport industry. In order to understand fully and be able to perform an effective implementation of a specific technology, a thorough understanding of the current business processes and the impact that these kinds of tools will have on these processes after implementation is required. The need for different implementation approaches, mainly because the factors of alignment between technology and business processes vary from company to company and between different solutions (Ruppel, 2004:311).

### *2.7.1. Choosing Technology to Support Business Continuity*

Technology will help improve an organisation's operations only if it is supported by all the relevant managers and users. This is as a result of the fact that technology is useful only when the correct information is fed into the system in a timely and accurate manner. Without a flow of correct information, it becomes difficult to monitor the supply chain activities. The bidirectional flow of information is imperative for the success of supply chain strategies. "There is no advantage in being choosy while exchanging information. The ability to share information by itself is a competitive differentiator" (Ram, 2006:2). It is essential that organisations fully understand the value of having and sharing information which technology will make possible before there are any improvements.

According to the Hitachi Data Systems, (2006), choosing either one technology or a combination of technologies to support business continuity starts with an assessment of the potential risks facing an organisation. An operational risk management approach will clarify business requirements and also reduce uncertainty by estimating the likelihood of potential loss that could occur either if the wrong technology is implemented, or if the correct technology is not implemented correctly and efficiently. By performing an operational risk analysis for each business-critical application, an organisation will be able to determine the extent of vulnerability and the impact on business downtime that may come with the new technology. This information will ensure that the technologies that are accessed will achieve the optimal balance of recovery speed, data value and cost. The following are a number of suggestions from the Aberdeen Group (2006) to ensure the smooth implementation of the desired technology:

- Start early; get ahead of your competitors.
- Understand your objectives.
- Pick the right partners and do not "self-integrate" unless you happen to be a data integration specialist.
- Your information architecture will either make or break the long-term return on investment (ROI).
- Run a pilot test. It is easy to miscalculate during the design process or underestimate the costs. A validation exercise greatly reduces the time to ROI.
- Test "what-ifs?"
- Look beyond compliance.

According to the Pivotal Corporation (2006:5), the use of technology enables organisations to keep a continuous record of the start and end dates of haulage contracts, as well as of income. Using this information, a system may automatically create a new alert for the organisation a few months before a contract ends, and assign the contract to the relevant personnel for follow-up and renegotiation, if needed. Gonzalez (2006:9) postulates that technology often means that fewer resources will be required or existing resources may be assigned to more value-added activities through the automation of many of the processes currently performed via telephone or fax, including such activities as order status confirmation, obtaining quotations for shipments and appointment booking. Utilising technology also enables better planning at the receiving warehouse and this, in turn, minimises the number of resources required to process deliveries.

The poor visibility of the status of orders and shipments creates uncertainty which organizations typically offset by carrying safety stock. Knowing exactly when an order will arrive enables an organisation to plan and respond to changes in a more efficient way. It also allows the organisation to shrink safety stock, thus reducing the amount of warehousing space needed (Gonzalez, 2006:8). Speed is yet another benefit of utilising technology as technology may reduce the time it takes from when a product or service is sold to the receipt of the revenue for the product or service. It is essential that today's organisations tighten their budgets to enable them to compete in a constantly evolving business environment. Reducing the time it takes to translate a customer order into money in the bank offers strategic benefits to organisations and results in more rewarding customer service.

The use of a manual process to coordinate the "order to cash" operation creates the potential for costly errors. In addition, manual processes are labour intensive and time consuming, and they require valuable resources to manage each part of the manual process (Esker Document Delivery, 2006:3).

### *2.7.2. Organisational Impact of a Real-time It-logistics Solution*

The implementation of a real-time, IT logistics solution may impact positively on a business in several ways. Boughton and Kehoe (2001:516) cite lower inventory levels as one such benefit, while Vollmann, Berry, Whybark and Jacobs (2005:532) claim that the system increases the effectiveness of the warehousing activities and provides the opportunity to reduce the amount of goods in stock. Vollmann et al. (2005:532) further claim that implementing a real-time system may reduce the need for ordering and forecasting. Another

effect of a real-time system is the optimisation of the flow of information between different actors (Moberg, Cutler, Gross & Speh, 2002:755), while Boughton and Kehoe (2001) claim that customer service level will increase and a stronger collaboration of business partners will be made possible. These positive effects all lead to both reduced costs in the long run and a stronger integration between the business partners.

Gustafsson and Norrman (2001:6) share this point of view, citing improved service levels as well as reduced administration and inventory carrying costs as the major effects of the implementation of a real-time system. The rapid development of information technology has meant that the information flow within the supply chain has become more important than ever before (Paulsson, Nilsson & Tryggestad, 2000:575). ICT has become a vital component in supply chain management with the development of IT creating many new opportunities for managing the supply chain (Paulsson et al., 2000:575). Vollmann et al. (2005:575) concur with Paulsson et al. (2000:575) and indicate systems that are able to improve the integration between business processes and the supply chain. The current methods in use for business modelling focus on the internal integration of autonomous firms with little focus on the overall business to business (B2B) integration (Li, Kumar & Lim, 2002:551).

Accordingly, Li et al. (2002:551) propose a coordinated supply chain modelling approach, which describes the coordination structure, interdependency, process and information flow, as the basis for Internet-based supply chain integration. The proposed model should be perceived from four dimensions with a modelling technique constituting each one of these four dimensions. A scenario model describes the total supply chain structure as a network of related companies with product and service flows. This network should be linked by Internet based technologies and applications. The interdependency model describes the relationships between the actors in the network while the process model provides a view of all the activities that manage the interdependencies and realise the products required by the customer. Finally, the information model is generated based on the process requirement. The models are related but describe various aspects that should be considered.

### *2.7.3. Consequences of Implementing Technology in Transport Logistics*

According to Howell and Wei (2010), as the utilisation and commercialisation of IT becomes more widespread throughout the world, the adoption of novel information technology can generate new business opportunities and various benefits. The business

environment today has been undergoing unprecedented change and many companies are seeking new ways to stand out from the competition by sustaining their competitive advantage. In today's highly competitive global marketplace, the pressure on organisations to find new ways of creating and delivering value to customers is growing stronger (Benitez, Llorens, Montes & Perez, 2010; Liang, You & Liu 2010).

The concept of IT implementation success raises the three following issues. First, in the cycle of IT innovation diffusion, adoption, implementation and post-implementation are three discrete phases. The adoption phase addresses the decision-making process of whether to adopt IT, the implementation phase includes the physical deployment of IT tools in business, and the post-implementation phase deals with further technology adoption and sophistication. ICT is today being applied in many organisations in a wide range of operational areas. According to Somuyiwa and Oyesiku (2010), it has provided new ways to store, process, distribute and exchange information both within companies and with customers and suppliers in the supply chain. This leads to increasing interaction between marketing and logistics, where logistics is considered a platform for supporting new strategic moves on the market. As an increasing number of firms are under pressure from their partners to change both their traditional styles of operation and organisation to replacing them with integrated systems that help increase the speed and fluidity of physical and information flows, reaching this kind of integration therefore requires investing in new information and communication technology (ICT). According to Somuyiwa and Adewoye (2010:181), with the advancement of ICT, many companies have adopted the use of the technologies to improve the efficiency and effectiveness of their activities.

The term IT-enabled business value, which has also been interpreted as IT effectiveness, is generally used to refer to the organisational performance effects of IT in terms of firm innovativeness, productivity/efficiency improvement, customer service enhancement, cost reduction and improved information sharing efficiency. According to Somuyiwa and Adewoye (2010:41), ICT is fast becoming one of the main drivers of change, posing new strategic challenges. The business environment today has been undergoing unprecedented change and many companies are seeking new ways to stand out from the competition by sustaining their competitive advantage. In today's highly competitive global marketplace, the pressure on organisations to find new ways to creating and delivering value to customers is growing stronger.

### *2.7.4. Critical Success Factors*

Chaharbaghi et al. (2002:219) argue for the alignment of strategy, people, processes and information technology, especially in fleet management systems. Any potential change needs to be assessed by first examining the strategic goals of the organisation in question and then linking these strategic goals to the change objectives. These change objectives should, in turn, be evaluated in terms of impact. The most critical changes should be selected (usually two to five) and form the basis of the critical success factors (CSFs), while all the CSFs selected must be capable of bringing about the desired change (Chaharbaghi et al., 2002:219). In addition, potential obstacles that may interfere with the CSFs must be identified. The next step will involve formulating the key processes that are essential in realising the change objectives. The information requirements of the business must be modelled and the interaction between business activities and information defined. The process/information view constitutes the basis of selecting the most appropriate, enabling technology.

When a certain process is configured, it is necessary to evaluate the impact of potential changes. If a process spans several business units with conflicting goals, it is necessary to decide on a compromise. Processes should be developed with the focus on changes that will make a clear difference in the eyes of the customers. The structured framework for alignment, which was described by Chaharbaghi et al. (2002:219), was implemented by companies such as Hewlett Packard in order both to enhance the level of transparency and to help reduce the redundancies. Flexibility should be a cornerstone when the current way of working is changed. Flexibility allows for rapid implementations when the competitive environment changes and new technology emerges (Chaharbaghi et al., 2002:219). However, the process of adopting ICT adoption may be problematic for organisations because of its requirements. Any ICT implementation is usually associated with significant investment and firms may not have sufficient financial resources to enable the high investment in hardware and software technology that is required (Lai et al., 2005:1). Another factor that may impede any ICT implementation may be that the organisation concerned lacks the necessary expertise and technical support required for the ICT implementation (Yeung, Shim & Lai, 2003:226).

## 2.8. Benefits of Implementing a GPS Fleet Management System

It is to be expected that the successful implementation of ICT to support the logistical processes will bring a number of benefits to organisations (Lai et al., 2000). According to

Gutiérrez and Durán (1997:73), Hammant (1995:32) and Piplani, et al. (2004:27), these benefits may include a reduction in the errors made in data entry and also improvements in customer services. They point out that the use of ICT makes it possible for organisations to monitor their inventories, improve the utilisation of their transportation and warehouse assets and eliminate the duplication of effort in the carrying out of their various logistical activities. Many logistics managers consider ICT to be a major reason for the improved productivity and competitiveness of their firms, while also regarding ICT as a key component in their logistics systems (Dawe, 1994:229).

Closs and Xu (2000:869) showed that ICT capabilities significantly influence the overall competence of transport logistics. According to the experts, there is no single factor that has greater potential to improve logistical operations than information communication technologies. In fact, ICT not only improves the effectiveness and efficiency of the logistical processes but the successful implementation of ICT may have a significant impact on logistical strategies and on organisational structure (Bowersox & Daugherty, 1995:65). In addition, a GPS improves service planning and contributes to increased productivity as a result of better safety management decisions (Sanders, 2007:1332). Thus, the GPS is becoming not only the preferred (Zeimpekis & Giaglis, 2006:367), but also the most widely used information system in logistics, especially in the transport industry (Abbott, Powell, Signal & Redmond, 1999:145-162).

Firms that leverage ICT in their transportation process by using GPS fleet management systems should gain many advantages, including an improvement in both the quality of their information and their process efficiency. However, the quickest return on this type of investment centres on reducing the labour and fuel costs which are considered to be two of the biggest expenses in the energy service business. Other advantages include greater employee accountability on a daily basis, fuel savings of 10 to 15%; savings on labour costs in the form of less overtime; a significant drop in vehicle maintenance costs; better employee safety and enhanced monitoring and correction of poor vehicle speeds and driving habits (Nietermayer, 2010:1). Various direct benefits to transport operations and logistics service providers and which may arise from the successful implementation of a GPS fleet management system in, and as cited by researchers, are discussed below:

### *2.8.1. Reduction in Accident Rate and Improvement in Incidence of Safe Driving*

Transportation companies have found that installing GPS vehicle tracking in their fleet vehicles is a sure way in which to improve safety. GPS tracking offers a wide variety of features and benefits that businesses with vehicle fleets can utilise to significantly improve their safety records and protect their businesses from undue costs. For example, by improving the safety of drivers and vehicles, businesses are able to significantly reduce the costs involved in accidents and traffic violations. The total cost of vehicle accidents include a variety of factors, including: lost time, lost revenue, failure to fill orders or meet deadlines, time spent on accident investigations and management reports and the possibility of increased insurance premiums. By focusing on safety, a business may decrease its insurance costs as an outstanding safety record lowers the risk to insurance providers and this may result in lower premiums.

In addition, many insurance companies offer rate reductions for additional safety equipment, including GPS tracking devices (Thomas, 2010:1). GPS recorders act like the black box in an aircraft in the event of an accident, noting the direction and speed of the vehicle at the point at which the accident occurred. In a world in which liability after accidents is becoming increasingly important, this kind of information is vitally important. In addition, when drivers are aware that they are being monitored, they tend to drive in a safer and more considerate manner that reduces the chances of an accident and this can play an active role in reducing insurance premiums (King, 2011:1).

### *2.8.2. Increase in Fleet Availability and Staff Productivity*

GPS fleet management tools aid in the completion of administrative tasks and, as a result, fewer man hours are spent on tasks such as compiling fuel sheets and therefore improving the profitability of the business. One of the major benefits of these types of system is that they enable a manager to have a complete understanding of the exact location of every single vehicle and this then facilitates personnel management, as any workers who are either driving in a dangerous way or are using a company vehicle for unauthorised purposes may be dealt with quickly and effectively. In addition, by having information on the driving habits of workers, it is possible to advise drivers on how to drive in a more fuel efficient manner, for instance, by reducing speeding and idling time (King, 2011:1). Fleet managers and business owners are able to determine the speeds at which drivers are travelling, fuel costs and the use of any fleet vehicle during working hours and after working hours. GPS fleet tracking may be regarded as a “virtual time-card” for employees as it indicates exact start/end times as well as

actual working hours and overtime hours. In addition, GPS improves service planning and results in increased productivity as a result of more effective management decisions (Sanders, 2007:1332).

### *2.8.3. Fuel Savings and Other Environmental Factors*

Tracking devices installed in the vehicles enable companies to monitor the actual fuel consumption against what is being reported by the employees. Companies will also be able to avoid additional fuel costs by quickly setting up drivers' routes in advance. This includes the ability to print turn by turn directions. According to a research study conducted by the Aberdeen Group, leading organisations are turning to GPS enabled service workforce and fleet management solutions to drive efficiencies into their service organisations in an effort to maintain customer satisfaction levels and manage resource utilisation levels while controlling service-related costs (Marketwire, 2009:1). The findings on "Driving Utilisation with Location Intelligence" indicated that respondent firms had achieved the following average improvements in key service performance indicators since the adoption of GPS enabled solutions:

- a 25% reduction in idle times
- a 32%increase in fleet utilisation
- a 22% decrease in fuel costs and a 31% drop in daily mileage
- a 23% boost in workforce productivity.

The reduction in idling time not only reduces fuel costs but also cuts down on repair and maintenance expenses. Diesel engines burn over a gallon of diesel an hour; in addition, it is not advisable that the newer diesel truck engines idle for extended periods of time as a result of their complicated exhaust regeneration systems. By addressing and controlling engine idling time, companies may be able to stay ahead of government regulations (Nietermayer, 2010:2).

### *2.8.4. Reduction in Overall Transport Operational Costs*

Most GPS fleet systems include maintenance management to track the point at which the vehicles reach the manufacturer-suggested mileage points. The GPS fleet tracking systems can also be used in the management of the maintenance schedule. Since fleet managers are able to prevent a problem from developing, this may result in significant savings. Hengst and Sol (2001:3) affirm that ICT enables organisations to decrease costs,

increase organisational capabilities and assist in shaping inter-organisational coordination. Some GPS fleet management systems even have the option of providing management with details of the relevant maintenance dates of vehicles, ensuring that routine services and oil changes are never missed. The result is a better maintained and, hence, more fuel-efficient fleet. It is possible to connect many of the most advanced systems to the vehicle's engine management system and, thus, if any problem does occur while in transit, headquarters are notified immediately, reducing the chance of further damage being done to the vehicle (King, 2011). A recent survey of the users of tracking systems published in m.logistics ( 2008:34) reported benefits such as increased productivity; reduced costs and enhanced fleet performance.

### *2.8.5. Improve Accountability and Information Flow*

The use of GPS fleet management tools enables transport firms to reduce the costs of communication and also enhance the information quality through the ability to share information (Cantor & Macdonald, 2008). Other benefits include reductions in overtime claims, insurance premiums, fuel usage, communications costs and administration (m.logistics, 2008:34). Employees may inflate their number of working hours or overtime hours while customers sometime complain that they are being overcharged transport costs. With a GPS fleet management system, the company is able to verify durations and working hours and this, in turn, may reduce labour costs and increase customer satisfaction (Nietermayer, 2010:2).

### *2.8.6. Improved Recovery of Stolen Motor Vehicles*

Online GPS technology enables real-time tracking and, if a vehicle is stolen, it is almost guaranteed that it will be recovered. GPS systems also have alerts that can be set for each vehicle in the fleet. Examples of such alerts include hours of normal operation, off hours and out-of-zone alerts. If a vehicle is stolen, any user can be notified and visual tracking can begin. This technology has a "ping" feature that enables a viewer to "ping" the vehicle and receive location updates within 45 seconds or less. A user is able to view the screen, ping the vehicle and inform the police where the vehicle is located (Nietermayer, 2010:2) while the improved efficiency of traffic data collection and storage results in enhanced security and the increased safety of the operators as a result of the use of the GPS tracking system (Li & Qin Zhu, 2003:6).

### *2.8.7. Increased Customer Satisfaction*

Today, more businesses are relying heavily on transportation as part of their vital business operations. All businesses that use vehicles are aware of the demands of their customers and, thus, it is essential that find ways in which to gain a competitive edge by providing superior customer service. For a business that manages a fleet of vehicles, a GPS vehicle tracking system will not only improve productivity and reduce operational costs, but it will also increase the profitability of the business by enabling the business to offer better customer service. Alam and Noor (2009:112) argue that ICT offers transport enterprises the opportunity to compete on a global scale with improved efficiency and closer customer and supplier relationships. Accordingly, ICT should be regarded by businesses as an essential strategy if they are to stay competitive. Similarly, Melville et al. (2004):283 state that the use of ICT brings about customer satisfaction by improving service quality thereby offering new opportunities for companies.

Apulu and Latham (2010:23) claim that ICT enables customers to receive immediate feedback that allows companies to react quickly to customer demands and recognise new market niches. In addition, the use of ICT in transport logistics has an important impact on the competitive advantage of organisations (Closs & Xu, 2000:869). Stock (1990:133) illustrates examples of firms using logistical ICT to gain a competitive advantage. According to Lai et al. (2005), a successful integration process between the transport logistics and ICT results in the following: (i) quick response and access to information; (ii) better customer service; (iii) increased competitiveness. Some of the businesses using GPS vehicle tracking systems now include food and beverage distributors, the construction industry, florists, manufacturers and suppliers of equipment, limousine companies, and many more. GPS fleet management is becoming an indispensable tool of any business that has a fleet of vehicles.

With a real-time fleet tracking system, business managers are able to go online and view the delivery status and real-time location of all their vehicles. In addition, they will have better communication with the entire fleet of vehicles, thus allowing them to reroute drivers in an instant. They also have the ability to increase their response time to customer requests regarding the status of their deliveries and this, in turn, may reduce the number of customer inquiry service calls. The overall outcome is often an extremely satisfied customer (Noton, 2011:1). A modern logistical system requires real-time monitoring and interaction with fleet vehicles in order to attain high fleet operation and provide a fast response to customer needs. The adoption of appropriate information and mobile communication technologies such as

GPS in logistical fleet management may effectively improve the fleet resource utilisation and enhance customer satisfaction (See, 2007:876).

## 2.9. Limitations of a GPS Fleet Management System

The GPS is extremely versatile in fleet management system and offers an excellent solution for positioning identifications. Although highly accurate, there are certain limitations in the use of the GPS. Owing to the nature of the way in which a GPS calculates location, the GPS receiver requires the undisturbed reception of signals from at least four satellites to provide readings and this can be achieved only when there is a clear sky while the receiver is obtaining signals from the satellites. Satellite signals are not able to penetrate solid or dense objects and cannot be used for subsurface marine navigation or for underground positioning. Mountains, dense jungles with trees with thick branches and leaves may also restrict the GPS signal from penetrating. In such areas, the signal may be obstructed for extended periods of time or be continuously unavailable (Robert, 1999:440).

GPS signal loss will occur where the route takes the vehicle between tall buildings, into a tunnel or through an area with a heavy tree canopy – all common phenomena with vehicle movements and parking areas. Under these circumstances, the signal is often lost because the GPS device is no longer able to "see" sufficient satellites to be able to fix a position. In addition, the satellites are compromised. The result is often that there are points missing over certain paths (Stopher, 2004:440). Accordingly, a GPS does not operate well (or at all) in such areas as:

- **Dense 'urban canyon' areas with large or tall buildings**, or even inside buildings which are grouped closely together. This may cause large multi-path and fading errors that may affect the ability to track offenders.
- **Terrain in deep canyons or under dense vegetation**. Signals may become degraded and the receiver system may not provide location information if the view of the sky is severely limited.
- **Weather**. Signal strength may become degraded by moisture, for example, rainfall, fog, or snowfall.
- **Multi-path** is a reflected signal from some reflective surfaces and may corrupt GPS data (Hoffman, 2000).

- **Satellite transmission power**. Since it is normally low, certain geographical conditions may cause problems with a GPS receiver's ability to record location data.

Yet, these are often the areas where the demand for location-based services is the highest. However, as a result of these factors, it is difficult to ensure complete or thorough GPS coverage at all times. For these reasons, it is clear that GPS performance will be degraded or, to some extent, no fixes will be possible in places such as urban areas, dense jungle, underground places or even hilly areas. In addition, as highlighted by Ramamoorthy (2004:2), "traditional GPS receivers require a timeframe of 30 seconds to several minutes to acquire and track satellites, depending on how much information they have previously gathered". This major limitation, which could take the receiver up to 10 minutes to acquire the first position, is commonly known as 'time-to-first-fix' (TTFF), according to LaMance, DeSalas and Jarvinen (2002:46).

GPS is a complex system based on data messages transmitted from a constellation of satellites and its accuracy may be limited by how the measuring system is constructed or how it may be corrupted by a number of different errors. There is a potential for failure at any one of a number of stages, from the production of the data messages and their upload to the GPS satellites to their transmission, reception and processing within the user receiving equipment. GPS measurements can be influenced by errors introduced at the satellite where the signal is generated and transmitted, errors may be caused as the signal travels from the satellite to the user receiver, and errors may be introduced when the measurements are made in the receiver. The following sub-sections present a number of things that could go wrong – and result in the loss of integrity – at system, operational environment and user receiver levels (Barker & Huser, 1998; Cobb et al., 1995; Walsh & Daly, 2000; Pullen, Xie & Enge, 2001).

**System Level**

System level failures are those failures that occur within the space segment, the control segment and the interface between the two (i.e. data transmission). Such failures, for example, as a result of weaknesses in the satellite design and algorithms within the master control station (MCS) environment result mainly in excessive range errors. The failure modes are listed in the following six categories; those related to erroneous clock behaviour, incorrect modelling and malfunction of the MCS, satellite payload performance and space vehicle performance.

**Operational Environment**

These failures are mainly as a result of interference (intended and unintended) and the effects of the media along the signal path. The failure modes are listed in three categories; namely, intended interference, unintended interference and signal propagation. The primary signal characteristic that makes GPSs vulnerable to interference is the low power of the signal. A receiver can lose lock on a satellite due to an interfering signal that is only a few orders of magnitude stronger than the minimal received GPS signal strength (10–16 watt, equivalent to x160 dB). A receiver trying to lock on to a GPS signal requires 6 to 10 dB more carrier-to-noise ratio than is required for tracking (Niesner & Johannsen, 2000:43; Volpe, 2001). The intervening media between the satellite and the antenna also affect signal propagation. This includes the effects of the ionosphere, troposphere and multipath.

**User Receiver**

These failures relate to the end user and the end-user equipment, i.e. receiver and receiver software. Wrong satellite positions or wrong range measurements will result in the incorrect calculation of the receiver position. If the faulty signals are not detected, the user will not know that the displayed position is wrong. Failures related to humans include a lack of adequate training, over-reliance on a single navigation system, etc. It is important to state that receivers used with GPS for safety critical applications such as aviation must be certified to meet the minimum standards, as specified by the relevant authorities (Niesner & Johannsen, 2000:43).

However, with the ongoing advances in technology, there are now certain system components and features available that improve the GPS equipment capabilities. For example, omni-directional antennas enable tracking devices to pick up GPS coverage in virtually any orientation. However, flat patch antennas are not as advanced and must maintain an upright position to receive coverage. Reliable radio frequency (RF) technology, cellular towers and advanced forward link trilateration (AFLT) can also be paired with GPS to enhance system accuracy.

## 2.10. Chapter Summary

This chapter contained a literature review on fleet management systems. Specifically, the chapter discussed the main characteristics of the various types of fleet management applications in use. The review underlines the many challenges facing the modern transportation process, including congestion, growth; higher costs; increased competition;

heightened terrorism/theft/security; information-sharing; regional multi-modal logistical growth; and the proliferation of new complex tools with which to optimise/schedule routes. A critical examination of the historical development of the fleet management systems in transportation and some of the proven research concepts, principles and applications in GPS technology were used to provide knowledge and understanding of the economics of operating a fleet as a result of using intelligent fleet tracking systems.

The evaluation of the accrued benefits of real-time data for prompt decision-making and the concomitant improvement in the various aspects of fleet operations underlines the need for real-time fleet management by transport and logistical service providers. Nevertheless, although the GPS is highly accurate, there are also certain limitations that may, potentially, degrade its performance. The organisational impact of implementing a real-time IT logistics solution has been well documented.

# CHAPTER THREE

**Stage in dissertation**

| | | |
|---|---|---|
| CHAPTER 1: Introduction | Provides an introduction to the general context of the research problem and briefly describes the research objectives and methodology for the proposed study. | |
| CHAPTER 2: Literature Review | Presents a review of relevant literature and examines the historical development of the FMS in respect of the research topic. | |
| **CHAPTER 3: RESEARCH METHODOLOGY** | 3.1 | Introduction |
| | 3.2 | Research process |
| | 3.3 | Research design |
| | 3.4 | Research philosophy |
| | 3.5 | Research approach |
| | 3.6 | Research strategy |
| | 3.7 | Time horizon |
| | 3.8 | Target population and sampling techniques |
| | 3.9 | Data collection techniques and instruments |
| | 3.10 | Data analysis and data interpretation methods |
| | 3.11 | Validity and reliability |
| | 3.12 | Ethics |
| | 3.13 | Summary of the research methods |

| | |
|---|---|
| CHAPTER 4: Data collection and data analysis | Describes the findings derived from the results of the data analysis carried out on the impact of the implementation of fleet management. |
| CHAPTER 5: Discussion on Research Findings and Recommendations | Describes in detail the research output and presents recommendations derived from the results obtained. |
| CHAPTER 6: Research summary and conclusion | Presents a summary of the key research findings from the research work accomplished and draws conclusions in respect of the research questions. |

# 3. Research Methodology

## 3.1. Introduction

Research methodology comprises a body of knowledge that enables researchers to explain and analyse the research methods they use, indicating their limitations and resources, identifying their presuppositions and consequences, and relating their potentialities to research advances (Miller, 1983). Research design may be viewed from many perspectives and is often seen as controversial (Knox, 2004). However, it underpins the types of questions that may be addressed and the nature of the evidence that is generated (Clark, Lotto & Astuto, 1984:41). Accordingly, the issue of research methodology is essential to any study and an appropriation between the research paradigm, type of data, and collection methods has significant implications for the research findings. A research methodology is a systematic process which is followed in conducting a research study (Kothari, 2005:10).

The research methodology assists in fulfilling the purpose of the study in question. The methodology, tools and instruments must, therefore, be systematic, valid, reliable, neutral and objective. The choice of research method constitutes the foundation on which the entire research is conducted. In this chapter, the research methodology used in this study is described. The primary objective of this study is to investigate the effectiveness of the GPS fleet management system installed at KPLC by carrying out an evaluation of its functionality and any improvement achieved in the transportation of staff, goods and materials after the full implementation in 2010.

Finally, a summary highlighting the central elements of the research methodology adopted is presented.

## 3.2. Research Process

The research process presented below consists of the following:

- research process, research design, approach and strategy
- target population, sampling, data collection and data analysis
- time horizon, data validity, reliability and ethics.

Saunders, Lewis and Thornhill (2003:83) suggest a useful model, the ‘research process onion’, which is made up of different layers. From the outside layers inwards, it helps

inform the research approach and choice of research strategy, beginning with the adoption of a research philosophy.

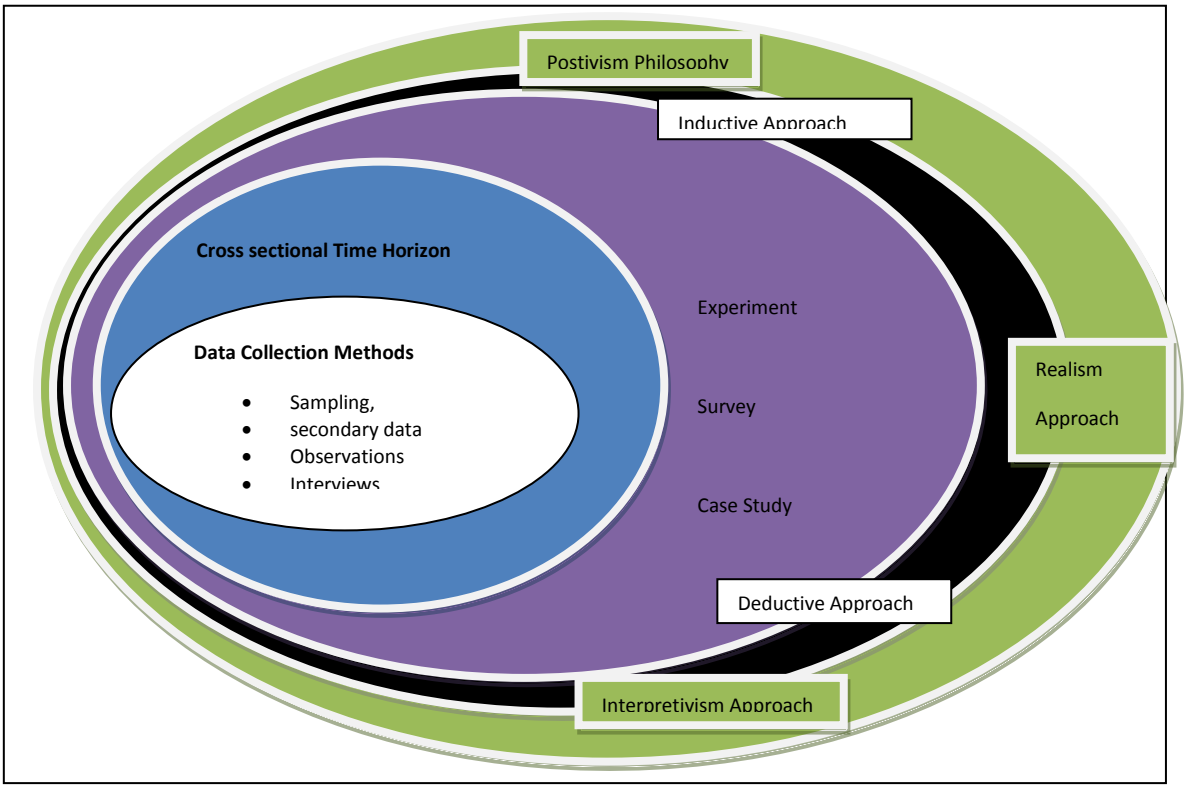



Figure 3.1: Research process onion
Source: Adapted from Saunders et al. 2003:83.

The above revised research process onion, as presented by Saunders et al. (2003:83), serves as a guide to approaching research methodically using different research philosophies, research approaches, research strategies, point of time horizons and data collection methods. The research process onion was considered suitable for adaption to the purposes of this study. The process helps to define and design the research methodology involved by peeling away each layer of the research process onion. This process starts with the outermost layer of the onion (research philosophy) and proceeds inwards until the core of the onion is reached (data collection methods). Each of these layers is discussed below.

## 3.3. Research Design

Research design provides an overall guide for the collection and analysis of the data of a study (Churchill, 1979). The importance of the research design stems from its role as a critical link between the theory and argument that informed the research and the empirical data collected (Nachmias & Nachmias, 2008:245). A choice of research design reflects

decisions about the priority being given to a range of dimensions of the research process (Bryman & Bell, 2007:40), and this, of course, will have considerable influence on lower-level methodological procedures such as sampling and statistical packages. Therefore, it is a blueprint that enables researchers to find answers to the questions being studied for any research project. Together with the clear research plan it provides, constraints and ethical issues that a study will, inevitably, encounter must be taken into account (Saunders et al., 2007:85). Each study follows a unique methodology in order to fulfil the purpose of that study.

Research in business may be classified into three types of research design, namely, exploratory research, descriptive research and explanatory (causal) research (Saunders et al., 2007; Babbie, 2004:94). An exploratory study is aimed at gaining familiarity with the phenomena in the situation before developing a model and setting up a rigorous design for comprehensive investigation (Sekaran, 2003:103). Therefore, the key point in conducting exploratory research is to understand a new interest and insights that provide the researcher with better clarification of the general nature of a problem. Zikmund, Babin, Carr and Griffin (2010) suggest that exploratory research is characteristically a first step, which is carried out with the expectation that further studies will be needed in order to gain more conclusive evidence. Several techniques could be used in conducting exploratory research, including a literature review, discussing or talking to experts in the field of study or focusing on a group and case study.

Descriptive studies are usually structured and designed specifically to measure the characteristics described in the research question (Hair, Babin, Money & Samouel, 2003). Descriptive research is employed to provide descriptions of phenomena or characteristics concerning a subject of a population, estimates of the proportions of the population that have those characteristics and to discover associations between different variables (Cooper & Schindler, 2003). In general, the descriptive study is guided by an initial hypothesis. Moreover, this type of research design may be an extension of a piece of exploratory research (Saunders et al., 2007:85). Explanatory research is concerned with determining cause-and-effect relationships (Zikmund et al., 2010). Moreover, explanatory research moves beyond description and seeks to explain the patterns and trends observed (Ticehurst & Veal, 1999). This kind of design may be conducted through field experiment and laboratory.

According to Cooper and Schindler (2003), descriptive studies are more formalised and typically structured with clearly stated hypotheses or investigative questions. This allows

the researcher to collect quantitative data concerning the current status of a phenomenon with respect to variables or conditions in a situation, which can be analysed quantitatively using descriptive and inferential statistics (Saunders, 2003:88). Descriptive methods range from surveys which describe the status quo, documentary analysis for empirical data, correlation studies investigating the relationships between variables, interviews to obtain first hand information to case studies. Therefore, the descriptive survey is deemed the best strategy in order to fulfil the research objectives. The descriptive study approach allows in-depth examination, albeit gathering information from a limited sample of subjects and can lead to new information in the area under study. For all these reasons and given the nature of this research objective (i.e. to investigate the effects of implementing a real-time IT logistics solution on a business and the consequences on the processes), the descriptive method was deemed the most appropriate option and was adopted for this study.

## 3.4. Research Philosophy

There are various research philosophical paradigms, but the most prominent are positivism, realism and interpretivism, as shown in the research process onion in figure 3.1. From the outside layers inwards, this helps inform the research approach and choice of research strategy, beginning with the adoption of a research philosophy. Research stems from an underlying philosophical paradigm. "A paradigm is a set of shared assumptions or ways of thinking about some aspect of the world" (Oates, 2006:13, 282). According to Creswell (1994), the design of a research investigation into a particular topic requires the selection of a philosophical position or paradigm, from which a research strategy or methodology can be derived (Easterby-Smith, Thorpe & Lowe, 1991). The definition of a paradigm varies with the context but, in the human and social sciences, and in business and management literature, 'paradigm' generally describes the progress of scientific practice based on people's philosophies. Paradigms evolve, advance assumptions about the world and of the nature and development of knowledge, and help us to understand phenomena by encompassing theories and methods (Creswell, 1994; Saunders et al., 2003:85).

Positivism, also referred to as the scientific method (Oates, 2006:283), views the world as structured and ordered. Positivist researchers aim to look at the world from an objective and 'real world' perspective (Cornford & Smithson, 1996:37).

The realistic philosophy, also commonly referred to as critical realism, states that "there is a reality independent of our thinking that science can study" (Trochim & Donnelly,

2007:99). Critical realist researchers, who subscribe to this philosophy, believe that what we perceive as reality now can be altered later. The goal is to seek out new understandings of reality (Trochim & Donnelly, 2007:99).

The interpretivist philosophy is concerned with the social context of phenomena (Klein & Myers, 1999). "The focus is on interpreting meaning. The purpose is to understand how others construe, conceptualize, and understand events and concepts" (Meredith, Raturi, Amoako-Gyampah & Kaplan, 1989:307). On the other hand, an interpretive or social constructivist views the observer as a part of what is being observed and human interests are the main drivers of science (Easterby-Smith et al., 2002). Thus, a researcher with the interpretive view is likely to grasp the subjective meaning of a particular social phenomenon as well as to share interpretations of his/her socially constructed perception.

However, it is understood from Saunders et al. (2003:88) that the positivist and interpretivist paradigms are at the two extremes of a continuum with, perhaps, realism in the centre. Oates (2006:283) states that the choice of the philosophical paradigm and the execution of appropriate research approaches, research strategies, and data collection methods result in findings that correspond to the chosen philosophical paradigm. However, the decision to adopt a research approach, strategy or data collection method should be considered on a case-by-case basis (Knox, 2004:119). The overriding concern is that this research should be both relevant to the research question, as set out in Chapter One, and rigorous in its operationalisation.

Generally, the interpretivist philosophy is acceptable for this purpose, that is, the understanding of how the use of information and communication technology, specifically GPS fleet management systems, impacts on the business and the consequences to the business processes. This research involves an element of technological transfer, insofar as this technology had not previously been installed in the organisation. The interpretivist research philosophy has been adopted in this study as it is the philosophy which is concerned with the interpretation and meaning of the research findings (Klein & Myers, 1999:67; Walsham, 1995:74) and this is of great interest to this study.

## 3.5. Research Approach

There are three main research approaches, namely, the deductive, the inductive or a combination of both, known as the adductive approach (Wigblad, 1997:27). The research approach affects how the research is carried out, that is, from a more general standpoint or

from a more specific standpoint. The selection of an appropriate approach must be based on the problem definition and the theory of science (Lundahl & Skärvad, 1999). As mentioned by Avgerou (2000:567), information systems research is issue oriented rather than theory driven and this corresponds with an inductive approach. The two main research approaches, namely, deductive and inductive reasoning, are depicted in the second layer of the research process onion.

The inductive approach starts with the empirical data and, thereafter, creates theories based upon these facts (Lundahl & Skärvad, 1999). It focuses on a specific view and then works towards a more general and conceptual understanding of theory (Wills, 2007:213). The process of inductive reasoning is also referred to as the "bottom-up" approach (Trochim & Donnelly, 2007:100) and is depicted in figure 3.2 below.

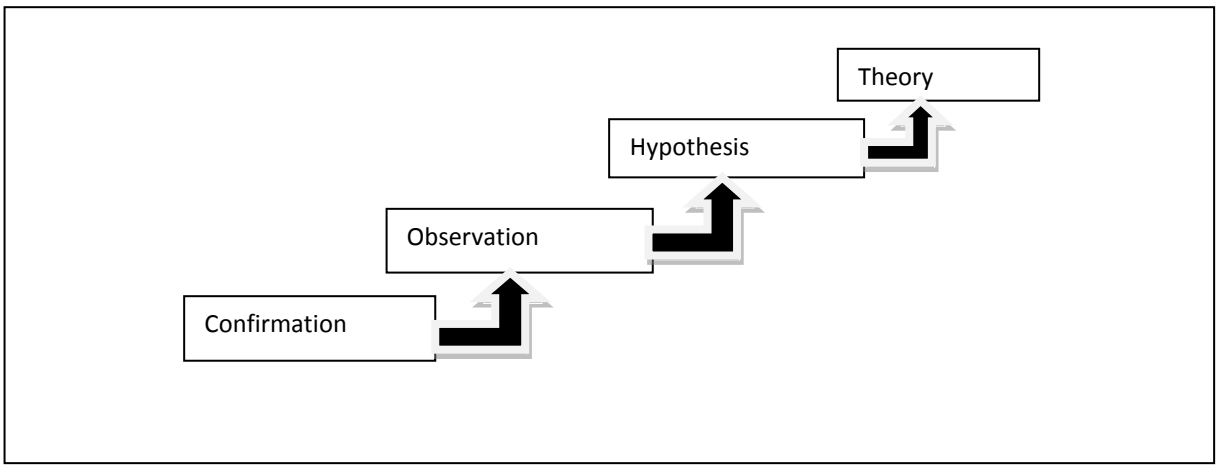



Figure 3.2: "Bottom-up" approach
Source: Trochim & Donnelly, 2007.

Deductive reasoning begins with the focus on a general, holistic understanding of the theory and then abstracts to a specific subject of focus (Wills, 2007:213). The process of deductive reasoning is also referred to as the "top-down" approach as depicted in figure 3.3 on the next page.

The deductive approach is based on already established theories and it draws logical conclusions and tests (verify or falsify) by means of empirical studies (Lundahl & Skärvad, 1999). In contrast, inductive reasoning focuses more on understanding the theory emerging from the findings and collecting qualitative data to gain an enriched understanding of the interpretation of events.

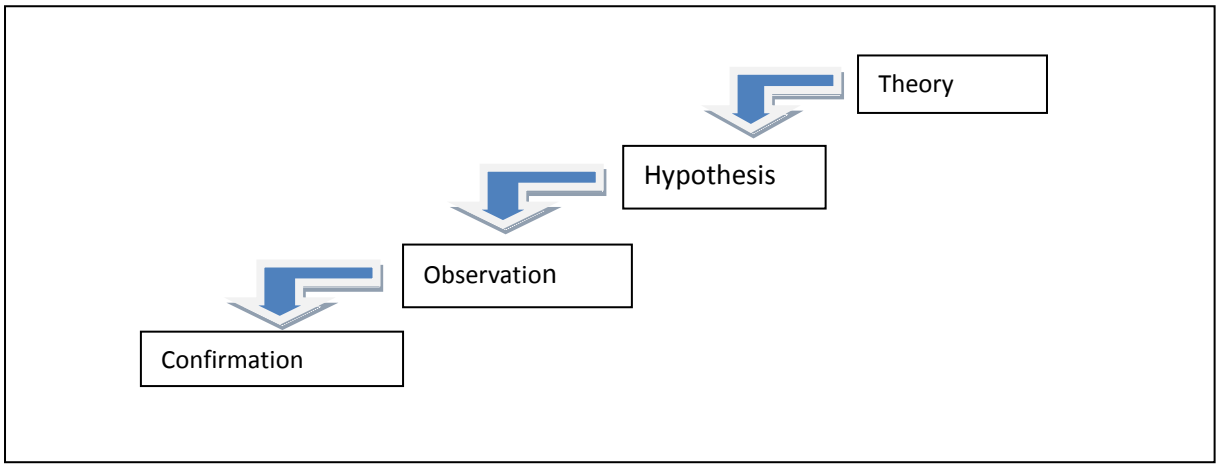



Figure 3.3: Top-down approach
Source: Trochim & Donnelly, 2007

Table 3.1 below illustrates that deductive reasoning focuses more on moving from theory to the collection of quantitative data and controls in order to ensure validity.

Table 3.1: Main differences between the inductive and deductive research approaches

| **Deductive reasoning** | **Inductive reasoning** |
|---|---|
| Scientific principles | |
| Moving from theory to data | Gaining an understanding of the meanings humans attach to events |
| Need to explain causal relationships between variables | Close understanding of the research content |
| Collection of quantitative data | Collection of qualitative data |
| Application of controls to ensure validity of data | More flexible structure to permit changes of research emphasis as the research progresses |
| Operationalisation of concepts to ensure clarity of definition | |
| Highly structured approach | |
| Researcher is independent of what is being researched | Realisation that the researcher is part of the research process |
| Need to select samples of sufficient size in order to generalise conclusions | |

According to Halvorsen (1992) and Wigblad (1997:29), the deductive approach is often associated with the quantitative method. This is in line with the view of Knox (2004) to the effect that the research philosophy should not limit the selection of research approach as it should be carefully considered in terms of the context and appropriateness of the study. This study is more issue-oriented and focuses more on finding effects and consequences rather than on hypothesis testing based on existing theories. The deductive approach, which is also referred to as the "deductive reasoning" approach (Trochim & Donnelly, 2007), was more appropriate for this study as it allowed the collection of literature findings on the

implementation of fleet management systems and then the collection of actual field results to confirm or refute the findings. The figure below (Figure 3.4) illustrates the top-down research approach adopted in this study.

The figure below (Figure 3.4) illustrates the top-down research approach adopted in this study.

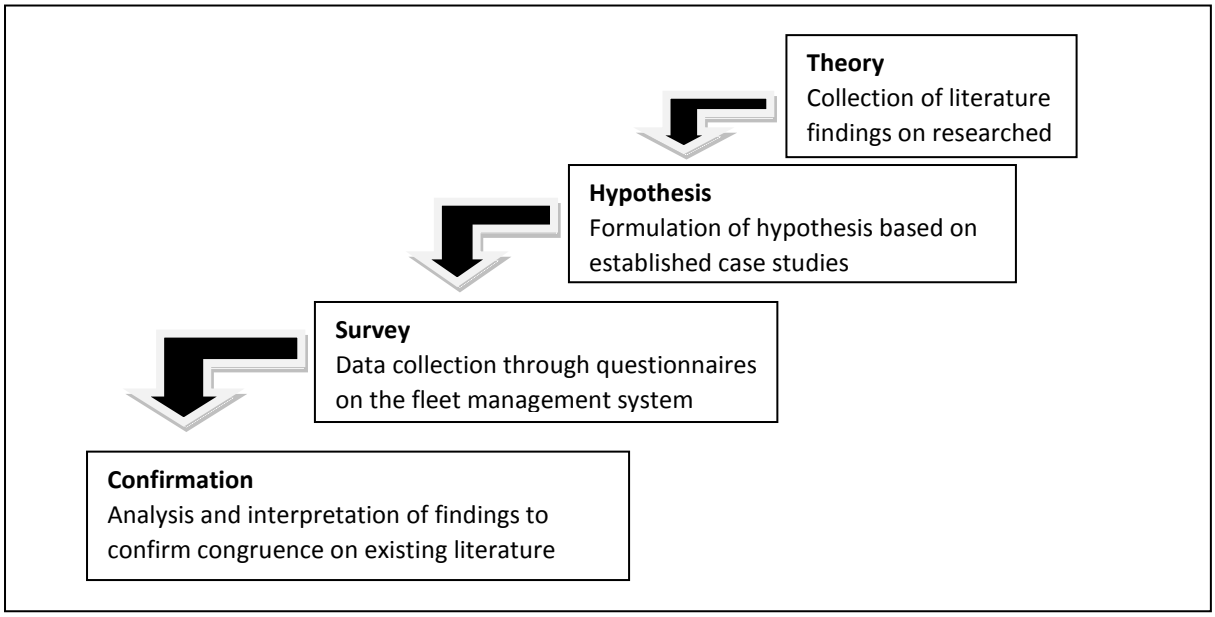



Figure 3.4: Deductive reasoning approach
Source: Trochim & Donnelly, 2007.

Two research methods exist, namely, quantitative and qualitative methods (Halvorsen, 1992). The choice of quantitative and/or qualitative method must be in accordance with the entire research approach and based on the selection of either an inductive or deductive approach. The following discussion includes the differences in the qualitative versus the quantitative approach based on these criteria.

**The quantitative method** involves some kind of measurement which should be reliable and valid (Lundahl & Skärvad, 1999). Mark (1996) defines the quantitative method as the approach which studies phenomena using numerical means. In this approach there is an emphasis on counting, describing and using standard statistics, such as means and standard deviations. A quantitative method is more suitable for highly structured research that may be statistically measured (Wigblad, 1997:31). According to Bryman and Burgess (1999), there is a tendency for quantitative researchers to reach generalised findings while contextual understanding outlines the basis for qualitative research. The quantitative approach to a

research study involves the use of statistical data analyses to obtain information about the study simply because the approach is based on measuring quantity or amount (Harvey, 2006).

**The qualitative method** is defined as research or study which generates results and conclusions with the help of qualitative analyses and, mainly, with qualitative data (Lundahl & Skärvad, 1999). The purpose of this method is to describe, analyse and understand the behaviour or impact of a certain phenomenon, often by using hermeneutic science (interpret and analyse) so a new theory or understanding may be outlined (Repstad, 1999; Lundahl & Skärvad, 1999). Mark's (1996) definition has almost the same significance since he states that the qualitative approach studies phenomena using general descriptions to describe or explain them. Also, narrative descriptions of persons, events and relationships tend to be used by researchers who use the qualitative approach. The approach consists of descriptions, quotes, observations and excerpts from books and other documents (Quinn, 2002:308).

Creswell (2003) explains that deductive reasoning is often used with the quantitative research method chiefly to test or verify theories or explanations, identify variables to study, relate variables in questions or hypotheses, use statistical standards of validity and reliability, and employ statistical procedures for analysis. The main emphasis of quantitative research is on deductive reasoning which tends to move from the general to the specific. Therefore, quantitative research methodology was adopted in this study since it was more appropriate in studying the nature of the effects identified and the consequences of the implementation.

### 3.6. Research Strategy

A research strategy provides pre-specified procedures that should be followed to address the research questions and fulfil the research objectives (Oates, 2006:284; Yin, 2003:13). Six of the popular research strategies are depicted in the third layer of the research process onion. Each of these six research strategies is briefly discussed next.

- **Experiment**. An experiment is defined as "a particular kind of research strategy that aims to isolate cause and effect by manipulation of what is thought to be the causal, or independent variable and measurement of its effect on the dependent variable(s)" (Oates, 2006:128). Experiments can take place in a laboratory setting or in the field, also referred to as field experiments, quasi-experiments, natural setting experiments (Oates, 2006:128). Experiments require a significantly

representative sample of research participants if the research is to be of any value (Oates, 2006:129).

- **Surveys**. These provide a means to "obtain the same kinds of data from a large group of people or events in a standardized and systematic way" (Oates, 2006:93). Several studies (Bueno & Salmeron, 2008:515; Buonanno, Faverio, Pigni, Ravarini, Sciuto & Tagliavini, 2005:384; Laukkanen, Sarpola & Hallikainen 2007:319) have evaluated the acceptance, adoption and use of information systems by small and medium enterprises using the survey research strategy. In statistics, survey sampling describes the process of selecting a sample of elements from a target population in order to conduct a survey. A survey may refer to many different types or techniques of observation. However, in the context of survey sampling, it most often involves a questionnaire which is used to measure the characteristics and/or attitudes of people. The different ways of contacting the members of a sample once they have been selected is the subject of the survey data collection. Surveys usually involve a significant sample size of research participants in order to support the generalisation of the findings (Oates, 2006:96). Surveys tend to focus on quantifiable findings and not necessarily on non-quantifiable findings (Oates, 2006:97).
- **Case study**. Yin (2003:13) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". A number of researchers (Liang & Xue, 2004:399; Light, 2005:606; Molla & Bhalla, 2006:1; Muscatello, Small & Chen, 2003:850; Olsen & Sætre, 2007:379; Verville, Bernades & Halingten, 2005:665) promote the use of the case study research strategy to assess user perceptions and evidence of information systems intervention (Huang & Palvia, 2001:276; Loh & Koh, 2004:3433; Roberts & Weston, 2007:357).
- **Grounded theory**. Grounded theory research is discovered empirically through induction and is more related to qualitative research. Its focus is to develop theories that minimally fit the immediate situation being addressed. The responsiveness of grounded theory research is aimed at contextual values and not merely the values of the investigator. It involves the formulation of local understandings that without the inquiry of the researcher would remain implicit

and unexplained (Lincoln & Guba, 1985). Glaser and Strauss (1967) advocate this inductive reasoning strategy to inform theory.

- **Ethnography**. Ethnography is regarded as "an art and science of describing a group or culture" (Fetterman, 2010:11). Ethnography provides a rich account of what has been investigated in a particular context. However, this account may not be generalised to other contexts (Oates, 2006:82).
- **Action research**. Action research is a research strategy that involves the participation of the researcher. Firstly, the researcher diagnoses a problem within a specific context. Secondly, the researcher plans to resolve the problem. Thirdly, the plan is implemented. Fourthly, evaluation to assess the resolution of the problem is conducted. Lastly, the researcher reflects on the outcomes from the intervention to resolve the problem (Oates, 2006:85).

A survey research strategy has been adopted as it enables the researcher to obtain data about practices, situations or views at one point in time through questionnaires or interviews and to examine and explain relationships between constructs, in particular cause-and-effect relationships (Saunders et al., 2007:87). The survey questionnaire allows an in-depth examination, albeit the gathering of information from a limited sample of subjects, and can lead to new information in the area under study. For all these reasons and with the nature of the research objective, that is, to investigate the effects of implementing a real-time IT logistical solution on a business and the consequences for the processes, the survey method was deemed to be the most appropriate option for this study.

## 3.7. Time Horizon

Time horizons relate to when research is conducted and may either be at a specific point in time, or across a specific period. Two time horizons, namely, cross-sectional and longitudinal, are described below:

- **Cross-sectional research** employs a single point of data collection for each participant or system being studied. It is used for examining phenomena which are expected to remain static through the period of interest. It takes place at a single, specific point in time of a number of variables and involves the observation of all of a population, or a representative subset, at one specific point in time (Trochim & Donnelly, 2007:110).

- **Longitudinal research** is research in which participants, processes or systems are studied over time, with data being collected at multiple intervals and it takes place over a specific period (Trochim & Donnelly, 2007:110). It involves collecting information from one point in time across to another point in time and is known as time-series data.

This study makes use of both cross-sectional and longitudinal research time horizon since the data collection will take place within a given period and, at the same time, snapshots of time before the installation of the GPS. The actual status at the end of the implementation exercise will be taken into account.

## 3.8. Target Population and Sampling Techniques

Quantitative research, which is adopted in this study, starts with a particular hypothesis which is then tested through the collection of data. The nature of the data for quantitative research means it must be more concerned with sampling issues and techniques. A study population is a well-defined or specified set of subjects, elements, traits, firms, or objects that are homogeneous. Thus, the population consists of all the cases of individuals, things or elements that may be divided into sub-populations or strata which are mutually exclusive. Mcneill and Chapman (2005:226) argue that the process of sampling involves selecting elements from the study population so that, by carrying a study of the sample and having an understanding of the properties of the characteristics of the subjects of the sample, it will be possible to generalise the properties to specific elements in the population.

### Target Population

Studying the whole population would be both laborious and time consuming, especially in sorting out vehicles so as to segregate those that were initially fitted with GPS units but were later disposed of or reallocated to different branches. Again, there may be complexity in dealing with secondary data if the vehicles are many and especially where the categorisation of data had not been done at the time of archiving for ease of reference.

According to Neuman (2000:518), a **sample** is “a smaller set of cases a researcher selects through scientific sampling procedure from a larger pool, and generalises to the population”. When the sample is representative, the results of the study may be generalised to the population. Unless the entire population is sufficiently small and the research cannot include the entire population in the study, a subgroup or representative sample is selected for

study. Usually, the population is too large for the researcher to attempt to survey all of its members. Therefore, in this study, the sampling frame was limited to only one thousand and two hundred vehicles fitted with the GPS tracking units and whose operations were homogenous.

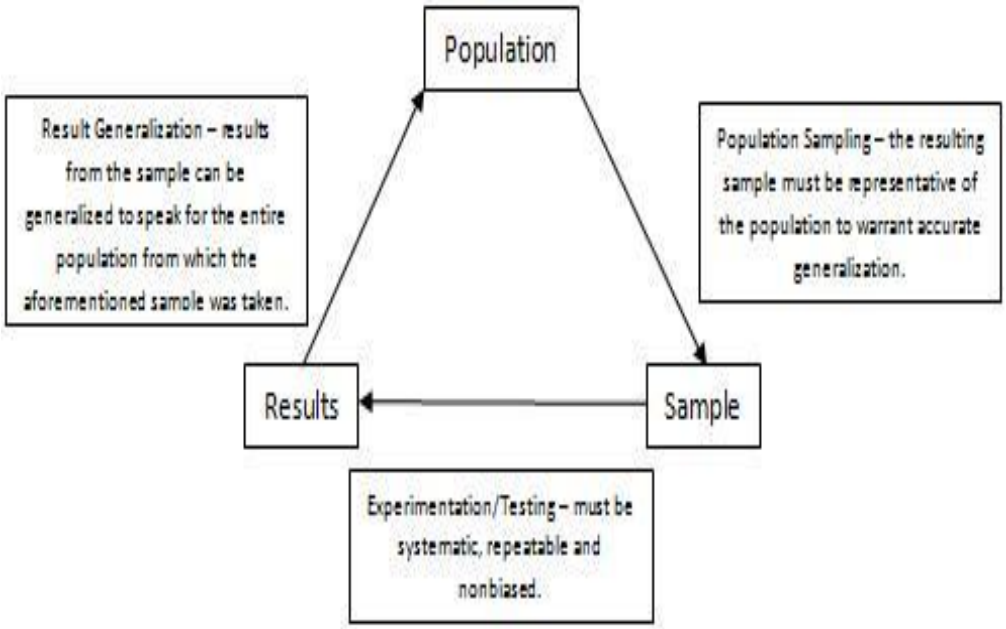



Figure 3.5: The research triad of study population, sample and results

The fleet is distributed to the ten administrative branches of the company and supervised by the respective transport officers, as shown in Table 3.2 below.

Table 3.2: Total fleet distribution on 1 July 2011 (from TMS records)

| KPLC branches | Current fleet size | Fleet GPS units |
|---|---|---|
| Stima Plaza | 195 | 143 |
| Nairobi North | 212 | 137 |
| Nairobi South | 256 | 144 |
| Nairobi West | 165 | 99 |
| Central Rift | 159 | 104 |
| West Kenya | 271 | 143 |
| North Rift | 158 | 101 |
| Mt Kenya North | 195 | 105 |
| Mt Kenya South | 117 | 69 |
| Coast | 254 | 155 |
| **Total** | **1982** | **1200** |

**Determining Sample Size for Research Study**

Within a quantitative survey design, determining the sample size and dealing with non-response bias are essential. "One of the real advantages of quantitative research methods is the ability to use smaller groups of a population to make inferences about larger groups that would be expensive to study" (Holton & Burnett, 1997: 71). This begs the question as to how large a sample should be in order to infer research findings back to a population. Krejcie and Morgan (1970:607) identify sample size as a function of the size of the population of interest, the desired confidence level and the level of precision where a formula may be used to determine the appropriate sample size or a tool used as a guide to minimum sample size.

Table 3.1 below shows the sample size needed when estimating a population percentage (or proportion) at the 95% confidence level and a + or – 5 percentage point confidence interval. The smaller the population, the higher the proportion of cases needed. If the population is 300, a sample size of 169, which is just over half the total population, is needed to obtain a confidence level of 95%.

Table 3.3: Sample size for research activities as depicted in Krejcie and Morgan, (1970:30).

| Population size | Sample size | Population size | Sample size |
|---|---|---|---|
| 10 | 10 | 550 | 226 |
| 20 | 19 | 600 | 234 |
| 40 | 36 | 700 | 248 |
| 50 | 44 | 800 | 260 |
| 75 | 63 | 900 | 269 |
| 100 | 80 | 1,000 | 278 |
| 150 | 108 | 1,200 | 291 |
| 200 | 132 | 1,300 | 297 |
| 250 | 152 | 1,500 | 307 |
| 300 | 169 | 3,000 | 341 |
| 350 | 184 | 6,000 | 361 |
| 400 | 196 | 9,000 | 368 |
| 450 | 207 | 50,000 | 381 |
| 500 | 217 | 100,000+ | 385 |

A population of 900 will require a sample size of 269 which is under a third and, when the population is larger than 100,000, 385 will be needed – a much smaller fraction. The above guide indicates at least 291 units would be a sufficient sampling size out of the total fleet size of 1,200 units.

Sampling is the strategy of selecting a smaller section of the population that will accurately represent the patterns of the target population at large (Sarantakos, 2000:154). It is neither possible nor is it necessary to collect information from the total population. Instead, a smaller subgroup of the target population or a sample is selected for the purpose of study and may be used to represent the population. Survey samples can be broadly divided into two types: probability samples and non-probability samples. Only surveys based on a probability samples can be used to create mathematically sound statistical inferences about a larger target population.

Surveys that are not based on probability sampling have no way of measuring their bias or sampling error. They are not externally valid since they may only be said to be representative of the people who have actually completed the survey. Sampling methods are classified as either probability or non-probability. In probability samples, each member of the population has a known non-zero probability of being selected. Probability methods include random sampling, systematic sampling, and stratified sampling. Probability sampling can be achieved by the random selection of the sample among all the units of the population. In non-probability sampling, members are selected from the population in some non-random manner. These include convenience sampling, judgment sampling, quota sampling, and snowball sampling.

In non-probability sampling, the degree to which the sample differs from the population remains unknown. There are several aspects to consider when sampling. These sampling aspects include identifying the sampling frame (potential sample), sampling technique (probability and non-probability sampling techniques to select the actual sample), response rate and non-responses, and sample size. It is recommended that an adequate sample size that represents the population statistically form part of the study in order to assist with the generalisation of the research findings (Bartlett, Kotrlik & Higgins, 2001:43).

The advantage of probability sampling is that the sampling error can be calculated. Sampling error is the degree to which a sample might differ from the population. When inferring to the population, results are reported plus or minus the sampling error. Probability sample design assists to establish baseline data or to assess the changes, effects or the impact that has taken place after the project has been in operation for some time. This design is generally used in quantitative studies. The random selection of the sample units enables you to confidently generalise results from the small sample to the larger population. Probability

methods include the simple random sampling, systematic sampling, and stratified sampling, as briefly described below:-

**Random Sampling**

The first statistical sampling method is simple random sampling. According to Charney (1996:584), in this method each item in the population has the same probability of being selected as part of the sample as any other item. Random sampling may be done with or without replacement. If it is done without replacement, an item is not returned to the population after it has been selected and, thus, can only occur once in the sample.

**Systematic Sampling**

The second sampling method is systematic sampling. According to Kish (1965:21).In this method, every nth element from the list is selected for the sample, starting with a sample element “n” which is randomly selected from the first “k” elements. Care must be taken when using systematic sampling to ensure that the original population list has not been ordered in a way that introduces any non-random factors into the sampling.

**Stratified Sampling**

The third statistical sampling method is called stratified sampling. According to Charney (1996:584), it is used when representatives from each subgroup within the population need to be represented in the sample. The first step in stratified sampling is to divide the population into subgroups (strata) based on mutually exclusive criteria. Random or systematic samples are then taken from each subgroup. The sampling fraction for each subgroup may be taken in the same proportion as the subgroup in the population. For example, a person conducting a customer satisfaction survey can select random customers from each customer type in proportion to the number of customers of that type in the population.

**Cluster Sampling**

The fourth statistical sampling method is called cluster sampling, also block sampling. In cluster sampling (Henry, 1990:29), the population that is being sampled is divided into groups called clusters. The process of sampling complete groups or units is called cluster sampling. In situations where there is any sub-sampling within the clusters chosen at the first stage, the term multistage sampling is used. In cluster sampling, the population is divided into units or groups, called strata (usually, they are units or areas into which the population has been divided), which should be as representative as possible of the population. After the

clusters have been established, a simple random sample of the clusters is drawn and the members of the chosen clusters are sampled. If all of the elements (members) of the clusters selected are sampled, then the sampling procedure is defined as one-stage cluster sampling.

If the elements contained in the clusters are as heterogeneous as the population, then estimates derived from cluster sampling are as precise as those from simple random sampling. The sampling procedure adopted in this study was one-stage cluster sampling because the elements contained in the clusters represent the heterogeneity of the population being studied and are homogeneous among them. Clustering the transport branches as they are distributed and then selecting three of the branches out of the ten through simple random sampling will give a sufficient representative sample (at least 291 units as given in the Guide to Minimum Sample Size (Krejcie & Morgan, 1970:608)).

One-stage cluster sampling procedure is as follows: Divide the population up into a set of different coherent areas. The vehicles fitted with tracking units and their spread in terms of the respective branches is shown in table 3.4 below.

A sample of clusters is chosen, using a probability method (often simple random sampling). Every element has the same probability of selection and every combination of elements has the same probability of selection. Random samples are taken by assigning a number to each unit in the population and using random number tables or software packages to generate the sample list of clusters for the research study. Only individuals within sampled clusters are surveyed.

Table 3.4: Distribution of fleet vehicles fitted with GPS units

| Listing | KPLC Branches | Fitted with GPS units |
|---|---|---|
| 1 | Stima Plaza | 143 |
| 2 | Nairobi North | 137 |
| 3 | Nairobi South | 144 |
| 4 | Nairobi West | 99 |
| 5 | Central Rift | 104 |
| 6 | West Kenya | 143 |
| 7 | North Rift | 101 |
| 8 | Mt Kenya North | 105 |
| 9 | Mt Kenya South | 69 |
| 10 | Coast | 155 |
| **Total** | | **1200** |

## 3.9. Data Collection Techniques and Research Instruments

A data collection method, also referred to as a data generation method, provides a means of gathering research findings (Oates, 2006:36). Questionnaires and interviews are widely used data collection methods in information systems research (Oates, 2006:38). However, before one selects a data collection method, one needs to understand the type of data that needs to be collected. It was essential to collect two types of data in the survey, namely, data directly and data indirectly related to the study.

**Data Collection Techniques**

There are primary and secondary methods of collecting data. Primary methods are those that collect data for the first time while secondary methods are those where the researcher uses data collected by other people. Secondary data includes documents, data, and information from previous studies that a researcher might use in a new study (Oates, 2006:234). According to Bryman and Bell (2007:10), secondary data collection methods refer to the ability of the researcher to carry out an analysis of the data that has already been prepared by other researchers.

- Observations are data collection methods that observe what the participants actually do (Oates, 2006: 202). It not only involves seeing the participants act within a context but also involves a careful assessment of the environment and the behaviour of the participant under observation. Observation could involve the senses of sight, sound, touch, taste and smell, depending on the context. The researcher could act as an invisible observer or an active participant in the research process
- Interviews allow the researcher to constructively communicate with the research participants to obtain detailed information that could not be otherwise obtained using other data collection methods (Oates, 2006:187). The researcher also observes the research participants during the interview interactions to assess possible changes in emotion or emotional responses to sensitive questions (Nandhakumar & Jones, 1997:109).

Questionnaires make it easier to collect large amounts of predefined data in a pre-determined order over a shorter period of time (Oates, 2006:217). Questionnaires are often related to the survey research strategy although questionnaires may be used as part of other research strategies, such as case studies (Oates, 2006:219). The questionnaire data makes it

easier for researchers to look for patterns within the research findings. These patterns can be used to generalise findings from the sample to the larger population under study (Oates, 2006:223). Questionnaires can be self-administered (completed by the research participant without the assistance of the researcher) or researcher-administered (the researcher completes the questionnaire after asking for a response from the research participant).

**Survey Questionnaire as Research Instrument**

The **survey questionnaire** has been adopted in this study for the purpose of collecting the required primary data. Structured questionnaires will be administered through the use of the company's intranet communication system to the respective fleet operators in the sampled areas. The questions that are commonly used in surveys and questionnaires are usually either open ended, closed-ended questions or Likert scales. Open-ended questions do not always provide answers from which a respondent may choose but allow participants to answer freely. On the other hand, closed ended questions provide answers from which the respondent may choose. Likert scale questions request respondents to respond to the question along a given continuum from the given responses. For example, "an organisation should have past experience of internationalisation for a successful process" (1) strongly agree (2) agree (3) disagree (4) strongly disagree. The questions asked are intended to obtain demographic, direct, and motivated responses. The research participants are encouraged to provide substantiating comments to support their responses.

The questionnaire is contained in Appendix 1: GPS FM Questionnaire. The self-administered questionnaires will be issued to respondents (completed by the research participant without the assistance of the researcher) through the use of the company's intranet communication system which makes it possible to reach all the intended respondents fast and conveniently. Likert scale questions were chosen to allow the respondents to respond to the questions in a manner that gives rise to information that is relevant to the impact of the implementation of the GPS real-time tracking system. The questions are specifically structured to ensure that the responses provide adequate raw data for further analysis and conclusions.

The questionnaire is structured as follows:

Part A – Demographic data

Part B – Reduction in motor fleet accidents between year 2009 and 2010

Part C – Improvement in fleet availability between year 2009 and 2010

Part D – Reduction in the fleet costs between year 2009 and 2010

Part E – Reduction in frequency of vehicle breakdowns between year 2009 and 2010

Part F – Reduction in vehicle theft between year 2009 and 2010

Part G – Perceptions of staff towards the GPS implementation

**Secondary Data**

The secondary data in this study included documents, data and information from previous studies such as existing official reports and documents from the named entities, journals, other empirical researches in the area and any other relevant document from the libraries and internet. Some of data used was generated from the records archived in the transport management system (TMS), which is a company software system with back-up servers for the storage of all operational transactions. Data downloads and computer printouts available from the system provided further information for authenticating the responses and providing collaborative information on the research problem.

## 3.10. Data Analysis and Interpretation Methods

Once the primary data was collected, it was checked for completeness in readiness for the analysis. The responses from the field were first put into categories and coded according to the themes so as to answer the research question and obtain the relevant information. The classified data was then presented in figures, tables and charts according to the study objectives for ease of interpretation, understanding, reading and discussion. According to Mogey (1999), the data collected using the Likert scale is ordinal data.

The best technique recommended for an overview interpretation of the data is a **descriptive technique**. This statistically descriptive technique is the mode. The mode refers to the most frequently occurring value in a data set (Oates, 2006: 256). This study makes use of the mode to determine the most frequently selected response on the Likert scale. Basically, descriptive statistics and correlations for the key variables will be used to present the characteristics and frequency distribution of the variables examined. They will be used in the study to provide a general overview of the variables being studied.

The secondary data collected from documents, archived data and information from previous studies was analysed using the **content analysis method**. Content analysis is an objective, systematic, quantitative and reliable method for the study of published information (Ellinger, Lynch, Andzulis & Smith, 2003:199) and also for measuring comparative positions

and trends in reporting (Kent & Flint, 1997). It involves the observation and detailed description of the objects, items or things that comprise the study. The technique is applied systematically and with proper controls, such as definite explorations of the variables to be analysed in order to yield appropriate levels of validity and reliability (Kolbe & Burnett, 1991:243). It also helps to avoid the element of subjectivity inherent in content analysis (Peterson, 1998:1541).

The **descriptive technique** and the **content analysis method** are the two methods of data analysis adopted in this study to enhance understanding for the accurate and concise presentation of the results obtained in a way that answers the study questions. According to Bazeley (2002:6, 9), the use of a mixed data analysis approach enriches the understanding of an experience or issue through a confirmation of conclusions, extension of knowledge or by initiating new ways of thinking about the subject of the research – coding or categorising of data is undertaken to facilitate understanding retrieved information.

### 3.11. Validity and Reliability

Derived from the Latin term *validitas*, meaning "strength," validity is a term used in both qualitative and quantitative research. It asserts that a finding can never truly be proven; it can only be argued (Trochim, 1999). In quantitative research, there are several ways in which to establish validity. Here, validity assumes a different meaning to the meaning used in qualitative studies. Validity refers to how well an instrument measures what the researcher wants to evaluate. Specifically, a measure has content validity if the items it contains address all of the topics the researcher aims to study and is assessed in terms of face validity (whereby experts examine the instrument to see if it looks right) or sampling-content validity, in which the researcher systematically identifies how items on an instrument cover the topics of interest. A more rigorous assessment, construct validity refers to the degree to which a measure captures the theoretical construct it aims to cover. It is typically evaluated by testing the measure for applicability under varying circumstances using probabilities. Specifically, it tests the statistical likelihood that the researcher is wrong.

Cook and Campbell (1979:37) believe that "validity is the best available approximation to the truth or falsity of propositions, including propositions about cause…at best; one can know what has not yet been ruled out as false". Therefore, conclusions that claim validity must be considered by researchers and academics alike as approximate or

tentative. The questionnaire that was designed was assessed for content validity, construct validity, and reliability.

- All the items it contains should address all of the study questions. Content validity "measures the degree to which the test items represent the domain or universe of the trait or property being measured" (Cook & Campbell, 1979:37). This fact is used to ground the content validity of the questionnaire.
- The degree to which all measures should capture the theoretical construct they aim to cover. The construct validity approach concerns the degree to which the test measures the construct it was designed to measure.
- The reliability of a research instrument concerns the extent to which the instrument yields the same results on repeated trials. "The process of pilot testing (testing and retesting) of the questionnaire assisted in ensuring reliability of the questionnaire in soliciting responses" (Cook & Campbell, 1979:37).

## 3.12. Ethics

Ethical research relates to, inter alia,

> … research that focuses on concise concepts as well as on variables. It collects information under controlled conditions, and uses structured and established procedures to do so. It uses objectivity in the analysis of information. It analyses numerical information using statistical procedures, it involves logistic and deductive reasoning, and the investigator does not interact with the event being researched (Unisa's Policy on Research Ethics, 2007).

## 3.13. Chapter Summary

This chapter has reviewed the various strategies and methodologies relevant to this research study. It has presented the specific research methodology used to carry out the study and the reasons for adopting it.

Figure 3.6 below illustrates a research process onion that provides a high-level overview of the research methodology adopted.

The choice of the research methodology is the underlying foundation to conducting the entire research study. The descriptive study approach was deemed to be the most appropriate option and adopted for this study. This is because it allowed the in-depth

examination and gathering of information to investigate the effects of implementing a real-time IT logistics solution. The interpretivist research philosophy was chosen for the interpretation and meaning of the findings.

A distinction was made between qualitative and quantitative methods. This study employed the quantitative method based on the deductive reasoning approach. The approach was more appropriate for studying the phenomena in this study and describes the nature of the consequences identified. The survey research strategy was adopted for the study to enable the collection of data. It allowed in-depth examination and the gathering of information that explains the relationships between constructs and, in particular, cause-and-effect relationships.

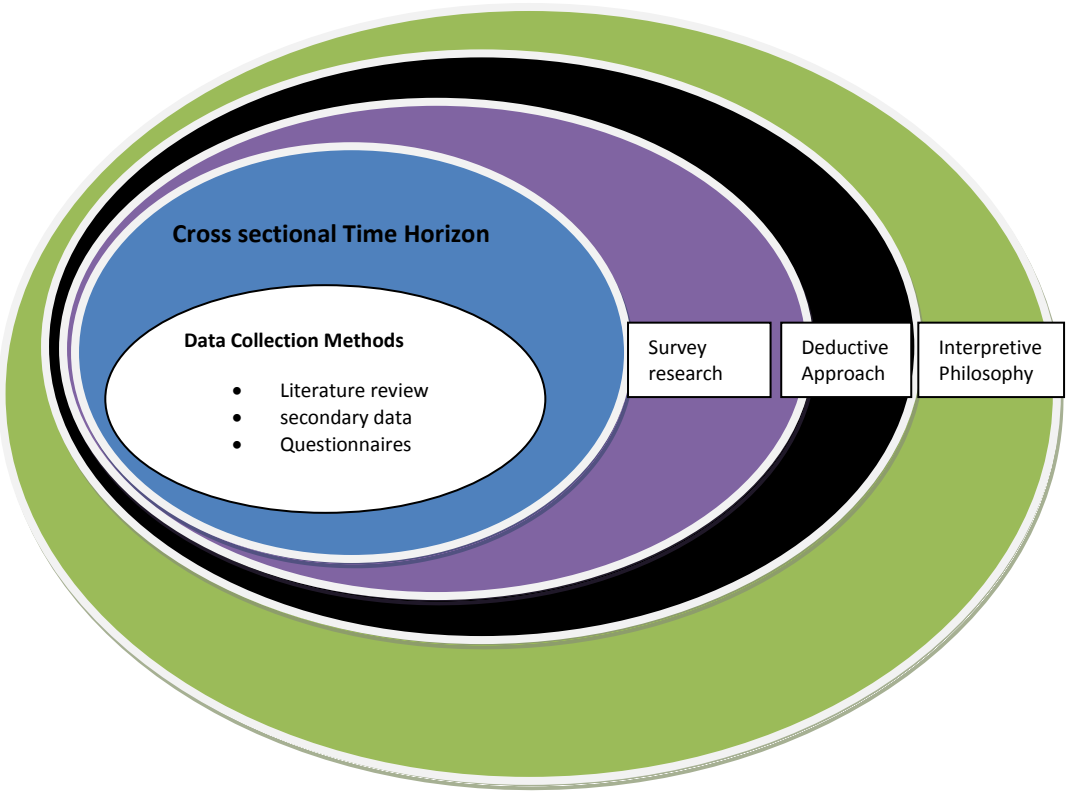



Figure 3.6: Process onion – overview of the research methodology adopted

Both cross-sectional and longitudinal research time horizons were used since data collection would happen in a given period and also from snapshots of time before and after the installation of the GPSs. The sampling procedure adopted in this study was one-stage cluster sampling due to the fact that the elements contained in the clusters represent the heterogeneity of the population being studied and are homogeneous among them. A simple

random sampling technique was used in selecting the required clusters that would provide a sufficiently representative sample for the study. The descriptive technique and the content analysis method were the two data analysis methods adopted to enhance the understanding for an accurate and concise presentation of the results obtained in a way that answers the study questions.

# CHAPTER FOUR

**Stage in Dissertation**

| | | |
|---|---|---|
| CHAPTER 1: Introduction | Provides an introduction to the general context for the research problem and also covers in brief the research objectives and methodology for the proposed study | |
| CHAPTER 2: Literature Review | Presents a review of literature and examines the historical development of the fleet management systems in respect to the research topic. | |
| CHAPTER 3: Research Methodology | Describes the design, target population, sample and sampling procedure used, research instruments, piloting of the instruments, data collection and data analysis. | |
| **CHAPTER 4: Data Collection and Data Analysis** | 4.1 | Introduction |
| | 4.2 | Data Collection using the Questionnaire |
| | 4.3 | Implementation of GPS FMS |
| | 4.4 | Data Collection and the Data Analysis Method |
| | 4.5 | Data Collection and Analysis from N/Rift |
| | 4.6 | Data Collection and Analysis from M/Kenya |
| | 4.7 | Data Collection and Analysis from C/Office |
| | 4.8 | Variables/Factors that influenced the Outcome |
| | 4.9 | Summary of Data Collection and Analysis |
| CHAPTER 5: Discussion on Research Findings and Recommendations | Describes in detail the research output and presents recommendations derived from the results obtained | |
| CHAPTER 6: Research Summary and Conclusion | Presents a summary of the key research findings from the research work accomplished and draws conclusions in respect of the research questions. | |

## 4. Data Collection and Data Analysis

### 4.1. Introduction

This chapter presents the results of the research study and outlines the effects of implementing a real-time IT logistics solution on a business. The research undertook to study the impact of implementing the GPS fleet management system on KPLC by carrying out an evaluation of any improvement achieved in the transportation of staff, goods and materials.

The results of the data analysis provide valuable understanding and possible answers to the research questions below and are, therefore, important in meeting the objectives of the study.

- What is the effect of GPS on reducing the rate of accidents?
- What is the effect of GPS on improving fleet availability?
- How has GPS assisted in reducing the fleet operations costs?
- How has GPS assisted in reducing the average vehicle breakdowns?
- What has been the effect of GPS in minimising theft of vehicles?
- What benefits have accrued from using IT solutions in fleet management?

The research findings of this study are presented for all the variables using tables and charts when appropriate, followed by discussion of the implications of the findings on the subject matter.

## 4.2. Data Collection Using the Questionnaire

### *4.2.1. The Random Sampling Procedure*

The sampling numbers were generated with the StatTrek's Random Number Generator (StatTrek, 2012), which uses a statistical algorithm to produce random numbers. Clustering the transport branches as they are distributed was done and then three out of the ten branches were selected using simple random sampling to give a sufficient representative sample. The random numbers generated by the StatTrek's Random Number Generator (Appendix VI) were as follows;-

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **08** | **01** | **07** | **09** | **04** | **10** | **03** | **06** | **02** | **05** |

**Fleet Distribution in the Ten KPLC Branches**

Table 4.1: List of KPLC branches

| Listing | KPLC branches | Fleet size | GPS units | Random sampling |
|---|---|---|---|---|
| **01** | **Central Office** | **195** | **143** | **Selection 2** |
| 02 | Nairobi North | 212 | 137 | |
| 03 | Nairobi South | 256 | 144 | |
| 04 | Nairobi West | 165 | 99 | |
| 05 | Central Rift | 159 | 104 | |
| 06 | West Kenya | 271 | 143 | |
| **07** | **North Rift** | **158** | **101** | **Selection 3** |
| **08** | **Mt Kenya North** | **195** | **105** | **Selection 1** |
| 09 | Mt Kenya South | 117 | 69 | |
| 10 | Coast | 254 | 155 | |
| **Total** | | **1982** | **1200** | |

Therefore, the first three numbers from the randomly generated list represent the three clusters selected for data collection as presented in Table 4.2 below;-

Table 4.2: Three clusters randomly selected for data collection

| Listing | KPLC branches | Total fleet | Fitted GPS units |
|---|---|---|---|
| 08 | Mt Kenya North | 195 | 105 |
| 01 | Central Office | 195 | 143 |
| 07 | North Rift | 158 | 101 |
| **Total** | | **548** | **349** |

The random sampling adopted in this study was one-stage cluster sampling and the procedure was as follows:

- The population was divided into a set of different coherent areas.
- The sampling clusters were selected through the simple random sampling technique.

### *4.2.2. The Selected Sample Size*

Using the random sampling procedure, three branches from different geographical regions were selected, giving a total sample size of 349 units to represent a fleet population size of 1,200 units, higher than the 291 units recommended as a minimum according to the Guide to Minimum Sample Size (Krejcie & Morgan, 1970). The sample size of 349 units was deemed sufficient representation of the whole population, as the elements contained in the

clusters represented the heterogeneity of the population being studied and were homogeneous among them. The details of the three branches selected are as follows:

- Out of a total fleet size of 158 units the North Rift branch has 101 vehicles fitted with GPS units, thus 64% of the overall fleet strength in the branch.
- Out of a fleet size of 195 units the Mt Kenya North branch has 105 vehicles fitted with GPS units, thus 54% of the overall fleet strength in the branch.
- Out of a total fleet size of 195 units the Central Office has 143 vehicles fitted with GPS units, thus 73% of the overall fleet strength in the branch.

The self-administered questionnaires (Appendix1) were issued via the company's intranet communication system to the respective fleet operators in the three selected areas with vehicles installed with GPS units. The research questionnaire was designed to obtain direct and motivated responses from the respondents. The information from the respondents was crucial in examining the contribution of the GPS fleet management system to the organisations under study. Bazeley (2002:6) states that "coding or categorizing of data is undertaken to facilitate understanding and retrieval of information". All the research findings were therefore coded to assist in the categorisation and review of the numerous research variables contained in the questionnaires.

## 4.3. Implementation of the GPS Fleet Management System

The company (KPLC) had awarded the tender for the supply and installation of a GPS fleet tracking system, initially consisting of 500 on-board computers units and accessories, to M/s Binary Computer Systems Ltd and a later tender for a further 700 on-board computers units to M/s FTS (Africa) Ltd. The implementation of the GPS fleet management system commenced in 2009 and the full implementation was completed by 2010.

The commissioning of the system was done by ascertaining the transmission of signals from the units via GPRS to an online web-based fleet management system for hosting and data storage purposes. The total cost for the supply and installation of the 1200 GPS fleet tracking units, inclusive of the service level agreement charges for the maintenance of the units and the software are as depicted in Table 4.3 in the next page.

Table 4.3: Cost of the supply and installation of the GPS fleet tracking units

| Firm | Units | Total cost in Ksh. | Average cost per unit in Ksh. |
|---|---|---|---|
| M/s Binary Ltd | 500 | 36,297,560 | 72,595 |
| M/s FTS Ltd | 700 | 43,922,114 | 62,745 |
| **Total** | **1,200** | **80,219,674** | **66,850** |

The overall supply, installation and maintenance costs for the randomly selected branches are presented in Table 4.4 below.

Table 4.4: Overall supply, installation and maintenance costs per branch

| Branch | Units fitted | Total cost in Ksh. |
|---|---|---|
| North Rift | 101 | 6,751,822 |
| Mt Kenya North | 105 | 7,019,221 |
| Central Office | 143 | 9,559,511 |
| **Total** | **349** | **23,330,555** |

In addition, the company implemented a complementary electronic fuel card system to control fuel usage and to deter fuel siphoning by fleet operators. The fuel transactions are transmitted online to a central server and the fuel data is integrated with the GPS to generate individual vehicle fuel consumption analysis reports for monitoring and control purposes.

## 4.4. Data Collection and Data Analysis Method

### *4.4.1. Response Rate*

A total of 334 responses out of the 349 questionnaires sent out were received, achieving an acceptable response rate of 96%. All the questionnaires were edited and checked for completeness and used in the data analysis.

### *4.4.2. Consolidation of Data for Analysis*

The actual data collected from the questionnaires received and consolidated for analysis are produced here as follows:

North Rift Sub-region – see section 4.5

Mt Kenya North Sub-region – see section 4.6

Central Office – see section 4.7

The data collected was based on the survey questionnaire which was used in the study for the purpose of collecting the required sample data. The questionnaires were structured to obtain responses to the key variables crucial in examining the contribution of the GPS fleet management system to the organisations under study.

These key variables and the respective research questions, as captured in the questionnaires, are reproduced below for convenience:

**Part A – Demographic data of the respondents**

1. What is your gender?
2. State your highest level of education
3. How long have you been working for KPLC?
4. Office location and sub-region

**Part B – Reduction in motor fleet accidents between year 2009 and 2010**

1. Indicate the number of accidents that occurred between 2009 and 2010.
2. Indicate the average rate of accidents between 2009 and 2010.
3. Has there been any reduction in the accident rate between 2009 and 2010?

**Part C – Improvement in fleet availability between year 2009 and 2010**

1. Indicate the average fleet availability in your area in the periods indicated:
2. Has the fleet availability increased in the same period?
3. How would you rate the importance of the GPS fleet tracking system in the improvement of efficiency in vehicle operations?

**Part D – Reduction in the fleet costs between year 2009 and 2010**

1. Indicate the monthly vehicle fuel and maintenance costs in the periods between 2009 and 2010 below:

- fuel and oil consumed in kilometres per litre
- maintenance costs in Ksh/km

2. How would you rate the contribution of the GPS fleet tracking system to the reduction in vehicle operational costs?

**Part E – Reduction in frequency of vehicle breakdowns between year 2009 and 2010**

1. Indicate the number of vehicles which broke down in the periods indicated below:

2. Has the number of vehicle breakdowns reduced in the same period?
3. How would you rate the contribution of the GPS fleet tracking system to the reduction in vehicle breakdowns?

**Part F – Reduction in vehicle theft between year 2009 and 2010**

1. Indicate the vehicles stolen in your area in the periods indicated below:
2. Has the number of vehicle thefts reduced in the same period?
3. Has the implementation of the GPS fleet tracking system contributed to the prompt recovery of any stolen motor vehicles?

**Part G – Perceptions of staff towards the GPS implementation.**

1. To what extent do you agree with the following statements as they relate to the implementation of GPS tracking in KPLC?
2. The Adoption of modern information technology in fleet management has led to improved efficiency in the service delivery at KPLC.
3. Adopting new technology equipment is a necessary tool for efficiency in service delivery.
4. The increased use of modern IT solutions will result in longer term relationships with prospective customers.
5. Organisations must be able to integrate knowledge from information technology to deliver new products or services efficiently.
6. In a fast-moving world, constant improvement on IT is essential for survival and success in efficient service delivery.

Descriptive statistics and correlations were employed in the study to analyse the data collected from each of the respective sub-regions in order to study the resultant effect on the key variables. The results of this study are intended to establish to what extent the GPS fleet management system has improved effectiveness and efficiency at KPLC.

## 4.5. Data Collection and Analysis from the North Rift Sub-Region

### *4.5.1. Number of Accidents*

Table 4.5A: Accident rate before GPS installation - North Rift

| | Period | Total fleet | Before GPS installation | Distance travelled in km | No. of accidents | Accident rate (per million km) |
|---|---|---|---|---|---|---|
| 1 | Jan-09 | 158 | | 170,231 | 0 | 0.00 |
| 2 | Feb-09 | 158 | | 154,632 | 0 | 0.00 |
| 3 | Mar-09 | 158 | | 200,478 | 0 | 0.00 |
| 4 | Apr-09 | 158 | | 200,318 | 0 | 0.00 |
| 5 | May-09 | 158 | | 233,555 | 0 | 0.00 |
| 6 | Jun-09 | 158 | | 241,694 | 0 | 0.00 |
| 7 | Jul-09 | 158 | | 229,932 | 0 | 0.00 |
| 8 | Aug-09 | 158 | | 242,684 | 0 | 0.00 |
| 9 | Sep-09 | 158 | | 219,462 | 1 | 4.56 |
| 10 | Oct-09 | 158 | | 219,633 | 0 | 0.00 |
| 11 | Nov-09 | 158 | | 234,970 | 2 | 8.51 |
| 12 | Dec-09 | 158 | | 213,298 | 1 | 4.69 |
| | **Average** | **158** | | **213,407** | | **1.56** |

Table 4.5B: Accident rate after GPS installation - North Rift

| | Period | Total fleet | GPS installation | Distance travelled in km | No. of accidents | Accident rate (per million km) |
|---|---|---|---|---|---|---|
| 1 | Jan-10 | 158 | 101 | 224,490 | 0 | 0.00 |
| 2 | Feb-10 | 158 | 101 | 221,784 | 0 | 0.00 |
| 3 | Mar-10 | 158 | 101 | 208,268 | 1 | 4.80 |
| 4 | Apr-10 | 158 | 101 | 233,005 | 0 | 0.00 |
| 5 | May-10 | 158 | 101 | 222,527 | 0 | 0.00 |
| 6 | Jun-10 | 158 | 101 | 200,967 | 1 | 4.98 |
| 7 | Jul-10 | 158 | 101 | 216,903 | 0 | 0.00 |
| 8 | Aug-10 | 158 | 101 | 242,098 | 0 | 0.00 |
| 9 | Sep-10 | 158 | 101 | 246,626 | 0 | 0.00 |
| 10 | Oct-10 | 158 | 101 | 234,184 | 0 | 0.00 |
| 11 | Nov-10 | 158 | 101 | 236,812 | 0 | 0.00 |
| 12 | Dec-10 | 158 | 101 | 227,833 | 0 | 0.00 |
| | **Average** | **158** | **101** | **226,291** | | **0.74** |

**Use of GPS Monitoring to Reduce Occurrence of Accidents**

The GPS vehicle tracking system is a valuable tool for providing speed violations and the recorded pre-accident and post-accident data which is critical during investigations in establishing the circumstances in which an accident occurred. The overall accident rate in North Rift was reduced from an average of 1.56 to 0.74 accidents per one million kilometres. After the installation there was a noticeable reduction in speeding which, in turn, contributed to an improvement on the safety records and a reduction in undue accident costs as depicted in Table 4.5A and 4.5B on the previous page.

Strong relationships have been established between speed and accident risk with higher speeds increasing the likelihood of an accident occurring. Therefore, the possibility of avoiding a collision becomes smaller as speed increases. With increasing speed, the accident risk increases more as the absolute speed is higher. The enhanced monitoring of driving behaviour through online GPS reports has led to improved driving habits and increased safety which reduce the chances of an accident happening. This has translated into a huge reduction in the rate of accidents measured in million kilometres. As indicated in figure 4.1 below, by the end of 2010, the rate of accidents had fallen to below 0.8 accidents per million kilometres.

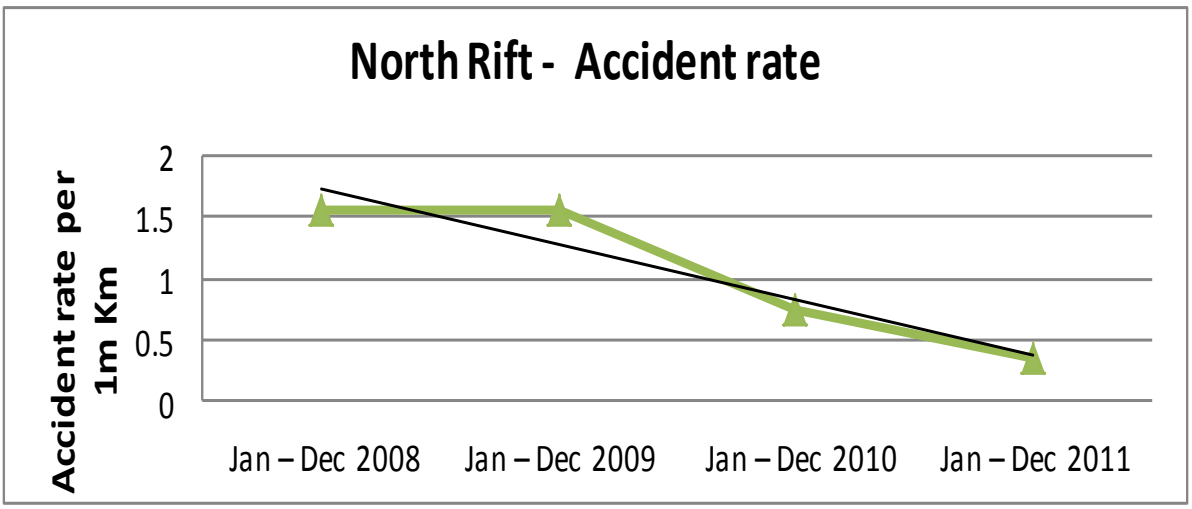



Figure 4.1: Reduction in accidents between 2008 and 2011 – North Rift

The driver's performance assessment based on GPS "green band driving" reports, factual investigation of all accidents (now augmented by GPS snapshot reports) and the taking of remedial action against careless driving has created an impetus for behavioural change with a consequent reduction in the rate of accidents. The overall reduction in the accident rate in North Rift dropped from an average of 1.56 to 0.74 accidents per one million

kilometres. In 2010, the company vehicles travelled an average of 226,291 kilometres in a month, amounting to a total of 2,715,497 kilometres. The accident occurrence dropped from approximately four to two accidents.

Table 4.6: Reduction in accident cost after GPS implementation – North Rift

| North Rift | Distance travelled in km | Rate of accidents per m km | No of accidents | Average cost of an accident – Ksh. | Annual accident cost – Ksh. |
|---|---|---|---|---|---|
| Before GPS implementation – 2009 | 2,560,887 | 1.56 | 4 | 100,000 | 400,000 |
| After GPS implementation – 2010 | 2,715,497 | 0.74 | 2 | 100,000 | 200,000 |
| **Reduction** | | **52.56%** | | | **200,000** |

The accident reduction of about 53% resulted in cost saving of approximately Ksh.200,000 in 2010 at an average total cost about Ksh.100,000 per accident in pay-outs for accidents, traffic violations and associated costs as depicted in Table 4.6 above.

### *4.5.2. Fleet Availability*

The increase in the percentage of available vehicles as compared to the total allocated fleet rose from 96.80 to 98.23% with a consequent increase in revenue generated as a result of the higher mileage covered. This represents a direct financial contribution from the resultant effect on a more efficient logistical process.

Table 4.7A: Fleet availability before GPS installation – North Rift

| | Period | Total fleet | Before GPS installation | Distance travelled in km | Fleet availability (%) |
|---|---|---|---|---|---|
| 1 | Jan-09 | 158 | | 170,231 | 96.80 |
| 2 | Feb-09 | 158 | | 154,632 | 97.00 |
| 3 | Mar-09 | 158 | | 200,478 | 95.40 |
| 4 | Apr-09 | 158 | | 200,318 | 95.30 |
| 5 | May-09 | 158 | | 233,555 | 96.95 |
| 6 | Jun-09 | 158 | | 241,694 | 96.15 |
| 7 | Jul-09 | 158 | | 229,932 | 97.33 |
| 8 | Aug-09 | 158 | | 242,684 | 97.08 |
| 9 | Sep-09 | 158 | | 219,462 | 97.51 |
| 10 | Oct-09 | 158 | | 219,633 | 96.68 |
| 11 | Nov-09 | 158 | | 234,970 | 97.68 |
| 12 | Dec-09 | 158 | | 213,298 | 97.74 |
| | **Average** | **158** | | **213,407** | **96.80** |

Table 4.7B: Fleet availability after GPS installation – North Rift

| | Period | Total fleet | GPS installed | Distance travelled in km | Fleet availability (%) |
|---|---|---|---|---|---|
| 1 | Jan-10 | 158 | 101 | 224,490 | 97.5 |
| 2 | Feb-10 | 158 | 101 | 221,784 | 97.64 |
| 3 | Mar-10 | 158 | 101 | 208,268 | 97.73 |
| 4 | Apr-10 | 158 | 101 | 233,005 | 98.8 |
| 5 | May-10 | 158 | 101 | 222,527 | 98.81 |
| 6 | Jun-10 | 158 | 101 | 200,967 | 98.7 |
| 7 | Jul-10 | 158 | 101 | 216,903 | 98.81 |
| 8 | Aug-10 | 158 | 101 | 242,098 | 98.86 |
| 9 | Sep-10 | 158 | 101 | 246,626 | 98.6 |
| 10 | Oct-10 | 158 | 101 | 234,184 | 97.97 |
| 11 | Nov-10 | 158 | 101 | 236,812 | 97.18 |
| 12 | Dec-10 | 158 | 101 | 227,833 | 98.24 |
| | **Average** | **158** | **101** | **226,291** | **98.23** |

The objective of improving fleet availability is one way in which to gain a competitive edge by providing superior customer service with improved efficiency and closer customer and supplier relationships. The greatest advantage has been the real-time monitoring and interaction with fleet vehicles to attain high fleet operation and provide a fast response to customer needs. This was largely as a result of enforcing speed limits and good driving habits, an important feature of the GPS technology. This, in turn, leads to increased productivity because of better safety and operational management decisions.

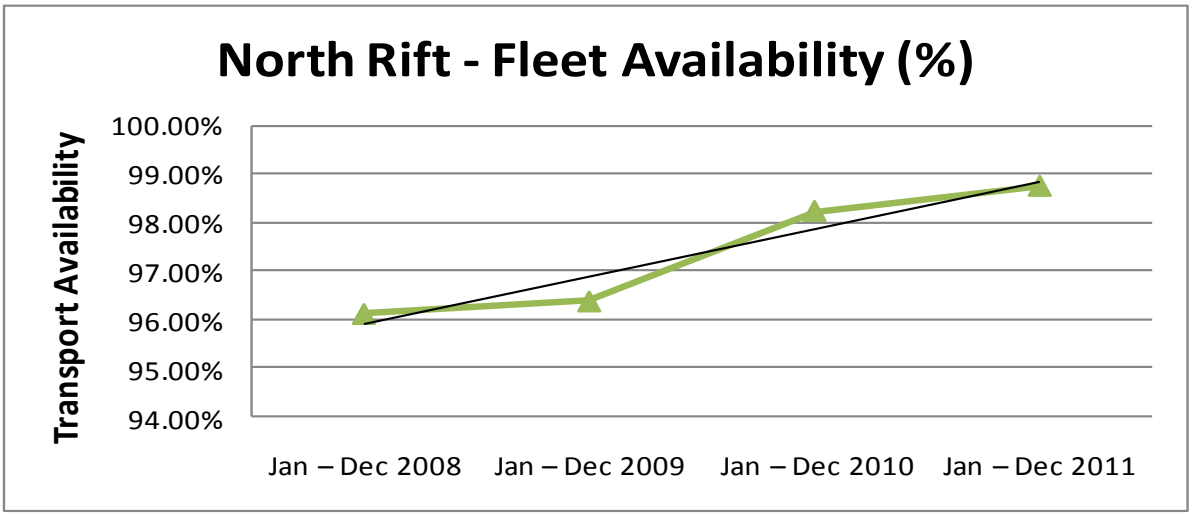



Figure 4.2: Fleet availability improvement between 2008 and 2011 – North Rift

**Improvement in Revenue Growth due to Increased Fleet Availability**

As illustrated in figure 4.2 on the previous page, the average transport availability improved to 98.23%. Consequently, there was an increase in the revenue generated from the higher mileage covered in the vehicle trips made for transportation activities.

Table 4.8: Revenue growth due to increased availability between 2009 and 2010 – North Rift

| North Rift | Fleet size fitted with GPS | Revenue generated in Ksh. | Annual yield per unit Ksh. |
|---|---|---|---|
| Before GPS implementation – 2009 | 0 | 125,780,762 | 1,245,354 |
| After GPS implementation – 2010 | 101 | 135,342,884 | 1,340,028 |
| Total increase | | 9,562,122 | 8% |
| **Revenue increase per vehicle** | | | **94,674** |

The increased fleet availability and the achievement of a more efficient logistical process resulted in a direct financial contribution to the company revenue. The data analysis shows an increase in the individual vehicle of 8%, resulting in an additional yield per unit of Ksh.94,674 as depicted in Table 4.8 above.

### *4.5.3. Fleet Costs and Fuel Efficiency*

Table 4.9A: Maintenance costs and fuel consumption rate before GPS installation – North Rift

| | Period | Total fleet | Before GPS installation | Distance travelled in km | Fuel consumed in km/litre | Maintenance costs (Ksh./km) |
|---|---|---|---|---|---|---|
| 1 | Jan-09 | 158 | | 170,231 | 6.45 | 8.45 |
| 2 | Feb-09 | 158 | | 154,632 | 5.79 | 8.74 |
| 3 | Mar-09 | 158 | | 200,478 | 6.86 | 7.15 |
| 4 | Apr-09 | 158 | | 200,318 | 7.22 | 7.52 |
| 5 | May-09 | 158 | | 233,555 | 7.28 | 7.28 |
| 6 | Jun-09 | 158 | | 241,694 | 7.26 | 8.09 |
| 7 | Jul-09 | 158 | | 229,932 | 6.96 | 7.79 |
| 8 | Aug-09 | 158 | | 242,684 | 7.28 | 9.02 |
| 9 | Sep-09 | 158 | | 219,462 | 6.85 | 7.63 |
| 10 | Oct-09 | 158 | | 219,633 | 6.55 | 8.05 |
| 11 | Nov-09 | 158 | | 234,970 | 6.84 | 7.30 |
| 12 | Dec-09 | 158 | | 213,298 | 6.77 | 7.51 |
| | **Average** | 158 | | **213,407** | **6.84** | **7.88** |

Table 4.9B:Maintenance costs and fuel consumption rate after GPS installation – North Rift

| | Period | Total fleet | GPS installed | Distance travelled in km | Fuel consumed in km/litre | Maintenance costs (Ksh./km) |
|---|---|---|---|---|---|---|
| 1 | Jan-10 | 158 | 101 | 224,490 | 8.58 | 8.45 |
| 2 | Feb-10 | 158 | 101 | 221,784 | 8.73 | 8.74 |
| 3 | Mar-10 | 158 | 101 | 208,268 | 8.11 | 8.62 |
| 4 | Apr-10 | 158 | 101 | 233,005 | 8.33 | 6.63 |
| 5 | May-10 | 158 | 101 | 222,527 | 8.03 | 7.78 |
| 6 | Jun-10 | 158 | 101 | 200,967 | 8.28 | 7.03 |
| 7 | Jul-10 | 158 | 101 | 216,903 | 8.01 | 5.41 |
| 8 | Aug-10 | 158 | 101 | 242,098 | 7.91 | 5.50 |
| 9 | Sep-10 | 158 | 101 | 246,626 | 8.05 | 4.67 |
| 10 | Oct-10 | 158 | 101 | 234,184 | 8.07 | 6.05 |
| 11 | Nov-10 | 158 | 101 | 236,812 | 7.65 | 5.88 |
| 12 | Dec-10 | 158 | 101 | 227,833 | 8.07 | 5.22 |
| | **Average** | **158** | **101** | **226,291** | **8.15** | **6.67** |

**Improvement in fleet maintenance costs**

The GPS function triggers an alert when any vehicle reaches its pre-set manufacturer mileage points and the operator may be reminded to take in the vehicle for servicing which reduces overall maintenance costs as shown in Table 4.9A (in previous page) and Table 4.9B above and figure 4.3 below. Previously, with manual maintenance records, it was impossible to effectively track each unit's servicing mileage intervals and this resulted in many premature breakdowns occasioning high maintenance costs.

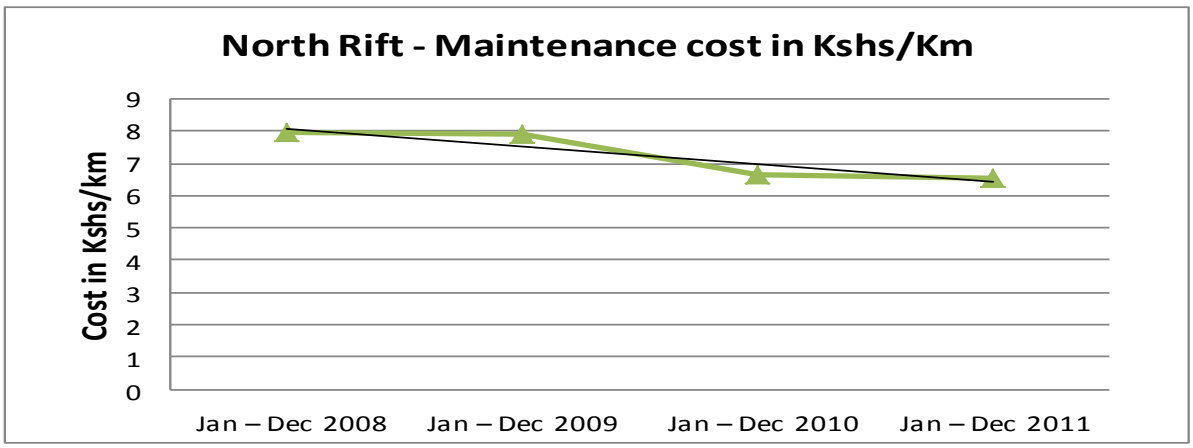



Figure 4.3: Fleet maintenance costs improvement between 2008 and 2011 – North Rift

The GPS alerts act as a tool of compliance to the planned maintenance schedule and help to prevent the premature failure of major vehicle parts. This results in significant savings in maintenance costs and increased fleet productivity.

As shown in Table 4.10 below this contributed to the achievement of higher operational efficiency.

Table 4.10: Reduction in fleet maintenance cost after GPS implementation – North Rift

| North Rift | Total distance travelled | Maintenance cost in Ksh./km | Annual maintenance cost in Ksh. |
|---|---|---|---|
| Before GPS implementation – 2009 | 2,560,887 | 7.88 | 21,398,116 |
| After GPS implementation – 2010 | 2,715,497 | 6.67 | 18,112,365 |
| **Savings on maintenance costs** | | **15.36%** | **3,285,751** |

The results show a reduction in maintenance costs of 15% from Ksh.7.88 to Ksh.6.67 per kilometres travelled. This is a significant saving in costs considering that, in 2010 in the North Rift area, the total distance travelled was 2,715,497 kilometres. In monetary terms and using this distance to compute the gains, the analysis shows that a saving of Ksh.3,285,751 in maintenance costs was made in only one year.

**Improvement in fuel efficiency measured in km per litre**

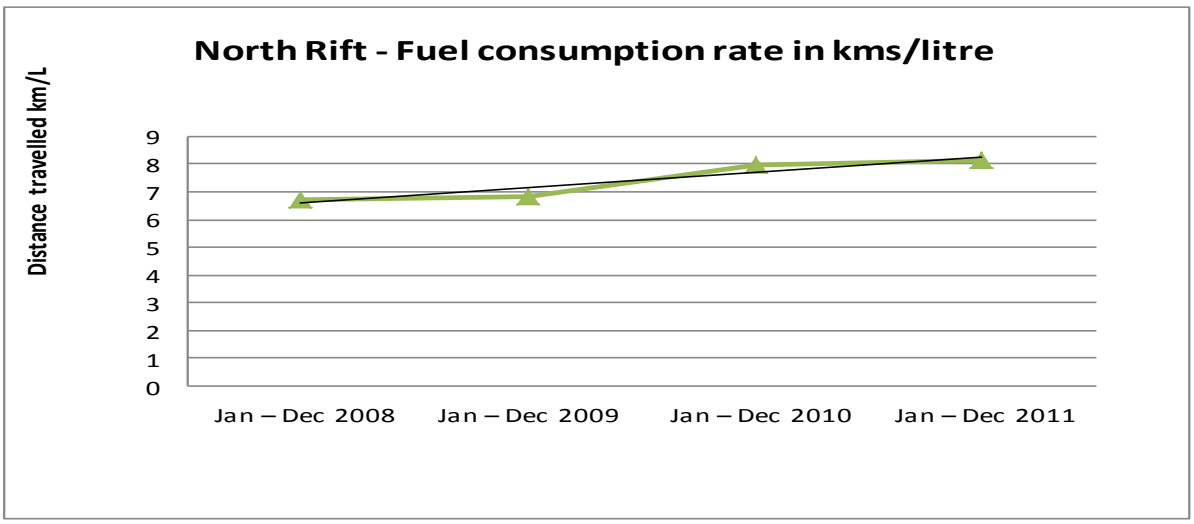



Figure 4.4: Fuel efficiency between 2008 and 2011 – North Rift

The fuel consumption efficiency at North Rift increased from an average of 6.84 km to 8.15 km per litre as shown in fig. 4.4 above. The integration of fuelling transaction data from electronic fuel cards with the GPS tracking system assists in monitoring the actual fuel consumption as compared to what is being reported by the employee. This helps to control

fuel usage and deter fuel siphoning by operators in collusion with the pump attendants. The fuel transactions are transmitted online to a central server and the fuel data integrated with the GPS to generate individual vehicle fuel consumption analysis reports for monitoring and control purposes. In addition, the use of GPS geo-fencing and routing of vehicle trips to minimise illegal journeys that are not authorised or planned resulted in more efficient resource utilisation levels while, at the same time, controlling service-related costs. As shown in Table 4.9A in page 87, Table 4.9B in page 88 and in Table 4.11 below, there was a reduction in the fuel consumption cost in Kenyan shillings per kilometre (Ksh./km). The results show an overall reduction of 9% from Ksh.14.5 to Ksh.13.2 per km and, using the distance of 2,715,497 travelled in North Rift, the savings from the reduction in fuel consumption amounted to Ksh.3,530,146 in only one year.

Table 4.11: Reduction in fuel consumption cost after GPS implementation – North Rift

| **North Rift** | **Total distance travelled** | **Fuel cost in Ksh./km** | **Total cost of fuel consumed in Ksh.** |
|---|---|---|---|
| Before GPS implementation – 2009 | 2,560,887 | 14.5 | 39,374,707 |
| After GPS implementation – 2010 | 2,715,497 | 13.2 | 35,844,560 |
| **Savings on fuel costs** | | **8.97%** | **3,530,146** |

The effective implementation of the maintenance programme and monitoring the actual fuel consumption rate for each individual vehicle resulted in significant savings and increased fleet productivity. The overall total savings from both maintenance and fuel consumption amounted to Ksh.6,815,897 in 2010.

### *4.5.4. Frequency of Vehicle Breakdowns*

A high frequency of breakdown not only causes high maintenance costs but also causes unnecessary downtime which compromises on service delivery. A reduction in breakdowns improves fleet serviceability and reliability in both operational and distribution activities.

The frequency of vehicle breakdowns in North Rift reduced from a monthly average of 21 vehicles to only 12 between 2009 and 2010. The use of the Green Band Assessment Method based on tracking reports which consider a number of factors that constitute good driving habits has resulted in improved productivity, reduced operational costs and better customer service as depicted in Table 4.12A and 4.12B in the next page.

Table 4.12A: Frequency of vehicle breakdowns before GPS installation – North Rift

| | Period | Total fleet | Before GPS installation | Distance travelled in kms | Breakdown incidences |
|---|---|---|---|---|---|
| 1 | Jan-09 | 158 | | 170,231 | 19 |
| 2 | Feb-09 | 158 | | 154,632 | 19 |
| 3 | Mar-09 | 158 | | 200,478 | 30 |
| 4 | Apr-09 | 158 | | 200,318 | 31 |
| 5 | May-09 | 158 | | 233,555 | 20 |
| 6 | Jun-09 | 158 | | 241,694 | 25 |
| 7 | Jul-09 | 158 | | 229,932 | 17 |
| 8 | Aug-09 | 158 | | 242,684 | 18 |
| 9 | Sep-09 | 158 | | 219,462 | 16 |
| 10 | Oct-09 | 158 | | 219,633 | 19 |
| 11 | Nov-09 | 158 | | 234,970 | 15 |
| 12 | Dec-09 | 158 | | 213,298 | 17 |
| | **Average** | **158** | | **213,407** | **21** |

Table 4.12B: Frequency of vehicle breakdowns after GPS installation – North Rift

| | Period | Total fleet | GPS installed | Distance travelled in kms | Breakdown incidences |
|---|---|---|---|---|---|
| 1 | Jan-10 | 158 | 101 | 224,490 | 14 |
| 2 | Feb-10 | 158 | 101 | 221,784 | 15 |
| 3 | Mar-10 | 158 | 101 | 208,268 | 13 |
| 4 | Apr-10 | 158 | 101 | 233,005 | 11 |
| 5 | May-10 | 158 | 101 | 222,527 | 12 |
| 6 | Jun-10 | 158 | 101 | 200,967 | 10 |
| 7 | Jul-10 | 158 | 101 | 216,903 | 10 |
| 8 | Aug-10 | 158 | 101 | 242,098 | 13 |
| 9 | Sep-10 | 158 | 101 | 246,626 | 10 |
| 10 | Oct-10 | 158 | 101 | 234,184 | 12 |
| 11 | Nov-10 | 158 | 101 | 236,812 | 14 |
| 12 | Dec-10 | 158 | 101 | 227,833 | 13 |
| | **Average** | **158** | **101** | **226,291** | **12** |

By focusing on safe and defensive driving habits, the incidences of accident-related breakdowns and premature engine failure have been drastically reduced, leading to fewer vehicles being referred to the workshop for repairs. Even though it is difficult to quantify the actual savings directly associated with the reduction in breakdowns, it is appreciated that a reduction in breakdowns contributes immensely to higher fleet availability and lower maintenance costs as depicted in figure 4.5 on the next page.

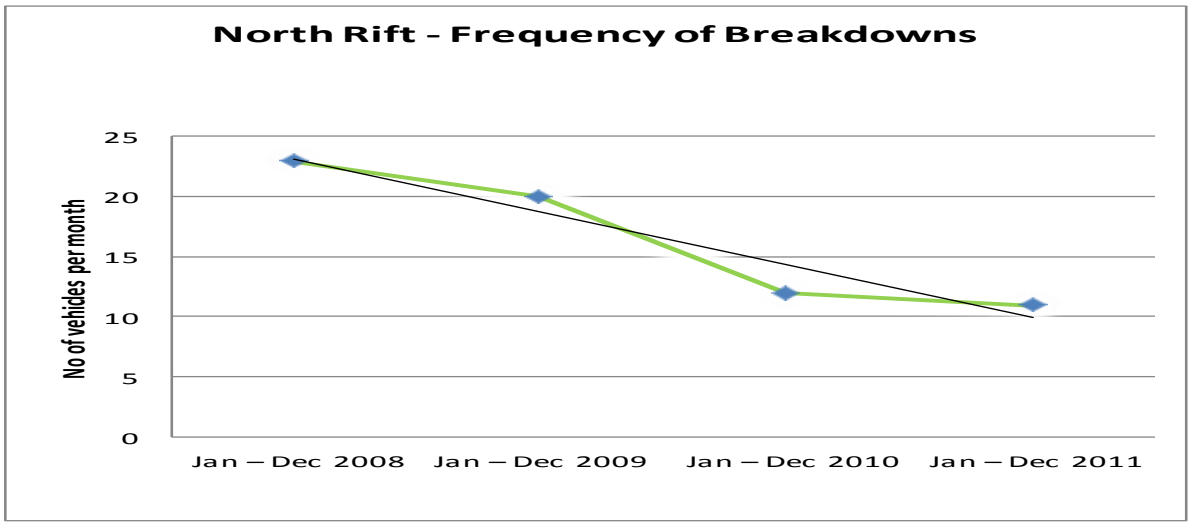



Figure 4.5: Frequency of breakdowns between 2008 and 2011 – North Rift

### *4.5.5. Rate of Theft and Recovery of Motor Vehicles*

Online GPS technology which allows real-time tracking has a variety of features and operational benefits that have improved the safety of drivers and the security of vehicles, significantly reducing pay-outs on accident costs and traffic violations as shown in figure Table 4.13A below, Table 4.13B and in figure 4.6 in the next page.

Table 4.13A: Rate of theft of motor vehicles before GPS installation – North Rift

| | Period | Total fleet | Before GPS installation | Vehicle thefts |
|---|---|---|---|---|
| 1 | Jan-09 | 158 | | 0 |
| 2 | Feb-09 | 158 | | 0 |
| 3 | Mar-09 | 158 | | 0 |
| 4 | Apr-09 | 158 | | 0 |
| 5 | May-09 | 158 | | 1 |
| 6 | Jun-09 | 158 | | 0 |
| 7 | Jul-09 | 158 | | 0 |
| 8 | Aug-09 | 158 | | 0 |
| 9 | Sep-09 | 158 | | 0 |
| 10 | Oct-09 | 158 | | 0 |
| 11 | Nov-09 | 158 | | 1 |
| 12 | Dec-09 | 158 | | 0 |
| | **Total** | **158** | | **2** |

Table 4.13B: Rate of theft of motor vehicles after GPS installation – North Rift

| | Period | Total fleet | GPS installed | Vehicle theft |
|---|---|---|---|---|
| 1 | Jan-10 | 158 | 101 | 0 |
| 2 | Feb-10 | 158 | 101 | 0 |
| 3 | Mar-10 | 158 | 101 | 0 |
| 4 | Apr-10 | 158 | 101 | 0 |
| 5 | May-10 | 158 | 101 | 1 |
| 6 | Jun-10 | 158 | 101 | 0 |
| 7 | Jul-10 | 158 | 101 | 0 |
| 8 | Aug-10 | 158 | 101 | 0 |
| 9 | Sep-10 | 158 | 101 | 0 |
| 10 | Oct-10 | 158 | 101 | 0 |
| 11 | Nov-10 | 158 | 101 | 0 |
| 12 | Dec-10 | 158 | 101 | 0 |
| | **Total** | **158** | **101** | **1** |

**Reduced rate of theft and increased recovery of motor vehicles**

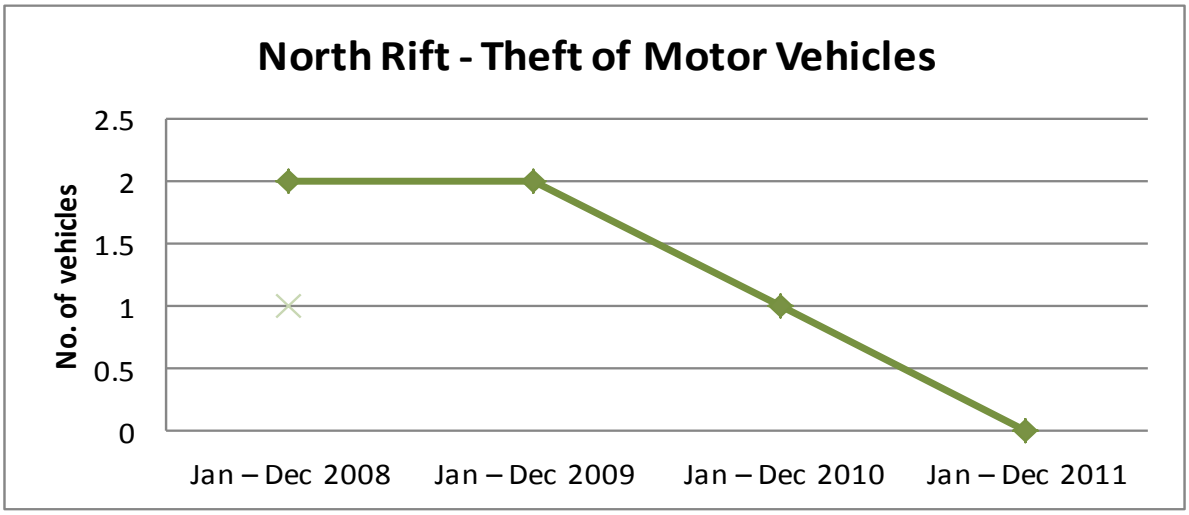



Figure 4.6: Rate of theft of motor vehicles between 2008 and 2011 – North Rift

Online GPS technology allows real-time tracking and, with the "ping" feature, regular updates on the stolen vehicle location appear on the dashboard screen which may be used to disable a vehicle in operation, remotely if necessary, in the course of security recovery. The one motor vehicle stolen in 2010 was recovered through security follow up with the aid of the GPS live tracking function. The system ensures the security of the vehicles and reduces the chances of vehicle being stolen as shown in Table 4.14 in the next page.

Table 4.14: Reduction in theft of vehicles after GPS implementation – North Rift

| North Rift | No of stolen vehicles | Cost of loss in million Ksh. per vehicle | Total cost in million Ksh. |
|---|---|---|---|
| Before GPS implementation – 2009 | 2 | 5.0 | **10.0** |
| After GPS implementation – 2010 | 0 | 0 | **0** |
| **Savings in reduced theft cases** | **0** | **100%** | **10.0** |

### *4.5.6. Perceptions of Staff towards the Implementation of the GPS*

The respondents were asked to rate how the Adoption of modern information technology and adopting new technology equipment in fleet management have increased efficiency in the service delivery at KPLC. With the response rate of 35% on 5 **(= strongly agree)** and 47% on 4 **(= agree**) and an overall acceptance level of 82% on all the items, this may be taken as a positive indicator of individual willingness to support the process of implementation and to adopt the new technologies in fleet management in order to enhance the efficiency of the company operations as shown in Table 4.15 below.

Table 4.15: Responses on the implementation of the GPS System – North Rift

| | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|
| 1-Adoption of modern information technology in fleet management has led to improved efficiency in the service delivery | 35% | 46% | 15% | 3% | 0% |
| 2-Adopting new technology equipment is a necessary tool for efficiency in service delivery. | 38% | 48% | 11% | 2% | 0% |
| 3-The increased use of modern IT solutions will result in longer term relationships with prospective customers | 36% | 42% | 15% | 2% | 4% |
| 4-Organisations must be able to integrate knowledge from IT to deliver new products or service efficiently | 30% | 55% | 15% | 0% | 0% |
| 5-In a fast moving world constant improvement in IT is essential for survival and success in service delivery | 37% | 42% | 18% | 3% | 0% |
| **Average approval %** | **35** | **47** | **15** | **2** | **1** |

Note: 5=strongly agree, 4= agree, 3=neutral, 2=disagree and 1= strongly disagree

### Benefits of and Preparedness in Adopting a Fleet Management System

The North Rift branch has 101 vehicles fitted with GPS units. Although the GPS fleet tracking units provides limited online data on location and distance only, the application of the system generated data greatly contributes towards more efficient and effective fleet management processes.

### *4.5.7. Implementation Expenditure and Cost Reduction Achieved*

The cost of the supply and installation of the GPS fleet tracking units was Ksh.66,850 and included the service level agreement (SLA) for the maintenance of the units and the software management as depicted in Table 4.16 below.

Table 4.16: Expenses for the implementation of the GPS system – North Rift

| Cost element | Total GPS units fitted | GPS units fitting costs in Ksh. | Costs per unit in Ksh. |
|---|---|---|---|
| Cost for the supply and installation of the GPS fleet tracking units | 101 | 6,751,822 | 66,850 |

**Overall net savings as a result of the improved efficiency in the operations**

The ability to constantly track the location of a vehicle and the online records on vehicle speed and the distance travelled leads to increased efficiency; faster retrieval of the historical records of the vehicle's previous movements and an efficient fleet maintenance programme. The greatest savings were in the reduction in the theft of motor vehicles, the deterrence to fuel siphoning by the operators and the assessment of individual driving performances.

Table 4.17: Net savings as a result of the improved efficiency in the operations – North Rift

| Cost element | Costs before GPS implementation | Costs after GPS implementation | reduction % |
|---|---|---|---|
| 1-Accident damages and traffic violations | 400,000.00 | 200,000 | 50.00 |
| 2-Maintenance cost | 21,398,116 | 18,112,364 | 15.36 |
| 3-Fuel consumption | 39,374,706 | 35,844,560 | 8.97 |
| 4-Theft of vehicles | 10,000,000 | - | 100.00 |
| Total | 71,172,822 | 54,156,925 | 23.91 |
| **Net savings per unit** | **704,681** | **536,207** | **23.91** |

The aggregate annual savings of Ksh.168,474 per unit fitted is a significant contribution towards the achievement of lower costs of operation and covered the cost of the supply and installation of the GPS fleet tracking units at Ksh.66,850, which included the service level agreement (SLA) for the maintenance of the units and the software management. The net savings as a result of the increased efficiency in the operations amounts to Ksh.101, 625 as depicted in Table 4.17 above.

**Increased revenue generation from improved fleet availability in North Rift**

The successful implementation of the GPS fleet management system has had a very significant impact on the operational processes through enhanced effectiveness and efficiency in KPLC.

Table 4.18: Revenue generation from improved fleet availability – North Rift

| Cost element | Costs before GPS implementation | Costs after GPS implementation | Increase in yield in Ksh. |
|---|---|---|---|
| Revenue generation | 125,780,762 | 135,342,884 | 9,562,122 |
| Yield per unit | 1,340,028 | 1,245,354 | 94,674 |

The increased fleet availability created a higher payload capacity transported, resulting in higher revenues and better customer service. An increase in fleet availability also results in additional vehicles being available for the prompt transportation of staff and materials to various customer sites. There was an increase in yield of Ksh.94,674 per unit in 2010 – an additional direct contribution to the bottom-line as depicted in Table 4.18 above. The overall cost savings and increased revenue income due to operational efficiency amounted to Ksh. 26,578,019 as compared to the cost for the supply and installation of the 101 GPS fleet tracking units of Ksh.6,751,822. Therefore, the net overall savings in North Rift amounted to Ksh.19,826,197 in one year only, which shows that the use of the GPS fleet management has led to increased effectiveness and efficiency in the service delivery.

## 4.6. Data Collection and Analysis from Mt Kenya North Sub-Region

### *4.6.1. Number of Accidents*

Table 4.19A: Accident rate before GPS installation – Mt Kenya North

| | Period | Total fleet | Before GPS installation | Distance travelled in km | No. of accidents | Accident rate (per million km) |
|---|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 215,561 | 2 | 6.14 |
| 2 | Feb-09 | 195 | | 245,384 | 1 | 8.15 |
| 3 | Mar-09 | 195 | | 259,566 | 1 | 2.64 |
| 4 | Apr-09 | 195 | | 307,464 | 1 | 6.69 |
| 5 | May-09 | 195 | | 301,522 | 1 | 6.87 |
| 6 | Jun-09 | 195 | | 316,825 | 1 | 4.36 |
| 7 | Jul-09 | 195 | | 342,660 | 2 | 8.06 |
| 8 | Aug-09 | 195 | | 340,251 | 1 | 2.03 |
| 9 | Sep-09 | 195 | | 316,402 | 3 | 9.48 |
| 10 | Oct-09 | 195 | | 321,223 | 1 | 6.09 |
| 11 | Nov-09 | 195 | | 313,686 | 2 | 8.28 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | Dec-09 | 195 | | 321,966 | 1 | 2.03 |
| | **Average** | | | **300,209** | **1.42** | **5.90** |

Table 4.19B: Accident rate after GPS installation – Mt Kenya North

| | Period | Total fleet | GPS installed | Distance travelled in km | No. of accidents | Accident rate (per million km) |
|---|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 105 | 323632 | 2 | 6.18 |
| 2 | Feb-10 | 195 | 105 | 319198 | 0 | 0.00 |
| 3 | Mar-10 | 195 | 105 | 349301 | 1 | 2.86 |
| 4 | Apr-10 | 195 | 105 | 325981 | 1 | 3.07 |
| 5 | May-10 | 195 | 105 | 352447 | 1 | 2.84 |
| 6 | Jun-10 | 195 | 105 | 344314 | 0 | 0.00 |
| 7 | Jul-10 | 195 | 105 | 342506 | 2 | 5.84 |
| 8 | Aug-10 | 195 | 105 | 346489 | 2 | 5.77 |
| 9 | Sep-10 | 195 | 105 | 324523 | 2 | 6.16 |
| 10 | Oct-10 | 195 | 105 | 338052 | 1 | 2.96 |
| 11 | Nov-10 | 195 | 105 | 336108 | 2 | 5.95 |
| 12 | Dec-10 | 195 | 105 | 305275 | 1 | 3.28 |
| | **Average** | | **105** | **333986** | **1.25** | **3.74** |

## Reduction in accidents in Mt Kenya North Sub-Region

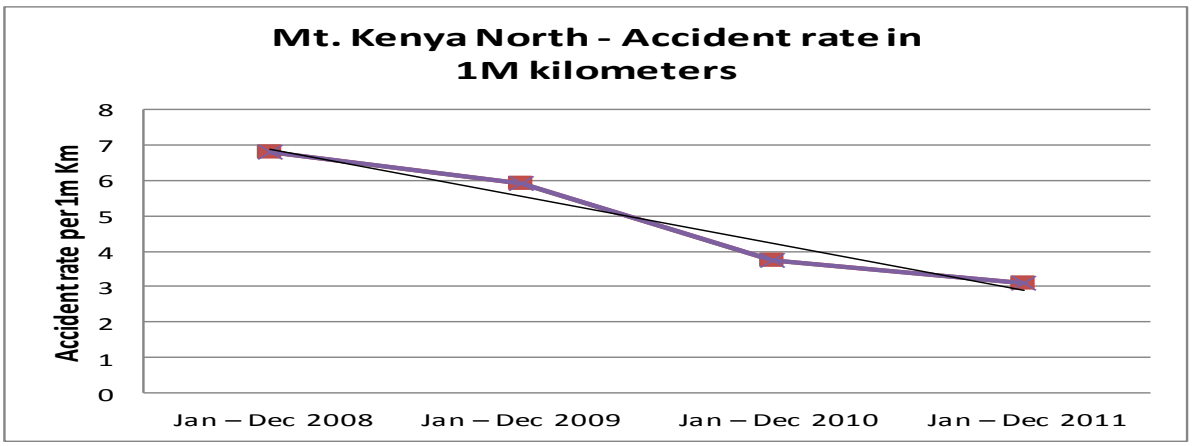



Figure 4.7: Reduction in accidents between 2008 and 2011 – Mt Kenya North

The region is vast with rough terrain occasioning long distance travel for company related trips. The road network scales the famous Mount Kenya and controlled speeds are advised to avoid veering off the slippery sides of the mountain. GPS speed violations reports and recorded pre-accident data are critical information in counteracting speeding and in

addressing the circumstances in which an accident occurred during accident investigations. The study results show a significant achievement in the improvement in the safety records and a reduction in undue accident costs as shown in Table 4.19A below, Table 4.19B and in figure 4.7 on the previous page.

The accident investigation reports show a correlation between high speeds and an increased risk of accident with a greater likelihood of an accident occurring as the driving speeds increases. With increasing speed, the accident risk increases more as the absolute speed is higher.

The remedial actions taken and the sensitising of operators on defensive driving based on the GPS generated reports and analysis have deterred careless driving. The overall accident rate in Mt Kenya North dropped from an average of 5.9 to 3.74 accidents per one million kilometres as shown in figure 4.20 below.

Table 4.20: Reduction in accident cost after GPS implementation – Mt Kenya North

| **Mt Kenya North** | **Distance travelled in km** | **Rate of accidents per m km** | **No of accidents** | **Average cost of an accident – Ksh.** | **Annual accident cost – Ksh.** |
|---|---|---|---|---|---|
| Before GPS implementation – 2009 | 3,602,510 | 5.9 | 17 | 100,000 | 1,700,000 |
| After GPS implementation – 2010 | 4,007,826 | 3.74 | 15 | 100,000 | 1,500,000 |
| **Reduction** | | **36.61%** | | | **200,000** |

The company vehicles travelled an average of 333,986 kilometres in a month in 2010 – approximately 4,007,826 kilometres in the year. With a reduction of 37% to fifteen (15) accidents from the previous seventeen (17), the company saved approx. Ksh.200,000 in the year on accident damages, traffic violations and associated handling costs.

### *4.6.2. Fleet Availability*

Table 4.21A: Fleet availability before GPS installation – Mt Kenya North

| | **Period** | **Total fleet** | **Before GPS installation** | **Distance travelled in km** | **Fleet availability (%)** |
|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 215,561 | 92.40 |
| 2 | Feb-09 | 195 | | 245,384 | 92.00 |
| 3 | Mar-09 | 195 | | 259,566 | 93.70 |
| 4 | Apr-09 | 195 | | 307,464 | 93.50 |
| 5 | May-09 | 195 | | 301,522 | 93.70 |
| 6 | Jun-09 | 195 | | 316,825 | 92.90 |
| 7 | Jul-09 | 195 | | 342,660 | 92.60 |
| 8 | Aug-09 | 195 | | 340,251 | 91.54 |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Sep-09 | 195 | | 316,402 | 92.61 |
| 10 | Oct-09 | 195 | | 321,223 | 92.60 |
| 11 | Nov-09 | 195 | | 313,686 | 91.00 |
| 12 | Dec-09 | 195 | | 321,966 | 92.50 |
| | **Average** | | | **300,209** | **92.59** |

Table 4.21B: Fleet availability after GPS installation – Mt Kenya North

| | Period | Total fleet | GPS installed | Distance travelled in km | Fleet availability (%) |
|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 105 | 323,632 | 94.38 |
| 2 | Feb-10 | 195 | 105 | 319,198 | 93.85 |
| 3 | Mar-10 | 195 | 105 | 349,301 | 94.44 |
| 4 | Apr-10 | 195 | 105 | 325,981 | 92.27 |
| 5 | May-10 | 195 | 105 | 352,447 | 95.72 |
| 6 | Jun-10 | 195 | 105 | 344,314 | 94.15 |
| 7 | Jul-10 | 195 | 105 | 342,506 | 93.65 |
| 8 | Aug-10 | 195 | 105 | 346,489 | 94.68 |
| 9 | Sep-10 | 195 | 105 | 324,523 | 96.29 |
| 10 | Oct-10 | 195 | 105 | 338,052 | 90.27 |
| 11 | Nov-10 | 195 | 105 | 336,108 | 91.90 |
| 12 | Dec-10 | 195 | 105 | 305,275 | 93.85 |
| | **Average** | | **105** | **333,986** | **93.79** |

## Fleet availability Improvement in Mt Kenya North Sub-Region

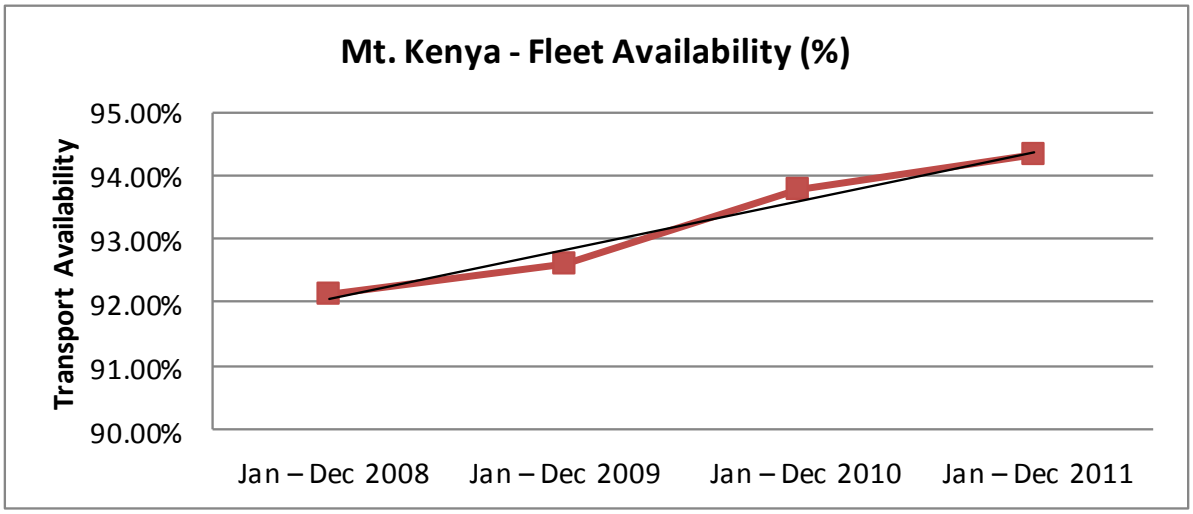



Figure 4.8: Fleet availability improvement between 2008 and 2011 – Mt Kenya North

The fact that accurate online data is available for the easier routing and scheduling of trips, as well as the combining of trips, results in economies of scale. The average transport availability achieved by December 2010 was 93.79% and continued to improve as illustrated in Table 4.21A, Table 4.21B and in figure 4.7 in the previous page. This was largely as a result of enforcing speed limits and the good driving habits that, in turn, lead to increased productivity because of better safety and operational management decisions.

**Improvement in Revenue Growth due to Increased Fleet Availability**

The increase in fleet availability increased the revenue generated as a result of the higher mileage covered in vehicle trips as part of the transportation activities.

Table 4.22: Revenue growth due to increased availability between 2009 and 2010 – Mt Kenya North

| Mt Kenya North | Fleet size fitted with GPS | Revenue generated in Ksh. | Annual yield per unit Ksh. |
|---|---|---|---|
| Before GPS implementation – 2009 | 0 | 165,549,610 | 1,576,662 |
| After GPS implementation – 2010 | 105 | 186,297,345 | 1,774,260 |
| Total increase | | 20,747,735 | 13% |
| **Revenue increase per vehicle** | | | **197,598** |

The increase in fleet availability resulted in an additional 13% direct financial contribution of Ksh.197,598 per vehicle to the company's revenue income.

### *4.6.3. Fleet Costs and Fuel Efficiency*

Table 4.23A: Maintenance costs and fuel consumption rate before GPS installation – Mt Kenya North

| | Period | Total fleet | Before GPS installation | Distance travelled in km | Fuel consumed in km/litre | Maintenance costs (Ksh./km) |
|---|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 215,561 | 6.80 | 5.01 |
| 2 | Feb-09 | 195 | | 245,384 | 6.20 | 4.10 |
| 3 | Mar-09 | 195 | | 259,566 | 6.40 | 5.83 |
| 4 | Apr-09 | 195 | | 307,464 | 5.70 | 6.83 |
| 5 | May-09 | 195 | | 301,522 | 5.90 | 5.05 |
| 6 | Jun-09 | 195 | | 316,825 | 6.16 | 6.04 |
| 7 | Jul-09 | 195 | | 342,660 | 10.10 | 8.78 |
| 8 | Aug-09 | 195 | | 340,251 | 5.47 | 3.39 |
| 9 | Sep-09 | 195 | | 316,402 | 6.85 | 3.98 |
| 10 | Oct-09 | 195 | | 321,223 | 5.80 | 3.44 |
| 11 | Nov-09 | 195 | | 313,686 | 9.20 | 6.62 |
| 12 | Dec-09 | 195 | | 321,966 | 8.18 | 4.12 |
| | **Average** | | | **300,209** | **6.90** | **5.27** |

Table 4.23B: Maintenance costs and fuel consumption rate after GPS installation – Mt Kenya North

| | Period | Total fleet | GPS installed | Distance travelled in km | Fuel consumed in km/litre | Maintenance costs (Ksh./km) |
|---|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 105 | 323,632 | 8.20 | 3.43 |
| 2 | Feb-10 | 195 | 105 | 319,198 | 7.20 | 4.75 |
| 3 | Mar-10 | 195 | 105 | 349,301 | 8.01 | 4.27 |
| 4 | Apr-10 | 195 | 105 | 325,981 | 7.99 | 8.51 |
| 5 | May-10 | 195 | 105 | 352,447 | 7.23 | 5.76 |
| 6 | Jun-10 | 195 | 105 | 344,314 | 7.21 | 5.07 |
| 7 | Jul-10 | 195 | 105 | 342,506 | 7.26 | 4.54 |
| 8 | Aug-10 | 195 | 105 | 346,489 | 7.10 | 3.81 |
| 9 | Sep-10 | 195 | 105 | 324,523 | 7.24 | 5.56 |
| 10 | Oct-10 | 195 | 105 | 338,052 | 8.21 | 4.02 |
| 11 | Nov-10 | 195 | 105 | 336,108 | 7.54 | 4.62 |
| 12 | Dec-10 | 195 | 105 | 305,275 | 7.22 | 4.93 |
| | **Average** | | **105** | **333,986** | **7.53** | **4.94** |

**Reduction Achieved in Fleet Maintenance Costs in Mt Kenya North Sub-Region**

The GPS function triggers an alert when any vehicle reaches its pre-set manufacturer mileage points and the operator may be reminded to take in the vehicle for servicing.

Previously, with manual maintenance records, it was impossible to effectively track each unit's servicing mileage intervals, resulting in many premature breakdowns which, in turn, occasioned extremely high maintenance costs.

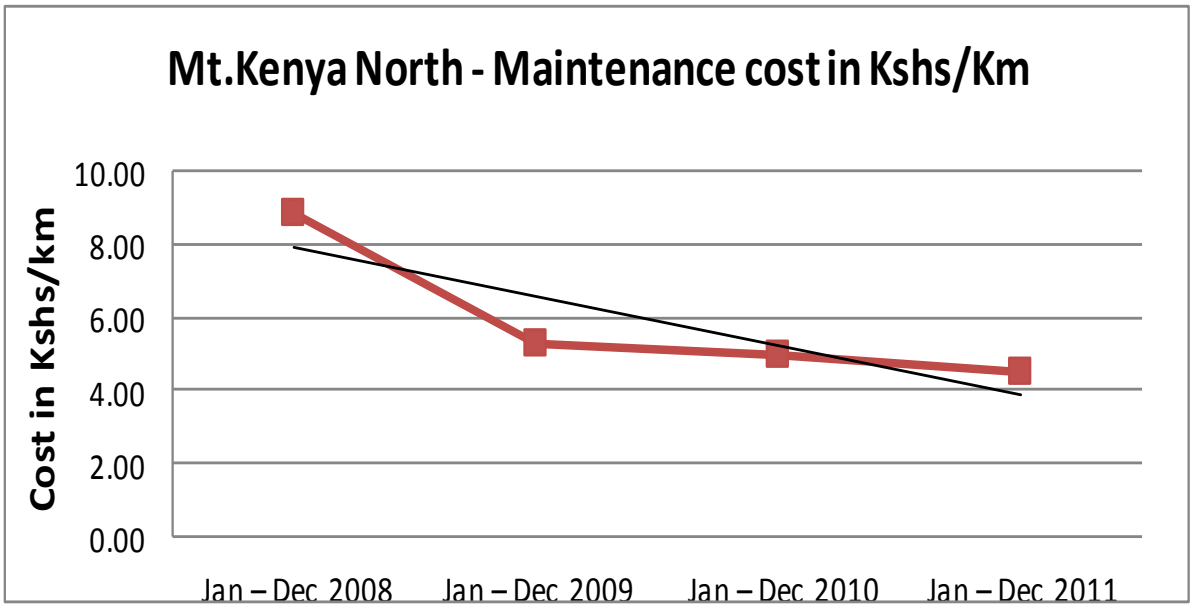


Figure 4.9: Fleet maintenance costs improvement between 2008 and 2011 – Mt Kenya North

The GPS alerts acts as tool for compliance to the planned maintenance schedule and helps to prevent the premature failure of major vehicle parts, resulting in great savings in maintenance costs and increased fleet productivity. This, in turn, contributes to higher operational efficiency.

Table 4.24: Reduction in fleet maintenance cost after GPS implementation – Mt Kenya North

| **Mt Kenya North** | **Total distance travelled** | **Maintenance cost in Ksh./km** | **Annual maintenance cost in Ksh.** |
|---|---|---|---|
| Before GPS implementation – 2009 | 3,602,510 | 5.27 | 21,121,243 |
| After GPS implementation – 2010 | 4,007,826 | 4.94 | 19,798,660 |
| **Savings on maintenance costs** | | **6.26%** | **1,322,582** |

As shown in table 4.24 above, the reduction in maintenance cost recorded was about 6% from Ksh.5.27 to Ksh.4.94 per kilometre – a significant saving in costs considering the total distance travelled in 2010 in Mt Kenya North was 4,007,826 kilometres. In monetary terms the computed gains translates into a saving in maintenance costs of Ksh.1,322,582 in one year only.

**Improvement in Fuel Efficiency Measured in Fuel Consumed in km/litre**

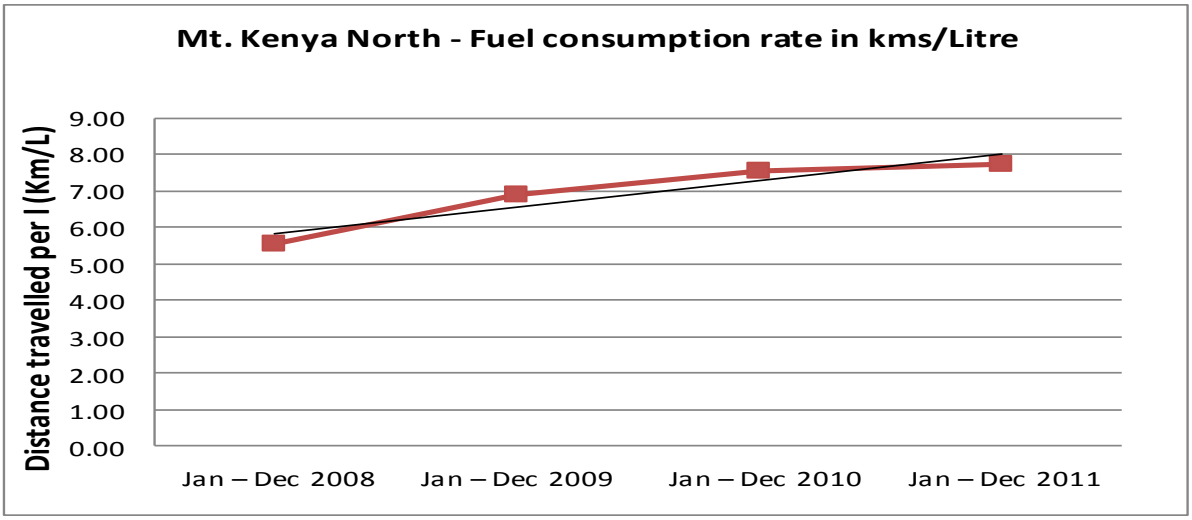



Figure 4.10: Fuel efficiency between 2008 and 2011 – Mt Kenya North

The reduction in idling time and control of fuel usage through GPS surveillance not only reduced fuel costs but helped to cut down on repair and maintenance expenses as well. The fuel consumption efficiency at Mt Kenya North rose from an average of 6.90 to 7.53 kilometres per litre as shown in fig. 4.10 above. The tracking devices installed in the vehicles

assisted in monitoring the actual fuel consumption as compared to what was being reported by the employee and the curbing of illegal journeys that had not been authorised, resulting in more efficient resource utilisation levels while controlling service-related costs. The integration of fuelling transaction data from electronic fuelling cards with the GPS fleet tracking system assisted in monitoring the actual fuel consumption against what was being reported by the employee. This helped to curb any fuel siphoning by the operators in collusion with the pump attendants. In addition, the tracking devices installed in the vehicles assisted in curbing illegal journeys that are not authorised and this resulted in more efficient resource utilisation levels while controlling service-related costs.

Table 4.25 Reduction in fuel consumption cost after GPS implementation – Mt Kenya North

| **Mt Kenya North** | **Total distance travelled** | **Fuel cost in Ksh./km** | **Fuel consumed in Ksh.** |
|---|---|---|---|
| Before GPS implementation – 2009 | 3,602,510 | 23.9 | 86,168,259 |
| After GPS implementation – 2010 | 4,007,826 | 18.5 | 74,144,781 |
| **Savings on fuel costs** | | **22.59%** | **12,023,478** |

The above table 4.25 shows an overall reduction of 23% from Ksh.23.9 to Ksh.18.5 per km which translates into a saving of Ksh.12,023,478 in the cost of overall fuel consumed in in Mt Kenya North one year only.

The overall total savings from both maintenance and fuel consumption in 2010 was Ksh.13,346,060. These results show that the use of the GPS fleet management led to increased operational effectiveness and efficiency in service delivery.

### *4.6.4. Frequency of Vehicle Breakdowns*

A high frequency of breakdown not only occasions high maintenance costs but also compromises on service delivery.

Table 4.26A: Frequency of vehicle breakdowns before GPS installation – Mt. Kenya North

| | **Period** | **Total fleet** | **Before GPS installation** | **Distance travelled in kms** | **Breakdown incidences** |
|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 215561 | 15 |
| 2 | Feb-09 | 195 | | 245384 | 16 |
| 3 | Mar-09 | 195 | | 259566 | 12 |
| 4 | Apr-09 | 195 | | 307464 | 13 |
| 5 | May-09 | 195 | | 301522 | 12 |
| 6 | Jun-09 | 195 | | 316825 | 14 |
| 7 | Jul-09 | 195 | | 342660 | 14 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | Aug-09 | 195 | | 340251 | 16 |
| 9 | Sep-09 | 195 | | 316402 | 14 |
| 10 | Oct-09 | 195 | | 321223 | 14 |
| 11 | Nov-09 | 195 | | 313686 | 18 |
| 12 | Dec-09 | 195 | | 321966 | 15 |
| | Average | | | 300209 | 14 |

Table 4.26B: Frequency of vehicle breakdowns after GPS installation – Mt. Kenya North

| | Period | Total fleet | GPS installed | Distance travelled in kms | Breakdown incidences |
|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 105 | 323632 | 11 |
| 2 | Feb-10 | 195 | 105 | 319198 | 12 |
| 3 | Mar-10 | 195 | 105 | 349301 | 11 |
| 4 | Apr-10 | 195 | 105 | 325981 | 15 |
| 5 | May-10 | 195 | 105 | 352447 | 8 |
| 6 | Jun-10 | 195 | 105 | 344314 | 11 |
| 7 | Jul-10 | 195 | 105 | 342506 | 12 |
| 8 | Aug-10 | 195 | 105 | 346489 | 10 |
| 9 | Sep-10 | 195 | 105 | 324523 | 7 |
| 10 | Oct-10 | 195 | 105 | 338052 | 19 |
| 11 | Nov-10 | 195 | 105 | 336108 | 16 |
| 12 | Dec-10 | 195 | 105 | 305275 | 12 |
| | Average | | 105 | 333986 | 12 |

## Reduction on breakdown improves fleet serviceability and reliability in Mt. Kenya North

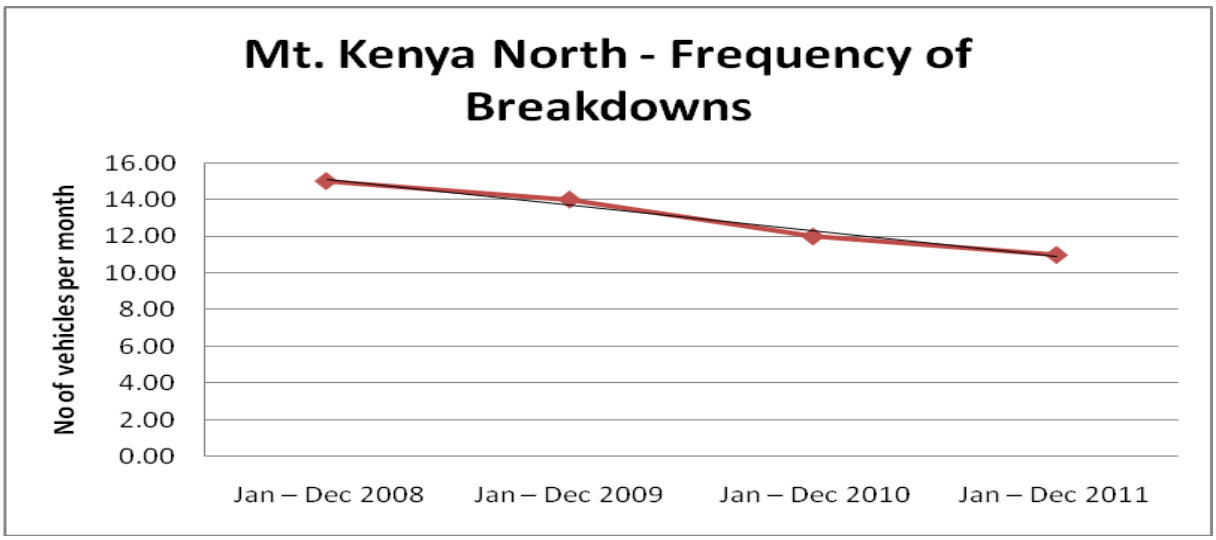



Figure 4.11: Frequency of breakdowns between 2008 and 2011 – Mt. Kenya North

The frequency of vehicle breakdowns in Mt. Kenya North reduced from an average of 14 to 12 vehicle breakdowns in a month as shown in Table 4.26A (page 103), Table 4.26B and in figure 4.11 on the previous page. The reduction resulted by evaluating each driver's driving performance reports generated from the "Green Band Assessment method" which considers a number of factors that constitute good driving habits. The installed GPS system monitors those factors and provides an assessment report for each driver. This has helped to curb careless driving of motor vehicles or illegal journeys that are not authorized and has resulted in more efficient resource utilization levels while controlling service-related costs.

By focusing on safe and defensive driving habits, incidences of accident related breakdowns and premature engine failure have been drastically reduced leading to fewer vehicles being referred to the workshop for repairs. This has consequently increased the fleet availability and more efficient utilization of fleet.

### *4.6.5. Rate of Theft and Recovery of Motor Vehicles*

Table 4.27A: Rate of theft of motor vehicles before GPS installation – Mt Kenya North

| | Period | Total fleet | Before GPS installation | Vehicle theft (No.) |
|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 1 |
| 2 | Feb-09 | 195 | | 0 |
| 3 | Mar-09 | 195 | | 0 |
| 4 | Apr-09 | 195 | | 0 |
| 5 | May-09 | 195 | | 0 |
| 6 | Jun-09 | 195 | | 0 |
| 7 | Jul-09 | 195 | | 0 |
| 8 | Aug-09 | 195 | | 0 |
| 9 | Sep-09 | 195 | | 0 |
| 10 | Oct-09 | 195 | | 0 |
| 11 | Nov-09 | 195 | | 0 |
| 12 | Dec-09 | 195 | | 1 |
| | **TOTALS** | | | **2** |

Table 4.27B: Rate of theft of motor vehicles after GPS installation – Mt Kenya North

| | Period | Total fleet | GPS installed | Vehicle theft (No.) |
|---|---|---|---|---|
| 1 | Jan-10 | 195 | 105 | 0 |
| 2 | Feb-10 | 195 | 105 | 0 |
| 3 | Mar-10 | 195 | 105 | 0 |

| | | | | |
|---|---|---|---|---|
| 4 | Apr-10 | 195 | 105 | 0 |
| 5 | May-10 | 195 | 105 | 0 |
| 6 | Jun-10 | 195 | 105 | 0 |
| 7 | Jul-10 | 195 | 105 | 0 |
| 8 | Aug-10 | 195 | 105 | 0 |
| 9 | Sep-10 | 195 | 105 | 0 |
| 10 | Oct-10 | 195 | 105 | 0 |
| 11 | Nov-10 | 195 | 105 | 0 |
| 12 | Dec-10 | 195 | 105 | 0 |
| | **TOTALS** | | **105** | **0** |

**Reduced Rate of Theft and Increased Recovery of Motor Vehicles**

Online GPS technology allows real-time tracking and, if a vehicle is stolen, there are alerts to signal the beginning of visual tracking. Using the "ping" feature regular updates on the stolen vehicle location appear on the dashboard screen which may be used to disable a vehicle in operation, if necessary, in the course of security recoveries and this enhance the security of the vehicles. This has drastically reduced the number of stolen vehicles as shown in Table 4.27A, Table 4.27B on the previous page and in figure 4.12 below.

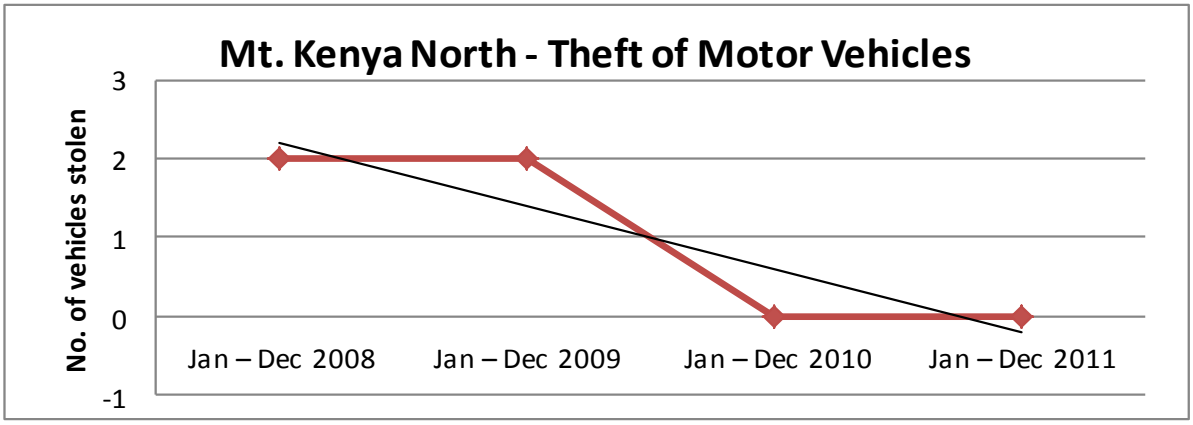



Figure 4.12: Rate of theft of motor vehicles between 2008 and 2011 – Mt Kenya North

The GPS tracking installed has a variety of features and operational benefits that have improved the safety of drivers and vehicles, thus significantly reducing the payouts for accidents and violations.

As shown in Table 4.28 on the next page, this has enhanced the control of the fleet and the ability to recover stolen or route diverted vehicles and, thus, reduced the chances of lost or stolen vehicle. The use of the live tracking ability to locate lost or stolen property with

exact location details and geographical positioning provides the security personnel with direct assistance and support. With this feature in place, this enables a prompt response to support efficient customer service.

Table 4.28: Reduction in theft of vehicles after GPS implementation – Mt Kenya North

| **Mt Kenya North** | **No of stolen vehicles** | **Cost of loss in million Ksh. per vehicle** | **Total cost in million Ksh.** |
|---|---|---|---|
| Before GPS implementation – 2009 | 2 | 5.0 | **10.0** |
| After GPS implementation – 2010 | 0 | 0 | **0** |
| **Savings in reduced theft cases** | **0** | **100%** | **10.0** |

### *4.6.6. Perceptions of Staff towards the Implementation of the GPS*

Table 4.29: Responses on the implementation of the GPS System – Mt Kenya North

| | **5** | **4** | **3** | **2** | **1** |
|---|---|---|---|---|---|
| 1-Adoption of modern information technology in fleet management has led to improved efficiency in the service delivery | 37% | 46% | 16% | 2% | 0% |
| 2-Adopting new technology equipment is a necessary tool for efficiency in service delivery. | 34% | 48% | 18% | 0% | 0% |
| 3-The increased use of modern IT solutions will result in longer term relationships with prospective customers | 38% | 56% | 4% | 2% | 0% |
| 4-Organisations must be able to integrate knowledge from IT to deliver new products or service efficiently | 42% | 50% | 9% | 0% | 0% |
| 5-In a fast moving world constant improvement in IT is essential for survival and success in service delivery | 28% | 56% | 14% | 2% | 0% |
| **Average approval %** | **36** | **51** | **12** | **1** | **0** |

Note: 5=strongly agree, 4= agree, 3=neutral, 2=disagree and 1= strongly disagree

An overall approval rating of 87% is shown in Table 4.29 above which is a strong indicator of the benefits arising from modern technologies on incorporating modern information technology and adopting new technology equipment in fleet management. The responses indicated that there had been an improvement of service delivery at KPLC. The results of 36% for 5 (= strongly agree) and 51% for 4 (= agree) may be taken as a very positive indicator of individual support and passion to adopt the new technologies in the fleet management systems in order to bring about efficiency in the operations and service delivery in KPLC.

### *4.6.7. Implementation Expenditure and Cost Reduction Achieved*

Mt Kenya North has 105 vehicles fitted with GPS units. Although the GPS fleet tracking units provide limited online data on location and distance only, the system generated data contributes greatly towards more efficient and effective fleet management processes.

### Expenses in implementing the GPS fleet management system

Table 4.30: Expenses for the implementation of the GPS system – Mt Kenya North

| Cost element | Total GPS units fitted | GPS unit fitting costs in Ksh. | Costs per unit in Ksh. |
|---|---|---|---|
| Cost for the supply and installation of the GPS fleet tracking units | 105 | 7,019,221 | 66,850 |

The cost for the supply and installation of the GPS fleet tracking units was Ksh.66,849 and included the SLA for the maintenance of the units and the software management a shown above in Table 4.30.

### Overall net savings as a result of the improved efficiency in the operations

The ability to constantly track the location of a vehicle and the online records on vehicle speed and the distance travelled lead to increased efficiency; the aster retrieval of the historical records of the vehicle's previous movements and an efficient fleet maintenance programme.

Table 4.31: Net savings as a result of the improved efficiency in the operations – Mt Kenya North

| Cost element | Costs before GPS implementation | Costs after fitting GPS units | Reduction % |
|---|---|---|---|
| 1-Accident damages and traffic violations | 1,700,000 | 1,500,000 | 11.76% |
| 2-Maintenance cost | 21,121,243 | 19,798,660 | 6.26% |
| 3-Fuel consumption | 86,168,259 | 74,144,781 | 13.95% |
| 4-Theft of vehicles | 10,000,000 | 0 | 100 |
| Total | 118,989,582 | 95,443,441 | 19.79% |
| **Net savings per unit** | **1,133,233** | **908,985** | **224,248** |

The savings resulted from the reduction in the theft of motor vehicles, the deterrents to fuel siphoning and the assessment of individual driving performances. The aggregate annual savings of Ksh.224,248 per unit fitted comprises a significant contribution towards the achievement of lower costs of operation and covers the cost of the supply and installation of the GPS fleet tracking units at Ksh.66,850, which includes the service level agreement (SLA) for the maintenance of the units and the software management. The net savings amounted to Ksh.23,546,141 in 2010, which is approximately a 20% reduction, as shown above in Table 4.31.

**Increased revenue generation from the improved fleet availability**

The successful implementation of the GPS fleet management system has had a very significant impact on the operational processes through enhanced effectiveness and efficiency at KPLC.

Table 4.32: Revenue generation from improved fleet availability – Mt Kenya North

| Cost element | Costs before GPS implementation | Costs after GPS implementation | Increase in yield in Ksh. |
|---|---|---|---|
| Revenue generation | 165,549,610 | 186,297,345 | 20,747,735 |
| Yield per unit | 1,576,662 | 1,774,260 | 197,597 |

The increased fleet availability created a higher payload capacity transported, resulting in higher revenues and better customer service. An increase in fleet availability creates additional vehicles which are available for the prompt transportation of staff and materials to various customer sites. There was a significant increase in the yield of Ksh.197,597 per unit in 2010 and this is an additional direct contribution towards the bottom-line a shown above in Table 4.32.

The overall cost savings and increased revenue income due to operational efficiency amounted to Ksh.47,056,964 as compared to the cost of the supply and installation of the 105 GPS fleet tracking units at Ksh.7,019,221. Therefore, the net overall savings in Mt Kenya North amounted to Ksh.40,037,743 in one year only, which shows that the use of GPS fleet management has led to increased effectiveness and efficiency in the service delivery.

## 4.7. Data Collection and Analysis from Central Office

### *4.7.1. Number of Accidents*

Table 4.33A: Accident rate before GPS installation – Central Office

| | Period | Total fleet | Before GPS installation | Distance travelled in km | No. of accidents | Accident rate (per million km) |
|---|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 191,892 | 1 | 5.23 |
| 2 | Feb-09 | 195 | | 183,994 | 1 | 5.44 |
| 3 | Mar-09 | 195 | | 195,849 | 0 | 0.00 |
| 4 | Apr-09 | 195 | | 225,662 | 1 | 4.43 |
| 5 | May-09 | 195 | | 198,420 | 1 | 5.05 |
| 6 | Jun-09 | 195 | | 215,979 | 0 | 0.00 |
| 7 | Jul-09 | 195 | | 233,992 | 1 | 4.27 |
| 8 | Aug-09 | 195 | | 237,872 | 1 | 4.21 |
| 9 | Sep-09 | 195 | | 224,975 | 0 | 0.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | Oct-09 | 195 | | 226,930 | 1 | 4.41 |
| 11 | Nov-09 | 195 | | 232,417 | 1 | 4.31 |
| 12 | Dec-09 | 195 | | 216,518 | 0 | 0.00 |
| | **Average** | | | **215,375** | **0.67** | **3.11** |

Table 4.33B: Accident rate after GPS installation – Central Office

| | Period | Total fleet | GPS installed | Distance travelled in km | No. of accidents | Accident rate (per million km) |
|---|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 143 | 183,898 | 1 | 5.44 |
| 2 | Feb-10 | 195 | 143 | 185,354 | 1 | 5.40 |
| 3 | Mar-10 | 195 | 143 | 188,908 | 0 | 0.00 |
| 4 | Apr-10 | 195 | 143 | 164,827 | 1 | 6.08 |
| 5 | May-10 | 195 | 143 | 167,901 | 0 | 0.00 |
| 6 | Jun-10 | 195 | 143 | 213,637 | 1 | 4.69 |
| 7 | Jul-10 | 195 | 143 | 204,968 | 0 | 0.00 |
| 8 | Aug-10 | 195 | 143 | 228,480 | 0 | 0.00 |
| 9 | Sep-10 | 195 | 143 | 192,392 | 1 | 5.22 |
| 10 | Oct-10 | 195 | 143 | 202,979 | 0 | 0.00 |
| 11 | Nov-10 | 195 | 143 | 199,768 | 1 | 5.03 |
| 12 | Dec-10 | 195 | 143 | 199,787 | 0 | 0.00 |
| | **Average** | | **143** | **194,408** | **0.50** | **2.65** |

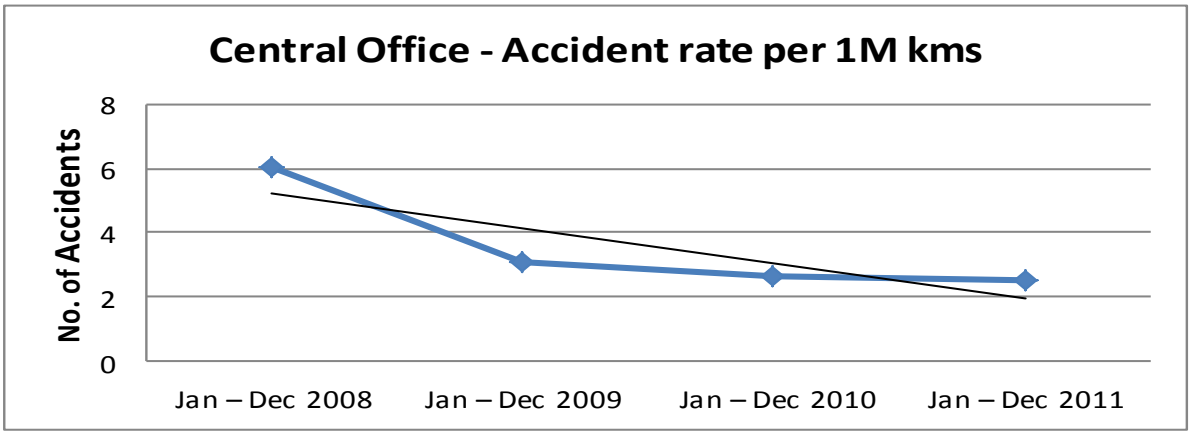



Figure 4.13: Reduction in accidents between 2008 and 2011 – Central Office

### Effects of the GPS on the Reduction of Accidents

The reduction in the accident rate has been achieved through the training of employees on safety in operations; supporting investigations into all accidents (now augmented by GPS reports) and taking remedial action where necessary and disciplining staff members who cause accidents through their own carelessness. The objective was to reduce

the number of accidents per one million kilometres covered by the company fleet as indicated in Table 4.33A, Table 4.33B on the previous page and figure 4.13 above

Table 4.34: Reduction in accident cost after GPS implementation – Central Office

| Central Office | Distance travelled in km | Rate of accidents per m km | No. of accidents | Average cost of an accident – Ksh. | Annual accident cost – Ksh. |
|---|---|---|---|---|---|
| Before GPS implementation – 2009 | 2,284,500 | 3.11 | 14 | 100,000 | 1,400,000 |
| After GPS implementation – 2010 | 2,332,899 | 2.65 | 6 | 100,000 | 600,000 |
| **Reduction** | | | **57.14%** | | **800,000** |

The company vehicles travelled 2,332,899 kilometres in 2010. With a reduction in the accident rate of 57% from the previous fourteen to six accidents, the company saved approximately Ksh.800,000 in the year for accident damages, traffic violations and associated handling costs a shown in Table 4.34 above.

### *4.7.2. Fleet Availability*

Table 4.35A: Fleet availability before GPS installation – Central Office

| | Period | Total fleet | Before GPS installation | Distance travelled in km | Fleet availability (%) |
|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 191,892 | 91.10 |
| 2 | Feb-09 | 195 | | 183,994 | 92.80 |
| 3 | Mar-09 | 195 | | 195,849 | 90.70 |
| 4 | Apr-09 | 195 | | 225,662 | 92.20 |
| 5 | May-09 | 195 | | 198,420 | 91.20 |
| 6 | Jun-09 | 195 | | 215,979 | 90.10 |
| 7 | Jul-09 | 195 | | 233,992 | 92.20 |
| 8 | Aug-09 | 195 | | 237,872 | 91.80 |
| 9 | Sep-09 | 195 | | 224,975 | 91.70 |
| 10 | Oct-09 | 195 | | 226,930 | 91.20 |
| 11 | Nov-09 | 195 | | 232,417 | 93.10 |
| 12 | Dec-09 | 195 | | 216,518 | 94.90 |
| | **Average** | | | **215,375** | **91.92** |

Table 4.35B: Fleet availability after GPS installation – Central Office

| | Period | Total fleet | GPS installed | Distance travelled in km | Fleet availability (%) |
|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 143 | 183,898 | 95.20 |
| 2 | Feb-10 | 195 | 143 | 185,354 | 91.50 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Mar-10 | 195 | 143 | 188,908 | 93.90 |
| 4 | Apr-10 | 195 | 143 | 164,827 | 91.70 |
| 5 | May-10 | 195 | 143 | 167,901 | 92.70 |
| 6 | Jun-10 | 195 | 143 | 213,637 | 92.30 |
| 7 | Jul-10 | 195 | 143 | 204,968 | 91.40 |
| 8 | Aug-10 | 195 | 143 | 228,480 | 93.50 |
| 9 | Sep-10 | 195 | 143 | 192,392 | 92.80 |
| 10 | Oct-10 | 195 | 143 | 202,979 | 95.40 |
| 11 | Nov-10 | 195 | 143 | 199,768 | 93.50 |
| 12 | Dec-10 | 195 | 143 | 199,787 | 94.40 |
| | **Average** | | **143** | **194,408** | **93.19** |

**Fleet availability improvement in Central Office**

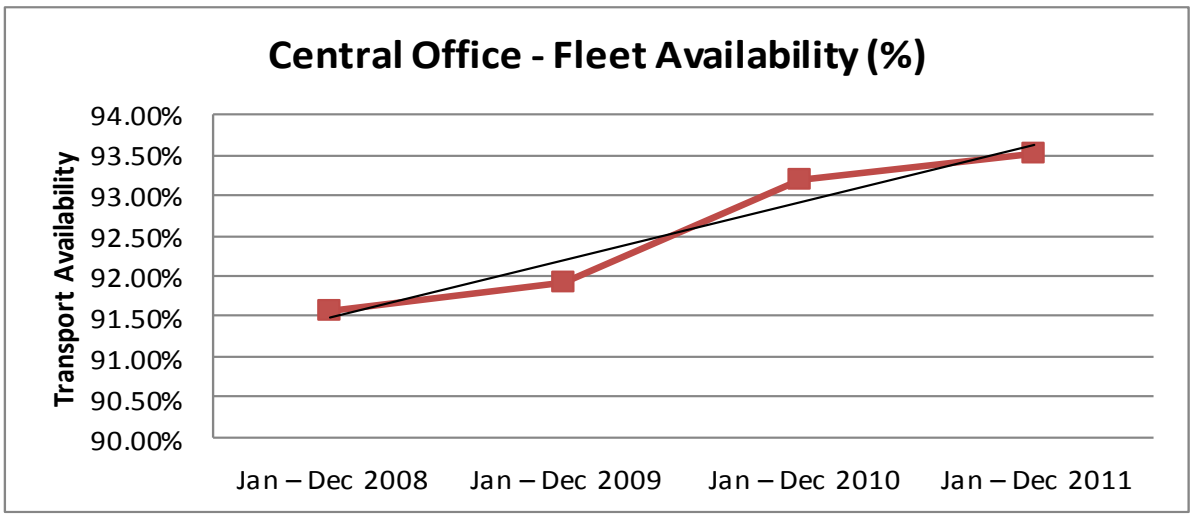



Figure 4.14: Fleet availability improvement between 2008 and 2011 – Central Office

**Improvement in Revenue Growth due to Increased Fleet Availability**

As illustrated in Table 4.35A and Table 4.35B on the previous page and figure 4.14 above, the average transport availability achieved by December 2010 was 93.19% and continued to improve. The increase in fleet availability increased the revenue generated as a result of the higher mileage covered in vehicle trips in transportation activities.

Table 4.36: Revenue growth due to increased availability between 2009 and 2010 – Central Office

| Central office | Fleet size fitted with GPS | Revenue generated in Ksh. | Annual yield per unit Ksh. |
|---|---|---|---|
| Before GPS implementation – 2009 | 0 | 120,022,005 | 839,314 |
| After GPS implementation – 2010 | 143 | 137,825,165 | 963,812 |
| Total increase | | 17,803,160 | 15% |
| **Revenue increase per vehicle** | | | **124,498** |

The improved fleet availability represents a direct financial contribution and its positive impact resulted in an individual vehicle yield of 15% of Ksh.124,498 which is shown above in Table 4.36.

### *4.7.3. Fleet Costs and Fuel Efficiency*

Table 4.37A: Maintenance costs and fuel consumption rate before GPS installation – Central Office

| | Period | Total fleet | Before GPS installation | Distance travelled in km | Fuel consumed in km/litre | Maintenance costs (Ksh./km) |
|---|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 191,892 | 5.10 | 11.70 |
| 2 | Feb-09 | 195 | | 183,994 | 5.50 | 11.70 |
| 3 | Mar-09 | 195 | | 195,849 | 5.60 | 5.90 |
| 4 | Apr-09 | 195 | | 225,662 | 5.30 | 11.41 |
| 5 | May-09 | 195 | | 198,420 | 6.88 | 10.36 |
| 6 | Jun-09 | 195 | | 215,979 | 5.89 | 7.07 |
| 7 | Jul-09 | 195 | | 233,992 | 6.06 | 11.20 |
| 8 | Aug-09 | 195 | | 237,872 | 6.70 | 4.20 |
| 9 | Sep-09 | 195 | | 224,975 | 6.10 | 6.90 |
| 10 | Oct-09 | 195 | | 226,930 | 5.40 | 11.96 |
| 11 | Nov-09 | 195 | | 232,417 | 4.50 | 9.50 |
| 12 | Dec-09 | 195 | | 216,518 | 6.68 | 11.08 |
| | **Average** | | | **215,375** | **5.81** | **9.42** |

Table 4.37B: Maintenance costs and fuel consumption rate after GPS installation – Central Office

| | Period | Total fleet | GPS installed | Distance travelled in km | Fuel consumed in km/litre | Maintenance costs (Ksh./km) |
|---|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 143 | 183,898 | 4.80 | 6.58 |
| 2 | Feb-10 | 195 | 143 | 185,354 | 7.70 | 11.66 |
| 3 | Mar-10 | 195 | 143 | 188,908 | 7.80 | 10.82 |
| 4 | Apr-10 | 195 | 143 | 164,827 | 5.60 | 6.99 |
| 5 | May-10 | 195 | 143 | 167,901 | 5.60 | 6.64 |
| 6 | Jun-10 | 195 | 143 | 213,637 | 5.40 | 6.07 |
| 7 | Jul-10 | 195 | 143 | 204,968 | 7.70 | 13.16 |
| 8 | Aug-10 | 195 | 143 | 228,480 | 6.70 | 5.33 |
| 9 | Sep-10 | 195 | 143 | 192,392 | 6.45 | 3.52 |
| 10 | Oct-10 | 195 | 143 | 202,979 | 9.10 | 4.32 |
| 11 | Nov-10 | 195 | 143 | 199,768 | 5.40 | 5.51 |
| 12 | Dec-10 | 195 | 143 | 199,787 | 10.90 | 7.89 |
| | **Average** | | **143** | **194,408** | **6.93** | **7.37** |

**Improvement in Fleet Maintenance Costs in Central Office**

The GPS function triggers an alert when any vehicle reaches its pre-set manufacturer mileage points and the operator may be reminded to take in the vehicle for servicing and this has drastically reduced repair incidences as shown in Tables 4.37A and 4.37B above.

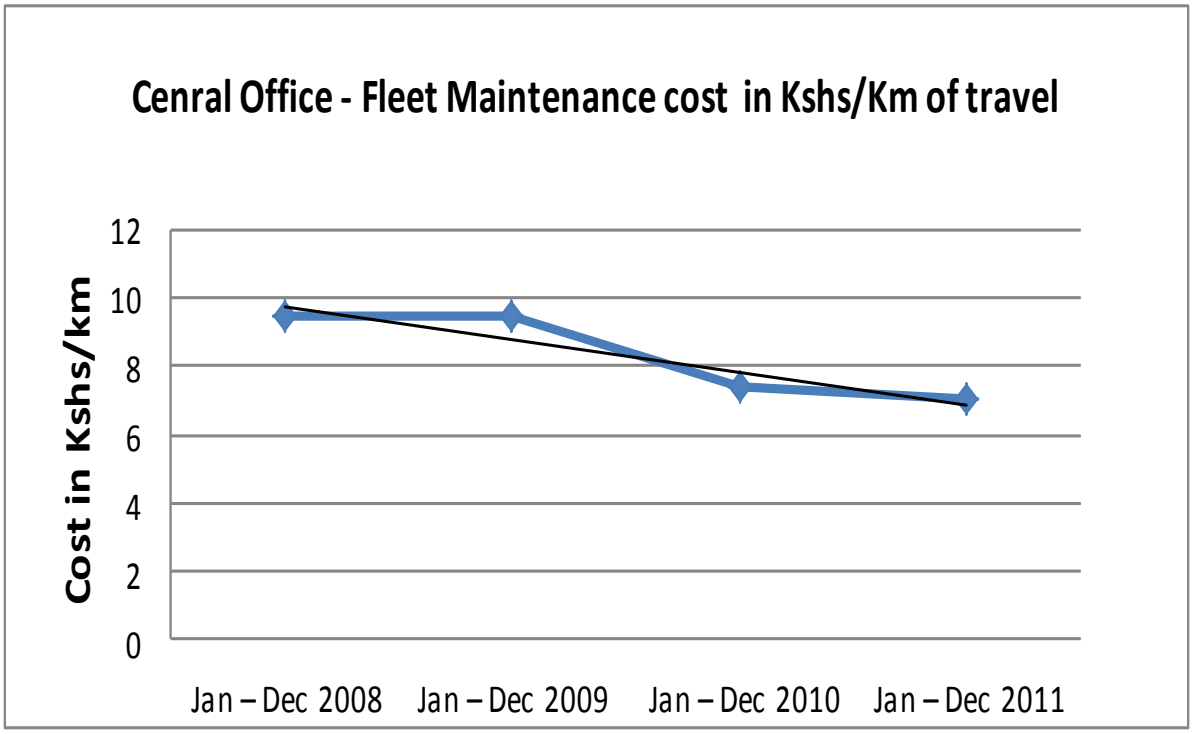



Figure 4.15: Fleet maintenance costs improvement between 2008 and 2011 – Central Office

Table 4.38: Reduction in fleet maintenance cost after GPS implementation – Central Office

| Central office | Total distance travelled | Maintenance cost in Ksh./km | Annual maintenance cost in Ksh. |
|---|---|---|---|
| Before GPS implementation – 2009 | 2,584,500 | 9.42 | 21,975,909 |
| After GPS implementation – 2010 | 2,332,899 | 7.37 | 17,193,466 |
| **Savings on maintenance costs** | | **21.76%** | **4,782,443** |

The GPS alerts acts as a tool for compliance with the planned maintenance schedule and helps to prevent the premature failure of major vehicle parts, resulting in great savings in maintenance costs and increased fleet productivity. As shown in figure 4.15 above this, in turn, contributes to the achievement of higher operational efficiency.

As shown in table 4.38 above the recorded reduction in maintenance cost was 22%, from Ksh.9.00 to Ksh.7.00 per km, which is a significant saving in costs, especially

considering the total distance travelled in 2010 in Central Office was 2,332,899 kilometres, thus translating into a savings of Ksh.4,782,443 in maintenance costs in only one year.

**Improvement in Fuel Efficiency Measured in Fuel Consumed in km/litre**

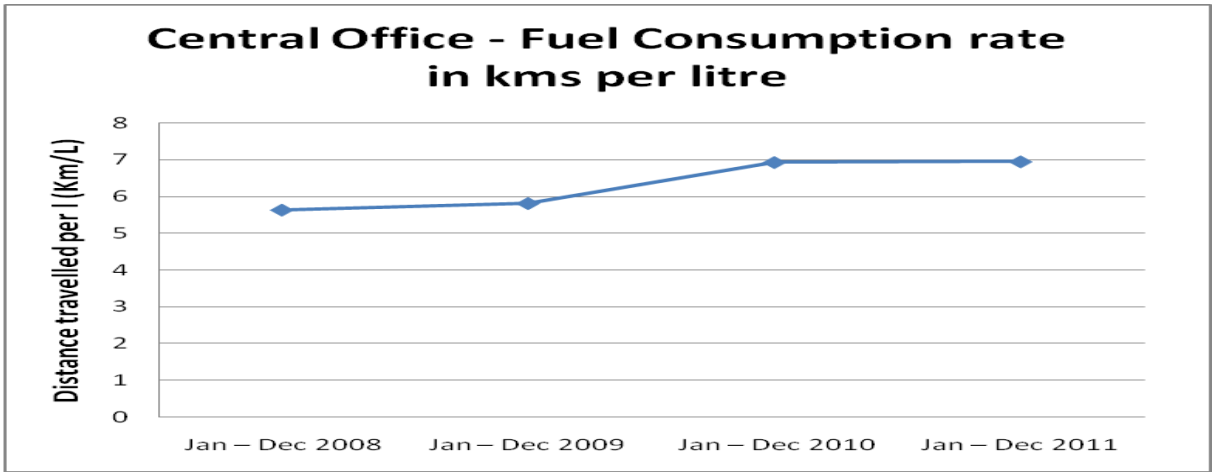



Figure 4.16: Fuel efficiency between 2008 and – Central Office

While the GPS fleet tracking provides only limited data picked on specific functions such as speeds, route details, alerts and live location of vehicles, the integration of fuelling transaction data from electronic fuelling cards with the tracking system assists in monitoring the actual fuel consumption as compared with what is being reported by the employee. This helps to curb any fuel siphoning by operators in collusion with the pump attendants. In addition, the minimisation on illegal journeys that are not authorised results in more efficient resource utilisation levels while controlling service related costs. The fuel consumption efficiency at Central Office rose from an average of 5.63 kilometres per litre to 6.93 kilometres per litre as shown in figure 4.16. The tracking devices installed in the vehicles assisted in curbing illegal journeys that are not authorised, thus resulting in more efficient resource utilisation levels while controlling service related costs.

Table 4.39: Reduction in fuel consumption cost after GPS implementation – Central Office

| Central Office | Total distance travelled | Fuel cost in Ksh./km | Total cost of fuel consumed in Ksh. |
|---|---|---|---|
| Before GPS implementation – 2009 | 2,584,500 | 14.8 | 34,526,905 |
| After GPS implementation – 2010 | 2,332,899 | 12.3 | 28,694,658 |
| **Savings on fuel costs** | | **16.89%** | **5,832,248** |

As shown in table 4.39 there was a reduction in the fuel consumption cost in Kenya shillings per kilometre (Ksh./km). The results show an overall reduction of 17% from Ksh.15 to Ksh.12 per km which, if calculated on a total distance of 2,332,899 kilometres travelled in

North Rift, translates into a saving in the fuel consumption cost of Ksh.5, 832,248 in only one year. The total savings from both maintenance and fuel consumption in 2010 was Ksh.10,614,691 which shows that the use of GPS fleet management has led to increased effectiveness and efficiency in service delivery.

### *4.7.4. Frequency of Vehicle Breakdowns*

A high frequency of breakdown not only causes high maintenance costs but also compromises service delivery.

Table 4.40A: Frequency of vehicle breakdowns before GPS installation – Central Office

| | Period | Total fleet | Before GPS installation | Distance travelled in km | Recorded breakdown incidences |
|---|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 191,892 | 25 |
| 2 | Feb-09 | 195 | | 183,994 | 20 |
| 3 | Mar-09 | 195 | | 195,849 | 27 |
| 4 | Apr-09 | 195 | | 225,662 | 23 |
| 5 | May-09 | 195 | | 198,420 | 26 |
| 6 | Jun-09 | 195 | | 215,979 | 36 |
| 7 | Jul-09 | 195 | | 233,992 | 23 |
| 8 | Aug-09 | 195 | | 237,872 | 24 |
| 9 | Sep-09 | 195 | | 224,975 | 24 |
| 10 | Oct-09 | 195 | | 226,930 | 25 |
| 11 | Nov-09 | 195 | | 232,417 | 20 |
| 12 | Dec-09 | 195 | | 216,518 | 15 |
| | **Average** | | | **215,375** | **24** |

Table 4.40B: Frequency of vehicle breakdowns after GPS installation – Central Office

| | Period | Total fleet | GPS installed | Distance travelled in km | Recorded breakdown incidences |
|---|---|---|---|---|---|
| 1 | Jan-10 | 195 | 143 | 183,898 | 14 |
| 2 | Feb-10 | 195 | 143 | 185,354 | 25 |
| 3 | Mar-10 | 195 | 143 | 188,908 | 18 |
| 4 | Apr-10 | 195 | 143 | 164,827 | 26 |
| 5 | May-10 | 195 | 143 | 167,901 | 23 |
| 6 | Jun-10 | 195 | 143 | 213,637 | 27 |
| 7 | Jul-10 | 195 | 143 | 204,968 | 31 |
| 8 | Aug-10 | 195 | 143 | 228,480 | 23 |
| 9 | Sep-10 | 195 | 143 | 192,392 | 26 |
| 10 | Oct-10 | 195 | 143 | 202,979 | 16 |
| 11 | Nov-10 | 195 | 143 | 199,768 | 23 |

| | | | | | |
|---|---|---|---|---|---|
| 12 | Dec-10 | 195 | 143 | 199,787 | 19 |
| | **Average** | | **143** | **194,408** | **23** |

**Frequency of breakdowns in Central Office**

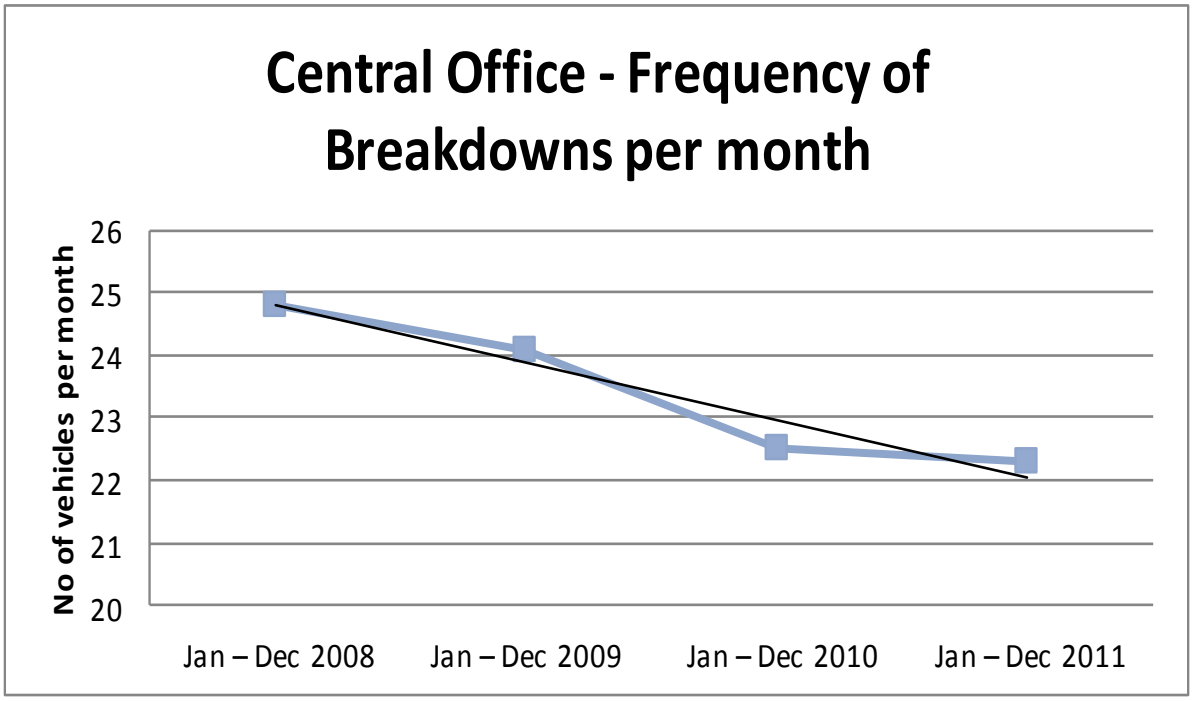



Figure 4.17: Frequency of breakdowns between 2008 and 2011 – Central Office

A reduction in breakdowns improves fleet serviceability and reliability in both operational and distribution activities. The frequency of vehicle breakdowns in Central Office reduced from an average of 24 vehicles in a month to approximately 23 vehicle breakdowns in a month as shown in Tables 4.37A and Table 4.37B on the previous page and figure 4.17 above. However, this is higher that the target of 20 vehicle breakdowns in a month. The failure was attributed to the long distances in difficult terrains and rough, unpaved roads covered in the commissioning and follow up of major projects countrywide. However, the improvement was remarkable compared with previous performances and in such circumstances.

The GPS system installed monitors those factors and violations and provides an assessment report for each driver. This has helped to curb the careless driving of motor vehicles or illegal journeys that are not authorised and has resulted in more efficient resource utilisation levels while controlling service related costs. This, in turn, has increased the fleet availability and the more efficient utilisation of the fleet.

### *4.7.5. Rate of Theft and Recovery of Motor Vehicles*

Table 4.41A: Rate of theft of motor vehicles before GPS installation – Central Office

| | Period | Total fleet | Before GPS installation | Vehicle theft (No.) |
|---|---|---|---|---|
| 1 | Jan-09 | 195 | | 1 |
| 2 | Feb-09 | 195 | | 0 |
| 3 | Mar-09 | 195 | | 0 |
| 4 | Apr-09 | 195 | | 0 |
| 5 | May-09 | 195 | | 0 |
| 6 | Jun-09 | 195 | | 0 |
| 7 | Jul-09 | 195 | | 0 |
| 8 | Aug-09 | 195 | | 0 |
| 9 | Sep-09 | 195 | | 0 |
| 10 | Oct-09 | 195 | | 0 |
| 11 | Nov-09 | 195 | | 0 |
| 12 | Dec-09 | 195 | | 0 |
| | **Total** | | | **1** |

Table 4.41B: Rate of theft of motor vehicles after GPS installation – Central Office

| | Period | Total fleet | After GPS installation | Vehicle theft (No.) |
|---|---|---|---|---|
| 1 | Jan-10 | 195 | 143 | 0 |
| 2 | Feb-10 | 195 | 143 | 0 |
| 3 | Mar-10 | 195 | 143 | 0 |
| 4 | Apr-10 | 195 | 143 | 0 |
| 5 | May-10 | 195 | 143 | 0 |
| 6 | Jun-10 | 195 | 143 | 0 |
| 7 | Jul-10 | 195 | 143 | 0 |
| 8 | Aug-10 | 195 | 143 | 0 |
| 9 | Sep-10 | 195 | 143 | 0 |
| 10 | Oct-10 | 195 | 143 | 0 |
| 11 | Nov-10 | 195 | 143 | 0 |
| 12 | Dec-10 | 195 | 143 | 0 |
| | **Total** | | **143** | **0** |

**Reduced Rate of Theft of Motor Vehicles**

The implementation of the GPS vehicle tracking in company fleet vehicles has drastically reduced the number of stolen vehicles as shown in Table 4.41A and 4.41B above. The GPS tracking installed has a variety of features and operational benefits that have improved the safety of drivers and vehicles, significantly reducing the pay-outs for accidents

and traffic violations. The fleet security and control function ensures the security of the vehicle while stopped or not in operation and also the ability to safely disable a vehicle while in operation. The use of the live tracking ability has enhanced the control of the fleet and the ability to recover stolen or route diverted vehicles and reduce the chances of vehicles being lost or stolen as shown in Table 4.42 below. With this feature in place, this enables a prompt response to support efficient customer service.

Table 4.42: Reduction in theft of vehicles after GPS implementation – Central Office

| **Central Office** | **No of stolen vehicles** | **Cost of loss in Ksh.** | **Total cost in Ksh.** |
|---|---|---|---|
| Before GPS implementation – 2009 | 1 | 250,000 | **250,000** |
| After GPS implementation – 2010 | 0 | 0 | **0** |
| **Savings in reduced theft cases** | **1** | **100%** | **250,000** |

### *4.7.6. Perceptions of Staff towards the Implementation of the GPS*

Table 4.43: Responses on the implementation of the GPS System – Central Office

| | **5** | **4** | **3** | **2** | **1** |
|---|---|---|---|---|---|
| 1-Adoption of modern information technology in fleet management has led to improved efficiency in the service delivery | 33% | 57% | 8% | 1% | 0% |
| 2-Adopting new technology equipment is a necessary tool for efficiency in service delivery. | 34% | 60% | 6% | 0% | 0% |
| 3-The increased use of modern IT solutions will result in longer term relationships with prospective customers | 34% | 49% | 13% | 4% | 0% |
| 4-Organisations must be able to integrate knowledge from IT to deliver new products or service efficiently | 37% | 57% | 6% | 0% | 0% |
| 5-In a fast moving world constant improvement in IT is essential for survival and success in service delivery | 40% | 57% | 3% | 0% | 0% |
| **Average approval %** | **36** | **56** | **7** | **1** | **0** |

Note: 5=strongly agree, 4= agree, 3=neutral, 2=disagree and 1= strongly disagree

The responses on the impact of incorporating modern information technology and adopting new technology equipment in fleet management showed that the efficiency in the service delivery at KPLC had improved a shown above in Table 4.43. The results of 36% for 5 **(= strongly agree)** and 56% for 4 **(= agree),** with a overall acceptance level of 92% for all the items, may be taken as a very positive indicator of individual willingness to support the process of implementation and a passion to adopt the new technologies in fleet management systems to create efficiency in the operations.

### *4.7.7. Implementation Expenditure and Cost Reduction Achieved*

In Central Office one hundred and forty three (143) vehicles were fitted with GPS units. Although the GPS fleet tracking units only provide limited online data on location and distance, the use of the system generated data greatly contributed towards more efficient and effective fleet management processes.

**Expenses in implementing the GPS fleet management system**

Table 4.44: Expenses for the implementation of the GPS system – Central Office

| Cost element | Total GPS units fitted | GPS unit fitting costs in Ksh. | Costs per unit in Ksh. |
|---|---|---|---|
| Cost for the supply and installation of the GPS fleet tracking units | 143 | 9,559,511 | 66,850 |

The total cost for the supply and installation of the 143 GPS fleet tracking units was Ksh.9,559,511, which translates into Ksh.66,850 per unit, inclusive of the service level agreement (SLA) for the maintenance of the units and the software management a shown above in Table 4.44.

**Overall savings as a result of the improved efficiency in operations**

The ability to constantly track the location of a vehicle and online records on vehicle speeds and the distance travelled lead to increased efficiency; faster retrieval of the historical records of a vehicle's previous movements and an efficient fleet maintenance program.

Table 4.45: Net savings as a result of the improved efficiency in the operations - Central Office

| Cost element | Costs before GPS implementation | Costs after GPS implementation | Reduction % |
|---|---|---|---|
| 1-Accident damages and traffic violations | 1,400,000 | 600,000 | 57.14 |
| 2-Maintenance cost | 21,975,909 | 17,193,466 | 21.76 |
| 3-Fuel consumption | 34,526,905 | 28,694,658 | 16.89 |
| 4-Theft of vehicles | 250,000 | 0 | 100.00 |
| Total | 58,152,814 | 46,488,124 | 20.06 |
| **Net savings per unit** | **406,663** | **325,092** | **20.06** |

The aggregate annual savings of Ksh.81,571 per unit fitted is a significant contribution to the achievement of lower costs of operations and covers the cost of the supply and installation of the GPS fleet tracking units which were fitted at a cost of Ksh.66,850. The net total savings amounted to Ksh.2,105,179 in 2010 as shown above in Table 4.45.

**Increased Revenue Generation from Improved Fleet Availability**

The successful implementation of the GPS fleet management system has had very significant impact on the operational processes through the enhanced effectiveness and efficiency at KPLC.

Table 4.46: Revenue generation from improved fleet availability – Central Office

| Cost element | Costs before GPS implementation | Costs after GPS implementation | Increase in yield in Ksh. |
|---|---|---|---|
| Revenue generation | 120,022,005 | 137,825,165 | 17,803,160 |
| Yield per unit | 839,314 | 963,812 | 124,497 |

The increased fleet availability created a higher payload capacity transported, resulting in higher revenues and better customer service. An increase in fleet availability creates additional vehicles which are available for the prompt transportation of staff and materials to various customer sites. There was a significant revenue increase of Ksh.17, 803,160 in 2010, which is an additional direct contribution towards the bottom-line as depicted in Table 4.46 above. The overall cost savings and increased revenue due to operational efficiency amounted to Ksh.29,467,850 as compared to the cost of the supply and installation of the 143 GPS fleet tracking units at Ksh.9,559,511. Therefore, the net overall savings in Central office amounted to Ksh.19, 908,338 in only one year, which shows the use of the GPS fleet management has led to increased effectiveness and efficiency in service delivery.

## 4.8. Other Variables and Factors that Influence the Outcome in the three sub-regions

The GPS tracking facility is extremely versatile but its own inherent limitations and operational drawbacks pose many challenges to the quality of the data and the reliability of the system. There are several different types of errors that may occur when using a GPS receiver. Further, technical problems such as the jamming of communication lines due to overload; cellular service not being available in remote areas and suchlike, may lead to disruptions in service. High voltage power lines may also create dead zones underneath them. GPS satellite coverage may also be weaker during certain parts of the day, lowering the amount of satellites the machine's system can use. Due to such limitations the tracking data was not been continuous on many occasions, resulting in several gaps in trip data.

These GPS limitations and other operational challenges are factors that had a variety of implications for each of the key variables and influenced the study results as follows.

### *4.8.1. Limitations and Other Factors that Influenced the Reduction in Accidents*

The significant reduction in the accident rate is attributed to enhanced driver management and the sensitisation of the drivers on the dangers of speeding which translated into a huge decrease in speed violations. While GPS fleet tracking system cannot prevent the occurrence of an accident, the details stored on each trip taken by a vehicle and the generated accident snapshots in the event of an accident provide additional evidence for the accident investigations. Trends in accident rates and data on speed violations within a given period have helped to structure relevant fleet operator seminars, refresher courses on defensive driving and sensitisation on safety precautions which minimise the chance of an accident occurring.

In addition, when drivers know they are being watched, they drive in safer and more considerate manner that reduces further the chance of an accident happening. However, cases of signal transmission loss due to a global system for mobile communications (GSM) failure and, at times, defective units may compromise the accident investigations due to the lack of the much need snapshot reports.

### *4.8.2. Limitations and Other Factors that Influenced the Fleet Availability*

The increased transport availability was largely as a result of the enforcing of speed limits and good driving habits that leads to increased productivity because of improved safety and prompt operational management decisions. The GPS data may be used to determine how fast drivers are going as well as their working hours and overtime hours as it indicates the exact start/end times and actual work and overtime hours. Good driving behaviour is critical to achieving efficient operations. The use of the system generated driving performance reports that help to instil discipline in driving and this, in turn, reduces operational costs while ensuring prompt response to customer demands.

Some of the challenges experienced at the introduction of the tracking units included negative staff reactions towards the vehicle trip monitoring and the disciplinary action that would be taken against repeated speed violations. Cases of GPS units destroyed in order to avoid route and speed recording were reported. Again, despite fitting the GPS units, the rampant traffic congestions and poor road conditions which are common in all major cities cause long delays and damage to the vehicles, seriously compromising any gains resulting from improved operations.

### *4.8.3. Limitations and other Factors that Influenced the Reduction in Fleet Costs*

The use of GPS alerts on each vehicle pre-set manufacturer recommended mileage points ensured that the preventive maintenance schedules were adhered to. This, in turn, prevented the premature failure of any major vehicle part, resulting in great savings in the overall operational costs. If the transport officer does not take advantage of the information to ensure that services or repairs are undertaken before the vehicle breaks down completely, the value of the GPS data would be totally lost. Since the GPS units installed did not have a fuel management function, the integration of fuelling transaction data from electronic fuelling cards with the tracking system assisted in monitoring the actual fuel consumption as compared with what was reported by the employees and also curbed fuel siphoning by operators in collusion with the pump attendants. Supervision ensured that cases of prolonged engine idling and fuel siphoning, if detected, are dealt with expeditiously to cut down on the fuel consumption bill and maintenance costs.

### *4.8.4. Limitations and Factors that Influenced Reduction in Vehicle Breakdowns*

The frequency of vehicle breakdowns results from the way in which the vehicles are driven, especially on poor road conditions, the quality of maintenance and the average age of the fleet. The poor driving behaviour and culture of impunity on the part of drivers increases the frequency of breakdowns due to high speeds on rough roads, harsh braking and the over revving of the engine. Refresher training has helped to inculcate good driving habits, thus resulting in increased fleet availability and the more efficient utilisation of the fleet. Adherence to manufacturer recommended service mileage intervals and implementing scheduled preventive maintenance programmes has greatly reduced vehicle outages, thus increasing availability. The annual renewal of old vehicles that are uneconomical to maintain is carried out in order to achieve a reliable and economical fleet for company operations. This, in turn, impacts positively on improved fleet age and increased fleet availability.

Compliance with enhanced fleet control and routing for company trips helped to minimise unauthorized detours, resulting in more efficient resource utilisation levels with increased operational efficiency.

### *4.8.5. Limitations and Factors that Influenced the Recovery of Stolen Motor Vehicles*

The use of the GPS live tracking ability to locate lost or stolen property with exact location details and geographical positioning provides the security personnel with direct assistance in the case of a stolen vehicle. The remote shutdown function ensures the ability to

disable a stolen vehicle while in operation. This has acted as a deterrent to the theft of company vehicles and enhanced the security of the operators. Physical damage such as dismantling the external GPS antennae placed on top of the vehicle and cutting the connecting cables from the vehicle battery to the GPS unit disables its functioning completely and live tracking would be rendered useless since the recovery of a vehicle depends solely on the availability of a continuous signal to assist in the follow-up on the web-based software mapping.

#### *4.8.6. General Assessment of the Perceptions of Staff towards the Implementation and the Effectiveness of the GPS Fleet Management System in the Organisation*

The ability to constantly track the location of a vehicle and online records on vehicle speeds and the distances travelled lead to increased efficiency; faster retrieval of historical records of a vehicle's previous movements and an efficient fleet maintenance programme. However, some of the challenges experienced at the introduction of the tracking units in respect of a negative staff reaction towards the implementation of the system included the following:

- Cases of malicious physical damage to the units by staff to avoid route and speed recording were reported.
- Signal loss due to an unstable GSM network system and which is necessary for transmission of data.
- Frequent breakdowns of company servers and disruptions during maintenance activities which contributed to data loss during those off-periods
- Defects on the GPS units during accidents which rendered the system ineffective and. consequently, no more data was received.
- The removal of the battery from the vehicle or a prolonged duration in the workshop for vehicle repairs may lead to the non-functioning of the GPS unit due battery discharge and this stops the unit from sending any signals.
- The non-integration of the vehicle tracking facility with other application packages and the inability to automatically download the actual distances covered to the existing integrated company information systems limited its overall use.

The GPS satellite signals can only be received with a unobstructed view of the sky, with the exception of clouds. However, large parts of the travel paths are under dense tree

cover, flyovers and bridges and between clusters of high-rise buildings, or vehicles may be parked under shelter.

## 4.9. Chapter Summary

The research study data was collected from the respondents in three clusters which were randomly selected for sampling and analysed to determine the extent to which the GPS fleet management system had improved effectiveness and efficiency in KPLC. The three selected clusters with a total sample size of 349 units represented a fleet population size of 1,200 and which is fitted with GPS fleet management system. This sample size was deemed sufficiently representative of the whole population as the elements contained in the clusters represented the heterogeneity of the population being studied and were homogeneous among them. The study utilised the survey approach and respondents were asked to fill in a survey questionnaire. The quantitative research techniques included a Likert scale in order to evaluate the effects of the GPS fleet management system implemented. The descriptive technique and the content analysis method of handling the data collected and the data analysis were employed in the study to enhance the understanding and processing of accurate and concise results. The results obtained showed a general improvement in the overall logistical performance of the organisation.

The results on the key performance parameters analysed showed the following notable improvements in the key service performance indicators since the adoption of GPS enabled solutions in the fleet management and operations in the company:

- The accident rate was drastically reduced to below six accidents from about 14 accidents per million kilometres recorded before the installation of the GPS fleet management system.
- In terms of fleet availability, the results showed a marginal achievement of an approximately 2% improvement annually, which translates to more vehicles being available for use. The increase in fleet availability represents a direct financial contribution to the company revenue and a more efficient logistical process.
- The data collected showed significant improvements in both the maintenance and fuelling processes. The overall reduction of approximately 31% on maintenance and 28% on the fuel consumption rate was very significant in the fleet operation budget.

- The overall frequency of vehicle breakdowns reduced within the period by about 28%, which translates into improved fleet serviceability and reliability in both operational and distribution activities.
- The reported cases of stolen motor vehicles and motor cycle have drastically reduced since the installation of the GPS tracking system which provides a very good chance of any stolen vehicle being recovered.
- The data showed reduced cases of misuse or illegal journeys resulting in more efficient resource utilisation levels while controlling service-related costs. This has consequently increased the fleet availability and the more efficient utilisation of the fleet.
- The overall approval rating of 87% on incorporating modern information technology and adopting new technology equipment in fleet management is a strong indicator of the benefits arising from modern technologies in increasing efficient service delivery in KPLC.
- The net savings in the three selected areas amounted to Ksh.79,772,279 in only one year after the implementation of the GPS fleet management system. This has led to greater effectiveness and efficiency in service delivery, resulting in lower unit costs and increased revenue income from the operations.
- Physical damage to the GPS units, signal transmission loss and breakdown of the servers are some of limitations that cause tracking gaps that compromise the accuracy and the integrity of the data collected. The non-integration of the vehicle tracking facility with other application packages and the inability to automatically download the actual distances covered to the existing integrated company information systems limited its overall use.

While the GPS fleet tracking provides only limited data picked on specific functions such as speeds, route details, alerts and live location of vehicles, the use of online data provided by the application is a significant contribution towards more efficient and effective fleet management. The study results shows that the use of that data in fleet management decision making has led to increased effectiveness and efficiency in the service delivery while controlling service-related costs at KPLC.

# CHAPTER FIVE

**Stage in Dissertation**

| | | |
|---|---|---|
| CHAPTER 1: Introduction | Provides an introduction to the general context for the research problem and also covers in brief the research objectives and methodology for the proposed study | |
| CHAPTER 2: Literature Review | Presents literature review examining the historical development of the fleet management systems | |
| CHAPTER 3: Research Methodology | Describes the research design, sample and sampling procedure and the research instruments used for data collection and data analysis. | |
| CHAPTER 4: Data Collection and Data Analysis | Describes the findings derived from the results of the data analysis carried out on the impact of the implementation of fleet management | |
| **CHAPTER 5:** Discussion on Research Findings and Recommendations | 5.1 | Introduction |
| | 5.2 | Summary of the Research Findings |
| | 5.3 | Key research findings |
| | 5.4 | Limitations of the Study |
| | 5.5 | Study Findings in the Light of the Research Questions |
| | 5.6 | Research Recommendations |
| | 5.7 | Recommendations for Further Research |
| | 5.8 | Outlined Implication of Research for Academic Understanding |

| | |
|---|---|
| CHAPTER 6: Research Summary and Conclusion | Presents a summary of the key research findings from the research work accomplished and draws conclusions in respect of the research questions. |

## 5. Discussion on Research Findings and Recommendations

### 5.1. Introduction

This chapter presents the detailed findings of the study based on the analysis carried out on the data collected from the respondents in the three clusters randomly selected for

sampling and then analysed to determine the extent to which the GPS fleet management system has improved effectiveness and efficiency in KPLC. The three selected clusters with a total sample size of 349 units represented a fleet population size of 1,200, which is fitted with the GPS fleet management system. This sample size was deemed sufficient representative of the whole population as elements contained in the clusters represent the heterogeneity of the population being studied and are homogeneous among them.

In the previous chapter, a data analysis was undertaken for each of the respective sub-regions. However, it is necessary to analyse the combined data further so as to establish the total effect on the key variables. Descriptive statistics and correlations based on the characteristics and frequency distribution are employed in the study to analyse the resultant effect on the key variables. The content analysis method has been used so as to ensure the reliability of the study of published information (Ellinger, Lynch, Andzulis & Smith, 2003:199) and also for measuring comparative positions and trends in reporting (Kent & Flint, 1997:15).

These key variables considered for this study and as captured in the research questionnaire are reproduced below for convenience:

Part A – Demographic data

Part B – Reduction in Motor fleet accidents between year 2009 and 2010

Part C – Improvement in fleet availability between year 2009 and 2010

Part D – Reduction in the fleet costs between year 2009 and 2010

Part E – Reduction in frequency of vehicle breakdowns between year 2009 and 2010

Part F – Reduction in vehicle theft between year 2009 and 2010

Part G – Perceptions of staff towards the GPS implementation

## 5.2. Summary of the Research Findings

The three selected geographical areas, namely, the North Rift, Mt Kenya North and Central Office sub regions, have a combined total fleet of 548 units. The sample size of 349 units fitted with GPS units, selected using the random sampling procedure, is representative of a fleet population size of 1,200 units and higher than the 291 units given as a minimum size in the “Guide to Minimum Sample Size” (Krejcie & Morgan, 1970:30). The elements contained in the clusters represent a well-spread coverage and are, therefore, deemed to sufficiently representative of the whole population for the research study.

### *5.2.1. Response Rate from the Three Sub-Regions*

Three hundred and thirty-four respondents of the total of 349 from the three sampled areas responded in good time, giving an acceptable response rate of 96%. All the questionnaires were edited and checked for completeness for use in the data analysis. The data collected was based on the key variables crucial in examining the contribution of the GPS fleet management system to the organisations under study.

### *5.2.2. GPS Effect on Reducing the Rate of Accidents per 1 Million km Travelled*

As shown in table 5.1 below the results of the survey indicated that the accident rate in the selected areas showed a cumulative reduction of up to 44%.

Table 5.1: Effect of GPS in reducing the rate of accidents – rate per million km

| | **North Rift** | **Mt Kenya North** | **Central Office** | **Average** |
|---|---|---|---|---|
| Jan – Dec 2009 without GPS | 1.56 | 5.9 | 3.11 | 3.52 |
| Jan – Dec 2010 with GPS fitted | 0.74 | 3.74 | 2.65 | 2.38 |
| **Reduction %** | **78.21** | **47.80** | **19.61** | **44.03** |

In the case of an accident, the GPS tracking system maintains records of the speed and direction of the vehicle, allowing a complete analysis in the investigation of the incident. While the GPS fleet tracking system may not directly stop the occurrence of an accident, the recorded data on specific functions such as speeds, route details, alerts and live location of vehicles facilitates accurate and defensible information useful for drivers' behavioural change and for police and insurance purposes. The consequences of accidents are dire and include direct costs such as medical treatment costs, failure to fill orders or meet deadlines, lost time on accident investigations, lost revenue due to absence from work, associated police and insurances costs, damage to property and other indirect costs.

It is noted that the assessment and monitoring of the operators is made possible through regular reports from the GPS fleet monitoring system regarding each trip taken by a vehicle so that the relevant data may be reviewed and discussed with the driver concerned. This has improved the general driver's driving habits, ensuring greater safety which, in turn, reduces the chance of an accident happening.

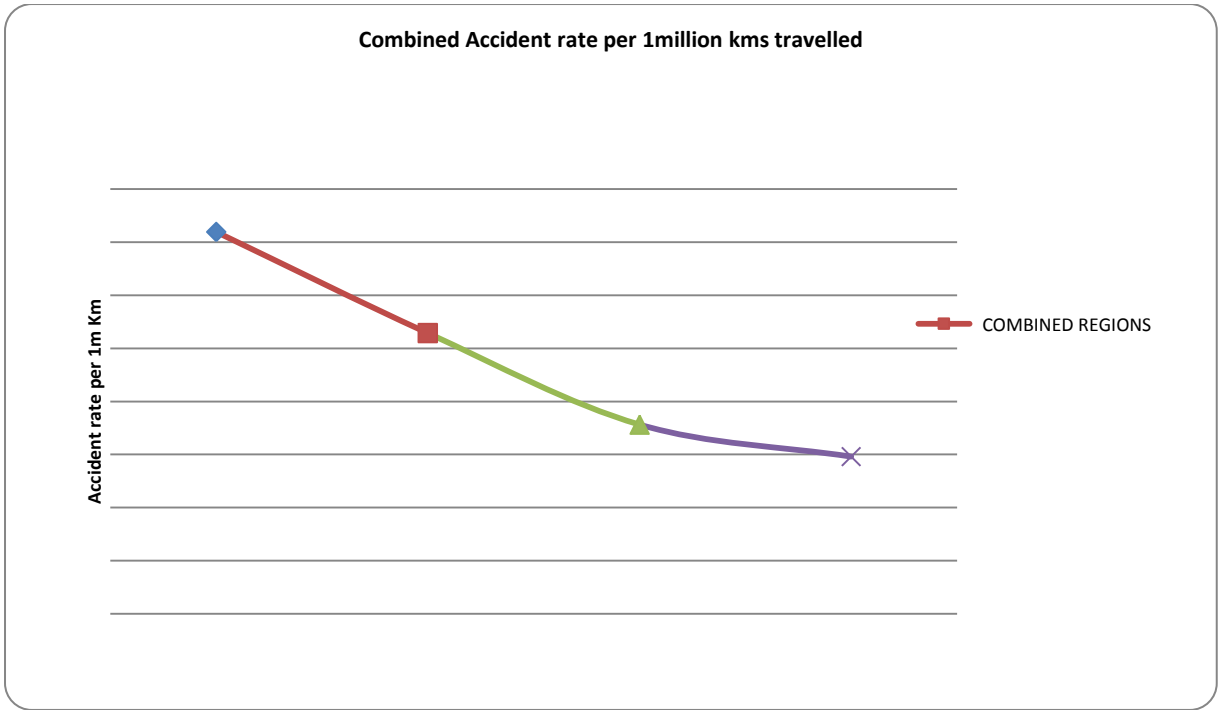



Figure 5.1: The effects of the GPS on the rate of accidents between 2008 and 2011 from the three sub-regions

The company fleet travels an average of 2.5 million kilometres in a month. Before the installation of the GPS units approximately 35 accidents would happen in a month and this has now reduced to about 15 accidents only as a result of the monitoring the average number of accidents dropped to 6.0 from an average of 14 accidents per million kilometres, as shown in fig. 5.1 above. In terms of costs, a reduction of 20 accidents per month would save approximately Ksh.24 million in year at an average total cost about Ksh.100,000 in pay-outs for accident costs, traffic violations and associated costs.

The GPS recorders have the ability to provide accident snapshots in the event of an accident, with vital details of the direction and speed of the vehicle. This information from the system generated accident snapshots is becoming increasingly important, especially in liability cases. This has translated into a huge reduction in the rate of accidents measured in a million kilometres. The company, therefore, recognises the GPS vehicle tracking system as a valuable tool for providing the critical information necessary in addressing the circumstances involved and level of liability during the investigation into all accidents.

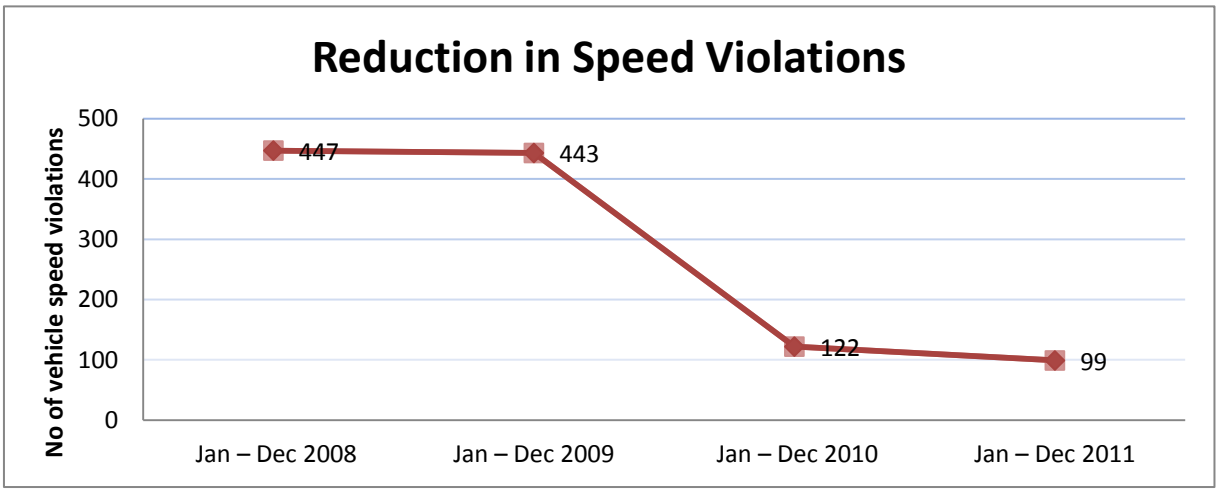



Figure 5.2: Reduction in speed violations after full implementation in 2010 from the three sub-regions

The significant reduction in the accident rate is attributed to enhanced driver management and the sensitisation of the drivers on the dangers of speeding and this translated into the huge reduction of 72% in speed violations, as shown in figure 5.2 above. In addition, when drivers know they are being watched, they drive in a safer and more considerate manner that reduces the chance of an accident. In the literature review, King (2011:1) maintains that both of these factors actively work towards reducing the premiums payable. Focusing on safety, the business may also decrease insurance costs. Thomas (2010:1) states an outstanding safety record may lower the risk to insurance providers and this, in turn, may result in lower premiums while, in addition, many insurance companies offer rate reductions for additional safety equipment, including GPS tracking devices. It was also noted in the literature review that the use of ICT has direct implications for firms.

According to Arvanitis and Loukis (2009:43), ICT helps in areas such as information gathering and dissemination, inventory control and quality control. More specifically, ICT in transportation fleet and freight management applications has been defined as a decision support tool in transportation planning, optimisation and execution. Applications help planners to choose transportation modes and also manage freight consolidation operations and coordinate company shipments. However, it is also being used as a reporting tool by logistics managers who need to know vehicle travel times, service times, and the delivery points that were visited.

### *5.2.3. Comparison of the Fleet Availability Achieved in the Sampled Regions*

The study results showed an improvement in the combined fleet availability from an average of 92.9 to 95.2%. This is a positive overall increase of approximately 2.3%, as shown in table 5.2 below.

Table 5.2: Effect of GPS on improving fleet availability (%)

| | **North Rift** | **Mt Kenya North** | **Central Office** | **Average** |
|---|---|---|---|---|
| Jan – Dec 2009 Without GPS | 96.80 | 92.59 | 91.92 | 94 |
| Jan – Dec 2010 With GPS fitted | 98.23 | 93.79 | 93.19 | 95 |
| **Improvement %** | **2.00** | **1.87** | **1.73** | **1.87** |

This average in transport availability was largely as a result of enforcing speed limits and the good driving habits that lead to increased productivity because of better safety and prompt operational management decisions. The use of the GPS vehicle tracking system in company fleet of vehicles improved productivity and reduced operational costs while ensuring a prompt response to customer demands. The recognition is that firms is no longer able to effectively satisfy its customers' various demands with just product and price, but they must also increase their performance in terms of response speed, delivery policy, information services and flexibility. An increase in fleet availability creates additional vehicles which are available for the prompt transportation of staff and materials to various customer sites. The attendant result is a higher payload transported which results in higher revenues and better customer service.

The objective of improving fleet availability is to gain a competitive edge by providing superior customer service with improved efficiency and closer customer–supplier relationships. "Reducing transport-costs while maintaining and improving customer service levels and levering private and third-party transportation systems caused the need for some serious technology to be developed in the supply chain" (Frazelle, 2002:169).

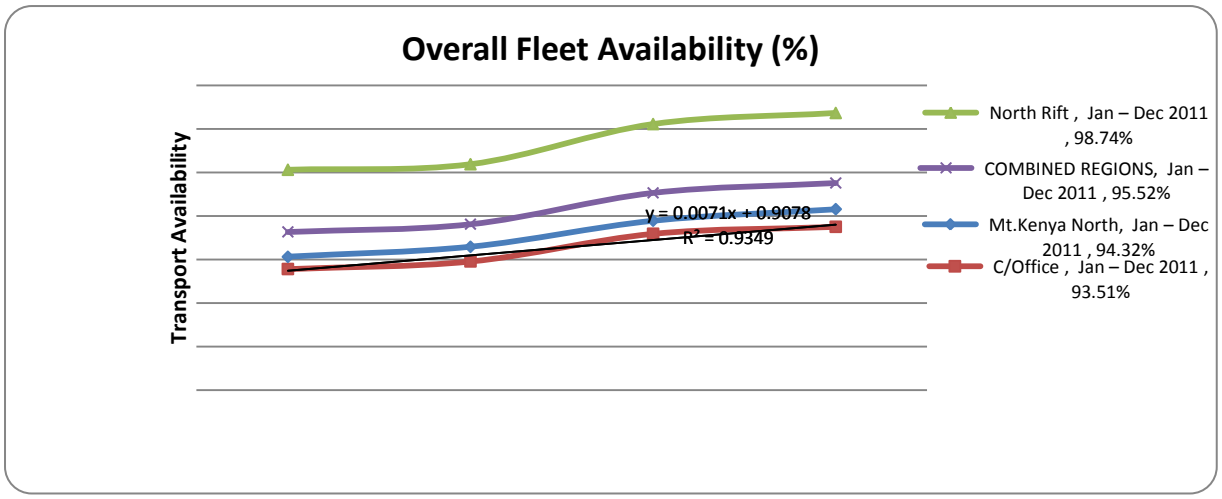



Figure 5.3: The fleet availability improvement between 2008 and 2011 from the three sub-regions

The result shows a positive overall improvement in fleet availability in the respective sub-regions, as shown on figure 5.3 above, which represents a direct financial contribution from the effect of more efficient logistical process. The objective of improving fleet availability is to gain a competitive edge by providing superior customer service with improved efficiency and closer customer and supplier relationships. The greatest advantage has been the real-time monitoring and interaction with fleet vehicles to attain a high fleet operation and provide a fast response to customer need. The findings of this study are consistent with the research findings published by the Aberdeen Group (Marketwire, 2009), showing that leading organisations were able to reduce their fleet related operating costs by 46% and increase service-related productivity by 41%. The revenue generated as a result of the higher mileage covered grew by 20% from Ksh.375M to Ksh.460M as shown in figure 5.4 below.

This positive improvement in fleet availability is corroborated by Sanders (2007:1332), who states that "GPS generated data improves service planning and develops increased productivity because of better management decisions". The company is now able to determine how fast drivers are going, working hours and after hours use of any fleet vehicle through the GPS "virtual time-card" for each employee as it indicates exact start/end times and actual work and overtime hours. Other prior studies have also noted the importance of the GPS mapping and scheduling function that increases the utility of the vehicles through the effective route planning of the intended vehicle trips for operations. The findings of this study are consistent with those of Bekiaris and Nakanishi (2004:60), who found that managers at

the dispatch centre are able to visualise in real-time the entire fleet, usually in digital maps, allowing them to obtain data on vehicle status, traffic updates, etc.

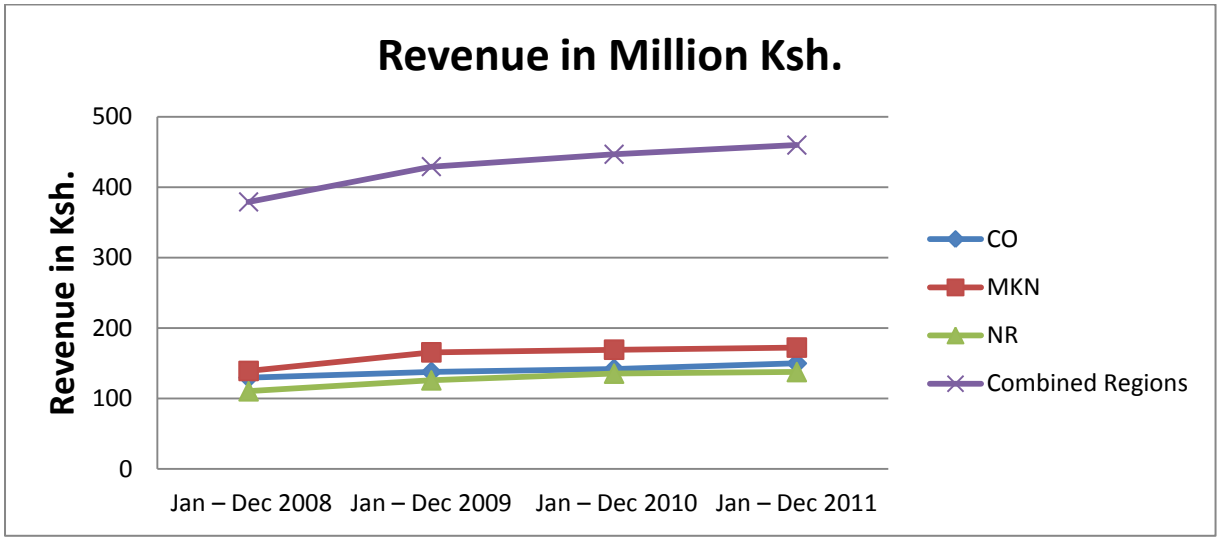



Figure 5.4: Revenue growth as the fleet availability improved from the three sub-regions

The integration of the system with automated company systems provides statistical data on staff salaries, financial and accounting and so on. Murphy (2004) views productivity as another benefit of real-time tracking and says: "Planning the best route to a job and discovering how long a particular job takes can add up to more productive days." The fact that accurate online data is available for management decision making provides a complete understanding of the exact location of every single vehicle and, understandably, this allows for easier personnel management. As mentioned in the literature review, by having information on the driving habits of workers, it is possible to find wasteful drivers and to give them instruction on how to drive in a more efficient manner, for instance, by reducing speeding and idling time (King, 2011:1).

### *5.2.4. Comparison and Analysis of Summarised Data on Operational Costs*

As shown in table 5.3 below, the recorded reduction in maintenance cost is 16% from Ksh.7.52/km to an average of Ksh.6.33/km – a significant saving in costs considering the total distance travelled in 2010 in the three areas under study was 9,056,222 km.

Table 5.3: Effect of GPS on reducing fleet maintenance costs

| | North Rift | Mt Kenya North | Central Office | Average |
|---|---|---|---|---|
| Jan – Dec 2009 Without GPS | 7.88 | 5.27 | 9.42 | 7.52 |
| Jan – Dec 2010 With GPS fitted | 6.67 | 4.94 | 7.37 | 6.33 |
| **Reduction %** | **15.36** | **6.26** | **21.76** | **15.82** |

In monetary terms the computed gains translate into a saving in maintenance costs of Ksh.24,904,610 in only one year. The GPS fleet management systems fitted includes maintenance management to trigger an alert when the vehicles reach the manufacturer suggested mileage points. This ensures that an effective maintenance schedule is maintained to prevent the premature failure of any major vehicle part and this has resulted in great savings in overall operational costs.

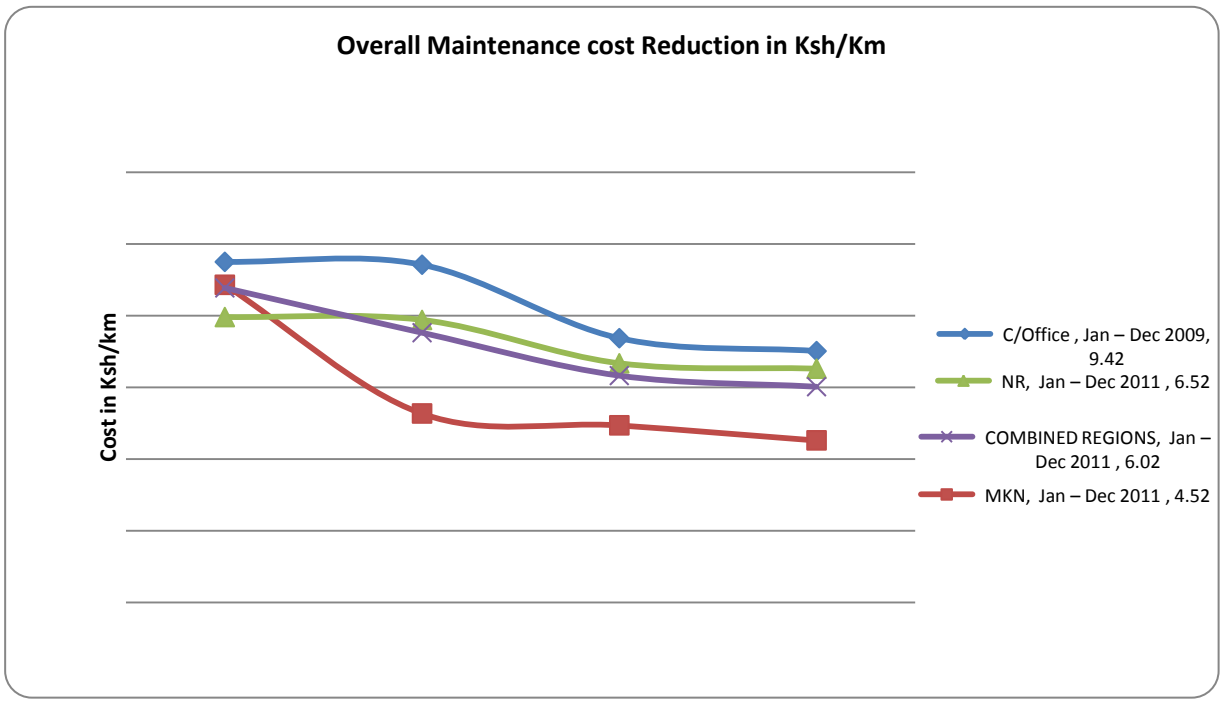



Figure 5.5: Reduction achieved in costs between Jan 2008 and Dec 2011 from the three sub-regions

The trend in the overall cost reduction resulting from controlling the maintenance process contributes to the achievement of higher operational efficiency, as shown in figure 5.5 above. The GPS fleet monitoring system provides information that may be used to ensure that services or repairs are done before the vehicle breaks down completely. With this monitoring tool, efficiency in operations may be achieved and this lowers the overall cost of

operations in terms of equipment acquisition, insurance, fuel, maintenance and repairs and ensures the sustainability of the company profitability. The overall achievement in reducing maintenance costs was 16%. The reduction varied from region to region with a significant reduction recorded in the North Rift area. In monetary terms, a reduction from Ksh.7.52 per kilometre to an average of Ksh.6.33 per kilometre by the end of December 2010 of US$1 = shs.90 – Central Bank of Kenya (CBK) Forex rate (2011).

Krishnaveni and Meenakumari (2010:282) assert that ICT has played a major role in reducing operational inefficiency and improving decision-making in many areas of governance. Cordella (2006) emphasises that the diffusion of ICT in the present era is associated with an increased amount of information becoming available. Furthermore, Hengst and Sol (2001:3) affirm that ICT enables organisations to decrease costs, increase organisational capabilities and also assist to shape inter-organisational coordination.

The greatest advantage of the GPS fleet system installed is the ability to track and trigger an alert when the vehicles reach the manufacturer suggested mileage points and also the ability to set up a preventive maintenance schedule. This has helped to prevent premature engine breakdowns, resulting in great savings in maintenance costs. The objective is to control the maintenance cost as much as possible so as to achieve a higher operational efficiency at the lowest possible maintenance cost.

Table 5.4: Improvement in fuel consumption rate in kilometres per litre

| | **North Rift** | **Mt Kenya North** | **Central Office** | **Average** |
|---|---|---|---|---|
| Jan – Dec 2009 Without GPS | 6.84 | 6.90 | 5.81 | 6.52 |
| Jan – Dec 2010 With GPS fitted | 7.96 | 7.53 | 6.93 | 7.47 |
| **Improvement %** | **13.01** | **18.11** | **19.62** | **16.71** |

While the GPS fleet tracking provides only limited data picked on specific functions such as speeds, route details, alerts and live location of vehicles, the study results shows that the use of that data in fleet management has led to increased effectiveness and efficiency in service delivery. The reduction in idling time and control of fuelling usage through the GPS generated reports not only reduced fuel consumption but helped to cut down on overall operational expenses as well. The overall fuel consumption efficiency for the three sampled sub-regions rose from an average of 6.52 kilometres per litre to 7.47 kilometres per litre. The

17% improvement is viewed as a major cost-cutting measure and a reduction in the overall transportation costs as shown in Table 5.4 above.

In the literature review, these results are corroborated by Hengst and Sol (2001:4), who affirm that ICT enables organisations to decrease costs, increase organisational capabilities and also assist in shaping inter-organisational coordination.

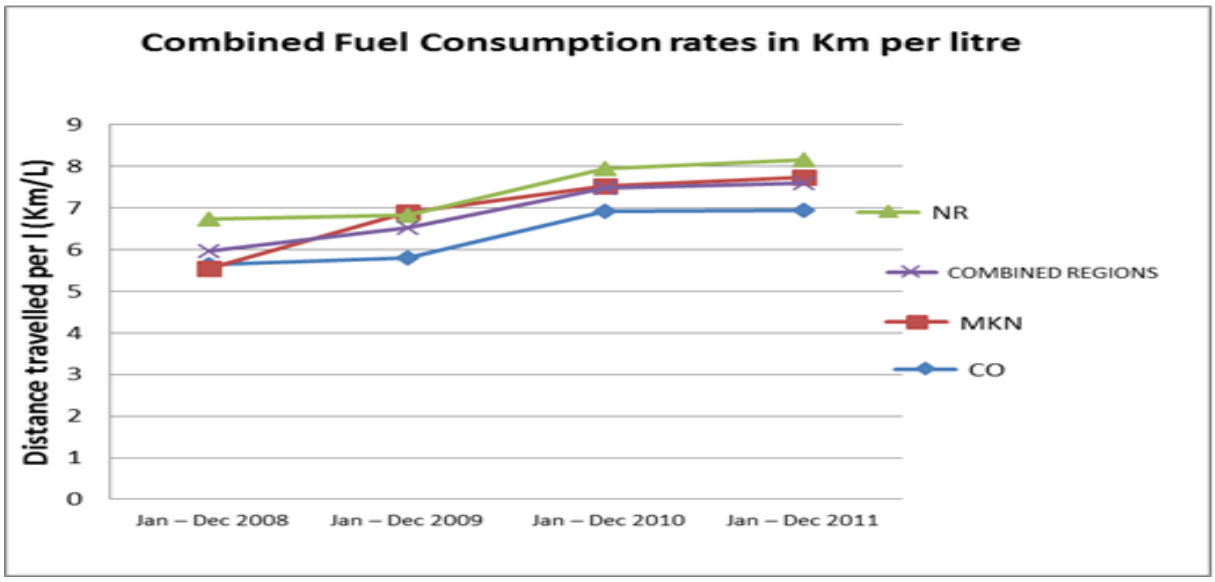



Figure 5.6: Reduction achieved in fuel efficiency between 2008 and 2011

The integration of fuelling transaction data from electronic fuel cards with the tracking system assisted in monitoring the actual fuel consumption as compared with what was being reported by the employee and also curbed any fuel siphoning by operators in collusion with the pump attendants. Again, the minimisation of illegal journeys that were not authorised resulted in more efficient resource utilisation levels while controlling service related costs as shown in figure 5.6 above. The recorded improvement of 16% in maintenance costs and 17% in fuel costs compares with the figures found in the research findings published by the Aberdeen Group (Marketwire, 2009:1) showing leading organisations were able to reduce fleet related operating costs by 46% and increase service related productivity by 41%. In addition, a 25% reduction in idle times and 22% decrease in fuel costs were recorded in the service organisations researched. The adoption of GPS-enabled solutions enabled higher customer satisfaction levels and better resource utilisation while controlling service related costs.

In the literature review, Nietermayer (2010:2) states “other advantages include: Employee accountability moves into the forefront of daily operations; fuel savings of 10% to

15% can be achieved; labour costs can be saved in the form of overtime; vehicle maintenance costs drop significantly; management of employee safety and the monitoring and correction of poor vehicle speeds and driving habits are enhanced". Other researchers such as Hengst and So (2001) affirm that ICT enables organisations to decrease costs, increase organisational capabilities and also assist to shape inter-organisational coordination. A recent survey of the users of tracking systems, published in m.logistics (2008:34) reported benefits such as increased productivity; reduced costs and enhanced fleet performance.

Surprisingly, it was found in a case study conducted on ABI, one of the Coca-Cola bottlers in South Africa in 2001, which had decided to implement Roadshow routing and scheduling software throughout all its large depots by utilising Roadshow to plan its routes, ABI was able to reduce its kilometres driven and, hence, its delivery costs. The use of Roadshow resulted in a savings of 23.6% for diesel and 13.9% for petrol (SAB, 2001:37). Their finding compares with the finding of this study of a 17% improvement in fuel efficiency. This finding corroborates those of Taniguchi and Shimamoto (2004:235), who found out that the total operational cost decreased by implementing the dynamic vehicle routing and scheduling model with real-time information. Mason-Jones and Towill (1999:13) and Sauvage (2003:236) state that firms improve their operation efficiency through the on-going implementation of information or automation technologies according to their business characteristics.

### *5.2.5. Overall Reduction in the Frequency of Vehicle Breakdowns*

Table 5.5: Reduction in average frequency of vehicle breakdowns in incidences per year

| | **North Rift** | **Mt Kenya North** | **Central Office** | **Average** |
|---|---|---|---|---|
| Jan – Dec 2009 Without GPS | 21 | 14 | 24 | 19.67 |
| Jan – Dec 2010 With GPS fitted | 12 | 12 | 23 | 15.67 |
| **Reduction %** | **47.67** | **21.43** | **8.32** | **25.42** |

The overall frequency of vehicle breakdowns reduced within the period by about 25%, which translates into a lesser number of vehicles being referred to the workshop for repairs as shown in table 5.5 above.

The GPS system installed monitors those factors and violations and provides an assessment report for each driver. This has helped to curb the careless driving of motor vehicles and illegal journeys that are not authorised and has resulted in more efficient resource utilisation levels while controlling service related costs.

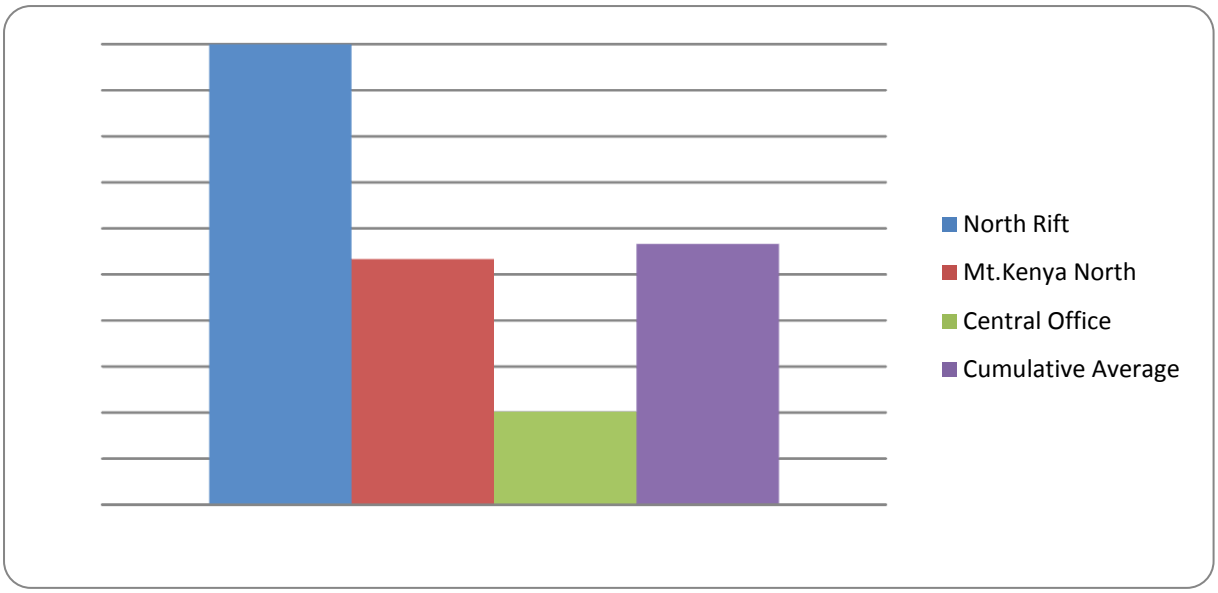



Figure 5.7: Reduction in average frequency of vehicle breakdowns

The findings shows according to figure 5.7 above an increased fleet availability and more efficient utilisation of fleet as a result of the introduction of a driver performance evaluation using the generated Green band reports. Driving performance reports with a number of factors that constitute good driving habits such as observing speed limits and avoiding harsh braking and over revving of the engine has resulted in more efficient resource utilisation levels while controlling service related costs. This has consequently increased the fleet availability and the more efficient utilisation of the fleet.

Operational and distributional efficiency are critical in meeting the required customer satisfaction levels and achieving higher resource utilisation levels while, at the same time, controlling service-related costs in the company. The use of GPS vehicle tracking reports has not only improved productivity and reduced operational costs, but the business has profited from providing a better customer service.

The findings of this study are consistent with the research findings published by the Aberdeen Group (Marketwire, 2009:1), showing improvements in key service performance indicators since the adoption of GPS-enabled solutions:

- 46% reduction in fleet related operating costs
- 41% increase in service related productivity
- 16% extended life of service vehicles.

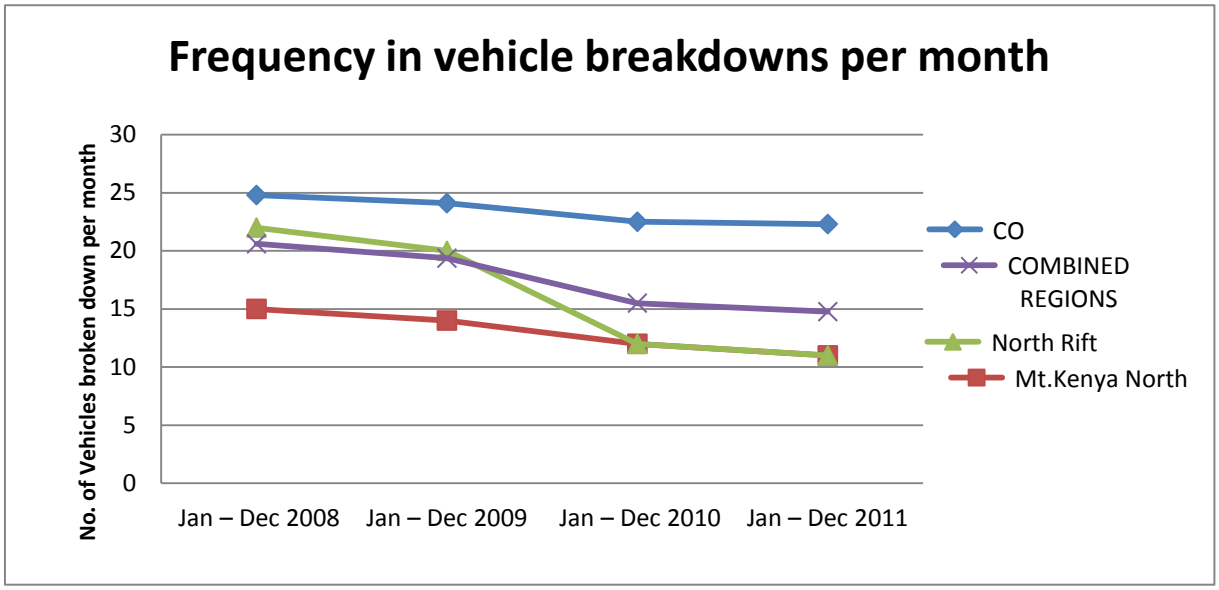



Figure 5.8: Overall reduction in the frequency of vehicle breakdowns from the three sub-regions

The overall frequency of vehicle breakdowns reduced, as shown in figure 5.8 above, which translates into a 25% improvement in fleet serviceability and reliability. As mentioned in the literature review, Alam and Noor (2009:112) argue that ICT offers transport enterprises the opportunity to compete on a global scale with improved efficiency and closer customer and supplier relationships. The use of ICT in transport logistics also impacts on a firm's competitive advantage (Closs & Xu, 2000:869). Stock (1990) provides examples of firms using logistical ICT to gain a competitive advantage. In a case study conducted on Willard Batteries, a South African company based in Port Elisabeth and, a producer of automotive and industrial batteries, it was found that the implementation of a modern fleet management solution had resulted in Willards needing six vehicles only in order to cope with their daily deliveries; a saving of approximately 40%. Willard's vehicle utilisation went up from 50 to 60% to over 90% (Opsi Systems, 2007).

These results are also consistent with those of other studies conducted in a beer distribution company, Gate City Beverage Distributors based in San Bernardino, California. Gate City Beverage Distributors supplies over 4000 grocery and liquor stores with 400 different stock-keeping units. The company's network consists of multiple depots and 70 trucks that make the 10 000 deliveries a month. The implementation of Roadshow's scheduling and routing software enabled Gate City Beverage Distributors to achieved a 50% improvement in on-time deliveries and reduce transportation costs by 5% (Avocus Group LLC, 2004:2).

### 5.2.6. *Theft and Recovery of Motor Vehicles*

The information about the fitting of the GPS vehicle tracking units on company fleet vehicles created fear and deterred many car thieves because the live tracking ability is able to locate the actual position of the stolen vehicle immediately the alarm is sounded. This has also contributed to an improvement of the safety of drivers and significantly reduced payouts for accidents and traffic violations.

Table 5.6: Reduction in theft of motor vehicles in incidences per year

| | North Rift | Mt Kenya North | Central Office | Total |
|---|---|---|---|---|
| Jan – Dec 2009 Without GPS | 2 | 2 | 1 | 5 |
| Jan – Dec 2010 With GPS fitted | 1 | 0 | 0 | 1 |
| Jan – Dec 2011 With GPS fitted | 0 | 0 | 0 | 0 |
| **Reduction %** | **50** | **100** | **100** | **80** |

The reported cases of stolen motor vehicles and motor cycle have drastically reduced since the installation of the GPS tracking system, as shown in table 5.6 above.

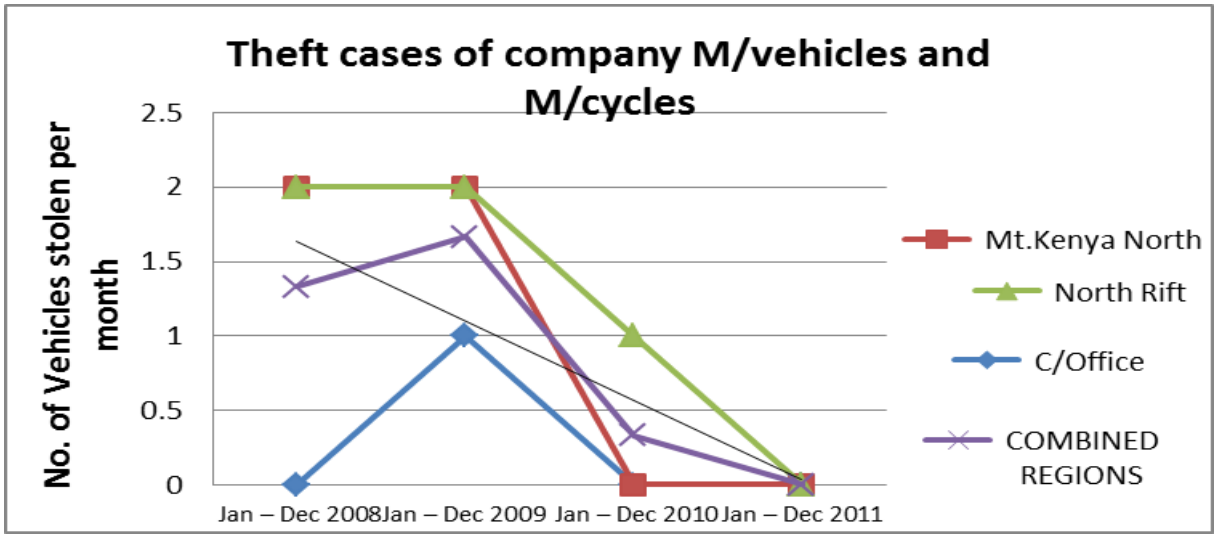



Figure 5.9: Reduced rate of theft of vehicles between 2008 and 2011 from the three sub-regions

This study found that the installation of the GPS vehicle tracking on company fleet vehicles has drastically reduced the number of stolen vehicles, as shown in figure 5.9 above. While the information that company vehicles are fitted with tracking systems is sufficient deterrence to many thieves, the live tracking ability to locate actual position once the alert has been sounded and aid in follow up provides a very good chance of the vehicle being recovered.

The reported cases of stolen motor vehicles and motor cycle have drastically reduced since the installation of GPS tracking system and, in the preceding year, not one motor vehicle had been stolen. This is a great saving in the replacement costs that would have been needed to purchase another vehicle and also the unnecessary down time and supply interruption occasioned by the unavailability of the stolen vehicle. The fleet security and control function ensures the security of the vehicle while stopped or not in operation and also the ability to disable safely a vehicle while in operation. This, in turn, has enhanced the control of the fleet and the ability to recover stolen or route diverted vehicles while also reducing the chances of vehicles being either lost or stolen, as shown in figure 5.10 below.

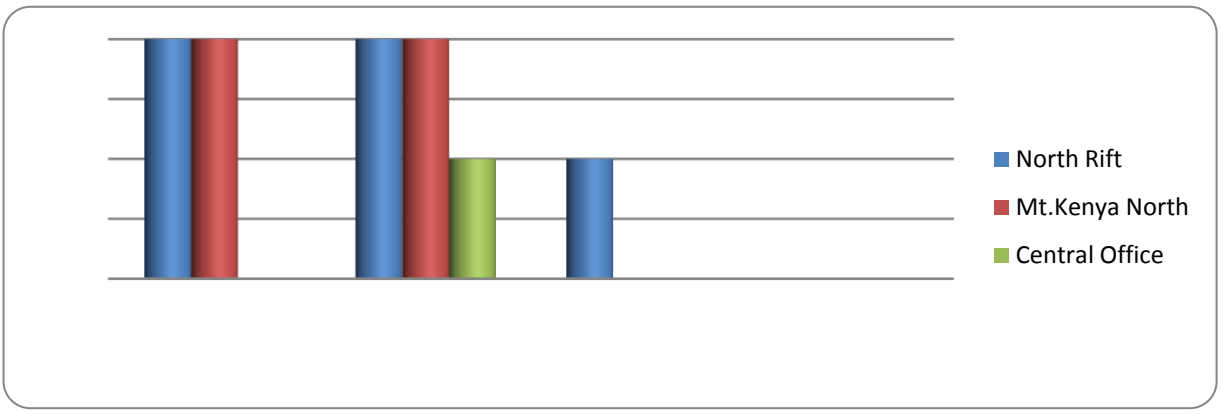



Figure 5.10: Reduction in theft of motor vehicles from the three sub-regions

The use of the live tracking ability to locate lost or stolen property with exact location details and geographical positioning provides the security personnel with direct assistance and support. With this feature in place, it enables a prompt response to support efficient customer service. The findings which show a drastic reduction in the theft of motor vehicles in the company, are consistent with the literature review where Nietermayer (2010:2) stated that "online GPS technology allows real-time tracking and, if a vehicle is stolen, the vehicle is almost guaranteed to be recovered".

GPS systems also have alerts that can be set for each vehicle in the fleet. Examples of the alerts include hours of normal operation, off hours and out-of-zone alerts. If a vehicle is stolen, any user may be notified, and visual tracking may begin. A user is able to view the screen, ping the vehicle and inform the police where the vehicle is located. Likewise, improved efficiency of traffic data collection and storage results in the enhancement of security and the safety of operators due to use of GPS tracking system (Li & Qin Zhu, 2003:6).

### *5.2.7. General Assessment on the Perceptions of the Staff towards the Implementation of the GPS fleet Management System in the Organisation*

Table 5.7: Responses on the implementation of the GPS from the three sub-regions

| | **5** | **4** | **3** | **2** | **1** |
|---|---|---|---|---|---|
| 1-Adoption of modern information technology in fleet management has led to improved efficiency in the service delivery | 35% | 50% | 13% | 2% | 0% |
| 2-Adopting new technology equipment is a necessary tool for efficiency in service delivery. | 35% | 52% | 12% | 1% | 0% |
| 3-The increased use of modern IT solutions will result in longer term relationships with prospective customers | 36% | 49% | 11% | 3% | 1% |
| 4-Organisations must be able to integrate knowledge from IT to deliver new products or service efficiently | 36% | 54% | 10% | 0% | 0% |
| 5-In a fast moving world constant improvement in IT is essential for survival and success in service delivery | 35% | 52% | 11% | 2% | 0% |
| % Average approval | **36%** | **51%** | **11%** | **1%** | **0%** |

Note: 5=strongly agree, 4= agree, 3=neutral, 2=disagree and 1= strongly disagree

The responses on the various parameters to gauge the level of satisfaction with and recognition of any benefits in terms of the service delivery through their experiences in the use of the GPS fleet management system are presented in table 5.7 above.

**Adoption of modern information technology in fleet management has led to improved efficiency in service delivery at KPLC**

The results show a combined positive acceptance level of approximately 85% on the part of the respondents that the Adoption of modern information technology in fleet management has led to improved efficiency in service delivery at KPLC. Some of the significant advantages noted by the respondents in using GPS fleet management system includes improved efficiency in service, faster adoption of new technology and increased use integration of modern IT solutions to deliver new products or service efficiently.

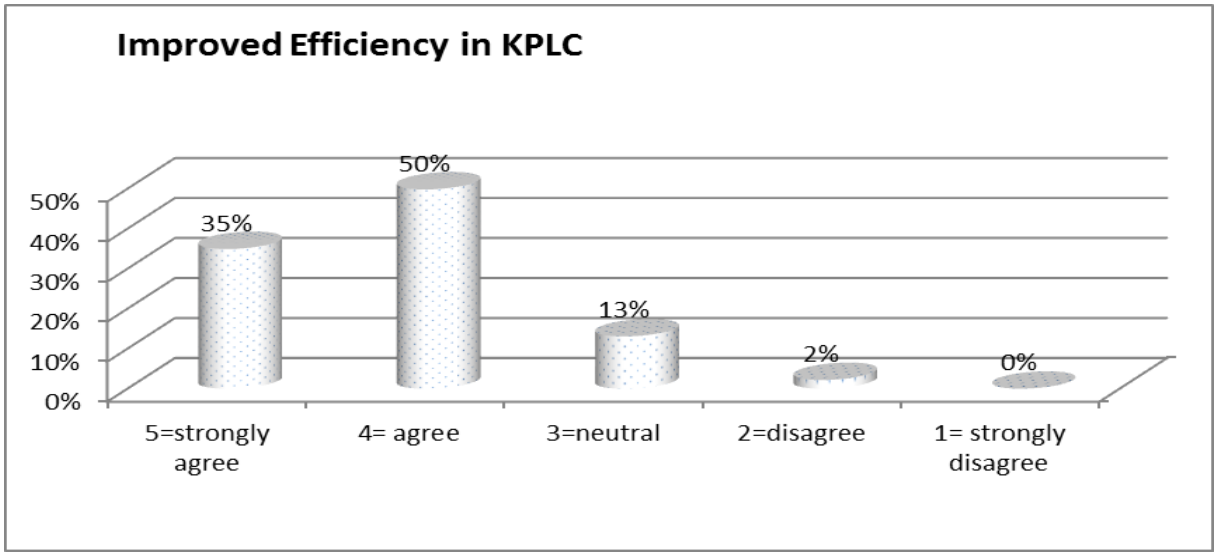



Figure 5.11: Improved efficiency in service delivery at KPLC from the three sub-regions

The ability to constantly track the location of a vehicle and the online records of vehicle speeds and the distances travelled lead to increased efficiency; faster retrieval of the historical records of a vehicle's previous movements and an efficient fleet maintenance programme as presented in table 5.11 above.

In the literature review, Noton (2011:1) states:

"GPS fleet management is becoming an indispensable tool of any business that has a fleet of vehicles. With a real-time fleet tracking system, a business manager can go online and view the delivery status and real-time location of all their vehicles. In addition, they will have better communication with the entire fleet of vehicles allowing them to re-route drivers in an instant. It also gives them the ability to increase their response time for customer requests regarding the status of their delivery. As a result, it can reduce the number of customer inquiry service calls. The overall outcome is a very satisfied customer".

**Adopting new technology equipment is a necessary tool for efficient service delivery**

In a bid to effectively maintain an equitable balance between the resources of an organisation and management of its fleet, the application of an efficient, cost effective, automated system such as information technology (IT) becomes inevitable, especially as regards an organisational service delivery agenda. The GPS fleet management system has greatly improved the business operations in terms of the formulation of transportation planning schedules which have resulted in increased employee productivity and efficiency by eliminating wait/down time, dispatch inaccuracies and tardiness.

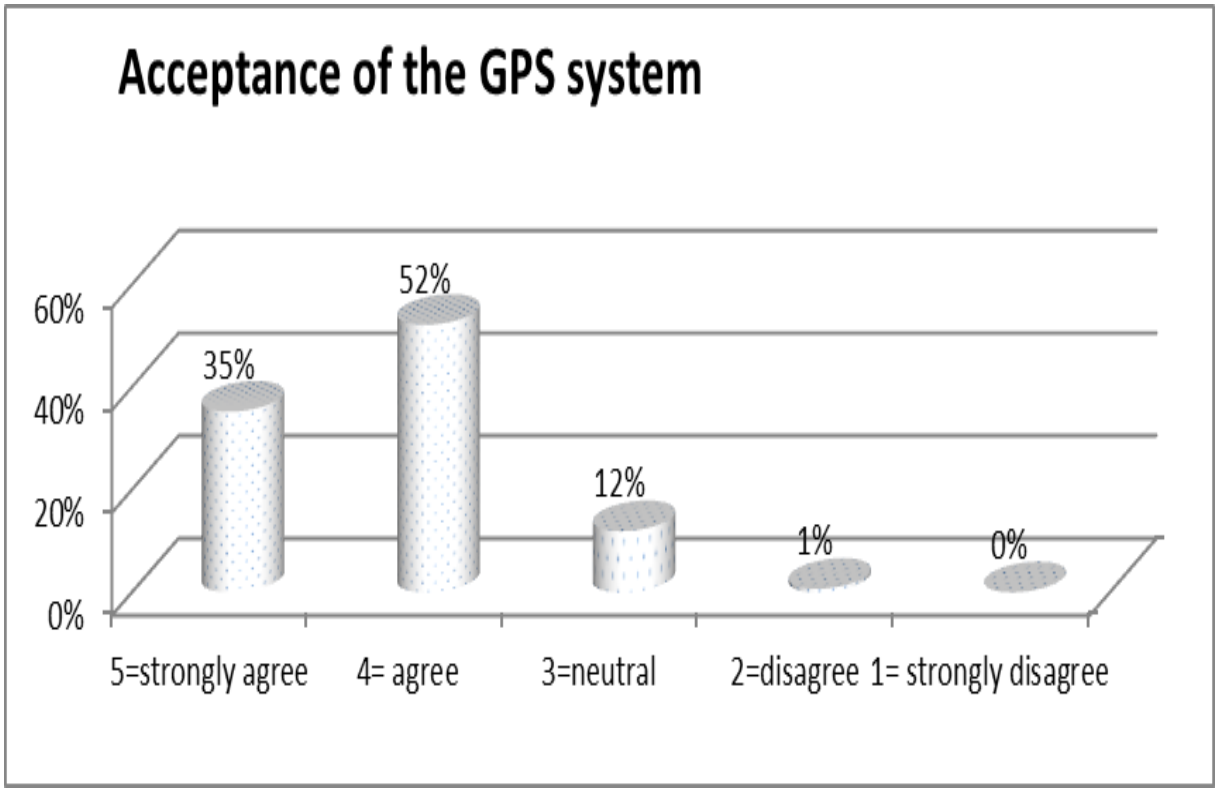



Figure 5.12: Adopting new technology equipment at KPLC from the three sub-regions

The findings showed positive acceptance of new technology as presented in table 5.12 above. In the literature review, Closs and Xu (2000:869) also showed that ICT capabilities significantly influence the overall competence of transport logistics. According to experts, it would appear that no single factor has greater potential to improve logistics operations than information communication technologies. In addition, Sanders (2007:1332) asserts that GPS improves service planning and results in increased productivity because of better safety management decisions.

Lai et al. (2000:1) also indicate that the successful implementation of ICT to support the several logistics processes is expected to bring a number of benefits to firms. According to Gutiérrez and Durán (1997), Hammant (1995) and Piplani et al. (2004:27), these benefits may range from a reduction in errors in the entry of data to improvements in customer services.

Irvine and Anderson (2008:200) comment that the use of modern ICT not only offers practical benefits for general management, but also enables companies to overcome the disadvantages of place and space utility inherent in transportation.

**The increased use of modern IT solutions will result in longer term relationships with prospective customers**

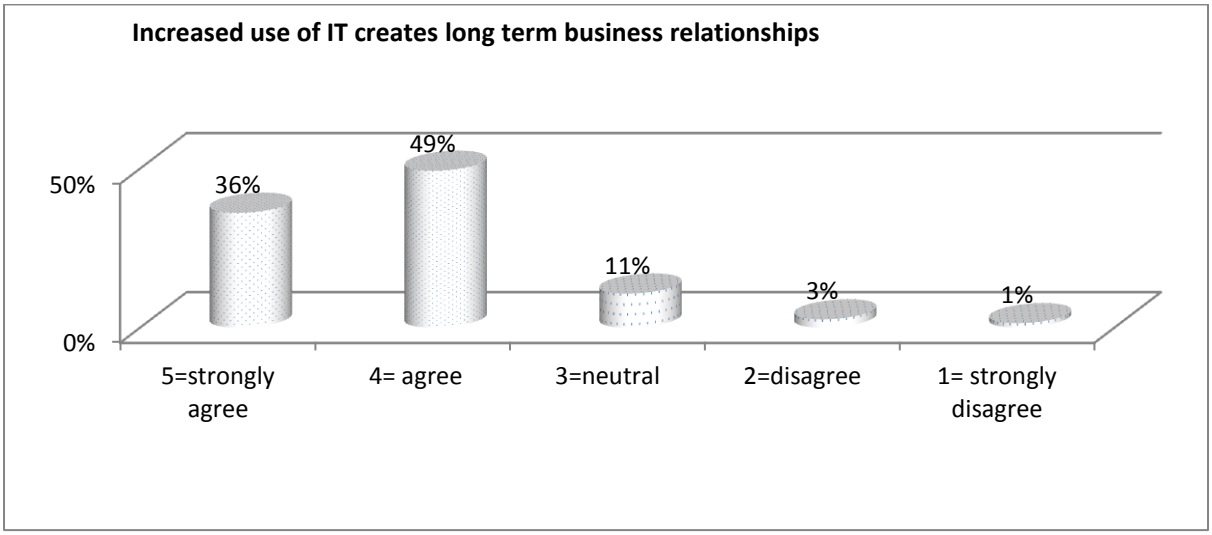



Figure 5.13: Increased use of modern IT solutions results in longer term relationships from the three sub-regions

Increased use of modern IT solutions is noted in Figure 5.13 above which can lead to longer term relationships with great impact in promoting and strengthening organisational competitiveness. In the literature review, Shanker (2008:50) ascertains that the use of ICT in many organisations has assisted in reducing transactional costs, overcoming the constraints of distance and cutting across geographic boundaries, thereby assisting to improve the coordination of activities within organisational boundaries. Also, Spanos et al. (2002:659) state that buyers and sellers are able to share information and transfer goods across national borders with the use of ICT, and this helps to increase access to global supply chains. According to Brynjolfsson and Hitt (2003:793), there is a substantial long-term productivity gain with the use of ICT in organisations. Buhalis (2003:805) also notes that the application of ICT in businesses causes fundamental changes that may provide powerful strategic and tactical tools for organisations if properly applied and used.

Alam and Noor (2009:112) argue that ICT offers enterprises avenues to compete on a global scale with improved efficiency and closer customer and supplier relationships. Therefore, ICT should be regarded by businesses as an important strategy to stay competitive. Similarly, Melville et al., (2004) highlight that the use of ICT brings about customer satisfaction by improving service quality, thereby offering new opportunities to companies. Apulu and Latham (2010:23) claim that ICT enables customers to receive immediate feedback that enables companies to react quickly to customer demands and recognise new

market niches. This means that organisations that are able to exploit the potentials offered by ICT are able to handle various types of innovative processes in their businesses since ICT influences the performance of an organisation in multifaceted ways.

**Organisations must be able to integrate knowledge from IT to deliver new products or service efficiently**

Modern logistic systems require real-time monitoring and interaction with fleet vehicles to attain high fleet operation and provide a fast response to customer needs. Thus, the integration of appropriate information and mobile communication technologies such as GPS into logistic fleet management, can effectively improve the fleet resource utilisation and customer satisfaction (See, 2007:876). Integration of knowledge from IT has been recognized as positive facilitator to deliver new products as shown in figure 5.14 below.

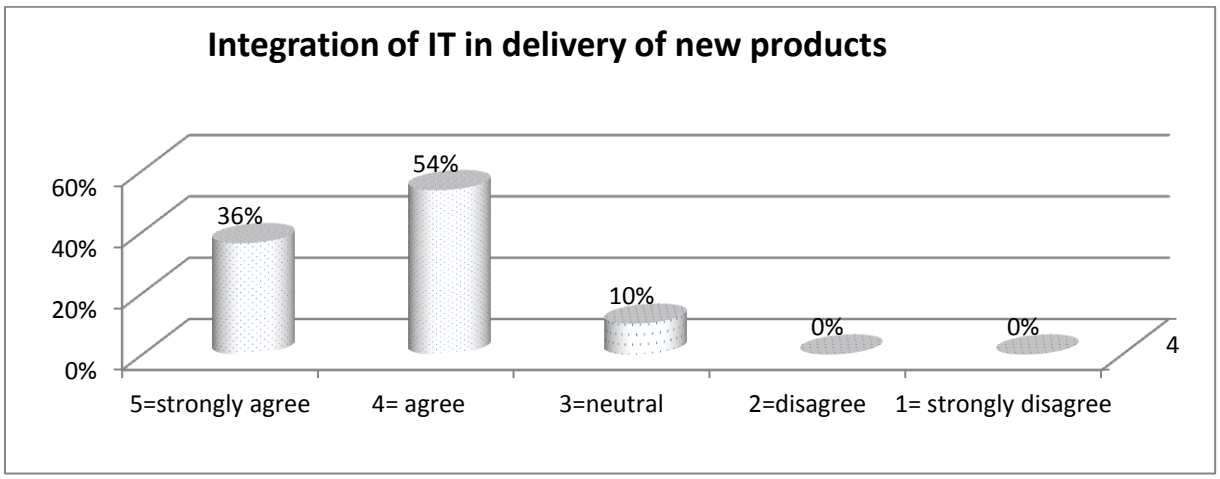



Figure 5.14: Integration of knowledge from IT to deliver new products from the three sub-regions

Firms are no longer able to effectively satisfy their customers' various demands with just product and price, but must also increase their performance in reaction speed, delivery policy, information services and flexibility. For this reason, firms are being forced to redesign their internal processes, using different methods. As one option among other possibilities, information technology (IT) has been recognised as one of the most prevalent facilitators of that process change (Chan & Land, 1999:311). Furthermore, IT not only enables firms to redesign internal processes but also aids them to achieve improved competitiveness on local and international markets (Motwani & Kumar, 1998:964).

**In a fast moving world constant improvement on IT is essential for survival and success in efficient service delivery**

The company is now able to provide more efficient service by utilising route guidance and turn-by-turn directions, which leads to a reduction in, the unnecessary overhead costs directly associated with excessive fuel consumption, fleet maintenance, overtime expenses, and unauthorised vehicle use. The recorded benefits in using GPS fleet management system is strong indicator of the contribution of modern technologies towards increasing efficiency in service delivery as shown in figure 5.15 below

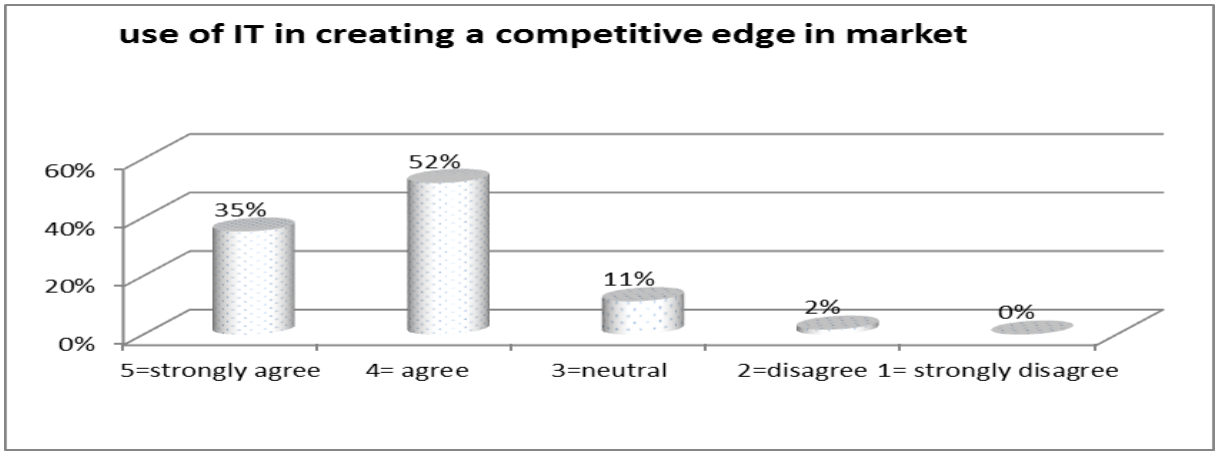



Figure 5.15: IT as a tool for competitive edge in service delivery from the three sub-regions

This study shows a response of an average of 35% on 5 **(= strongly agree)** and 52% on 4 **(= agree)** with an overall acceptance level of 87% on all the items on the implementation and adoption of fleet management system. Porter (1990:1189) defines competitive advantage as the heart of a company's performance. It reflects a company's ability to offer consumers greater value either by lowering prices or by providing greater benefits and services that justify higher prices. In the past decade, firms have faced unprecedented change: globalisation and internationalisation, rapid advances in information technology (Chan & Peel, 1998:46), higher value of competition (Carr, 2002:447), increased availability and flexibility of products/services (Ahmad & Schroeder, 2001:16), as well as greater internal and external customer needs (Marjanovic, 2000:43).

Kapurubandara and Lawson (2006:35) recommend that organisations adopt ICT in order to remain competitive in the present competitive global economy. The noted improvement in service delivery in KPLC through the use of the GPS fleet management system has given internal impetus to the adoption of modern IT solutions, faster integration

of IT knowledge in new products and constant improvement in IT systems to provide a platform for offering efficient customer service and improving the bottom line.

Davies et al. (2006:12) examined the extent to which Internet freight exchanges and the use of ICT processes are affecting general haulage in a field survey focusing on the UK. The main findings in the UK companies were that 85% consider ICT important for their companies while there was also a positive association between fleet size and the importance of ICT. At present, the extensive use of ICT is changing the way in which people or companies work. Researchers (e.g. Hipp & Grupp, 2005:517; Castellacci, 2006:849) refer to ICT as a very important tool for innovation in this era. The benefits of ICT for a firm include saving inputs, general cost reductions, higher flexibility and improvements in product quality (Mouelhi, 2009:961).

## 5.3. Key Research Findings in Light of the Research Questions

The primary objective of this study was to investigate the effectiveness the GPS fleet management system which had been installed by carrying out an evaluation of its functionality and of any improvements in the transportation of staff, goods and materials after the full implementation the project in 2010 with the sole purpose of ultimately improving the effectiveness and efficiency of KPLC. Therefore, the results from the data analysis provide valuable understanding and possible answers to the research questions below and are, therefore, important in meeting the objectives of this study. GPS is an application which may be utilised for a number of indirect issues, such as fuel saving, speed control and vehicle routing purposes. However, the possibility of providing online data on fleet operations represents a significant contribution to more efficient and effective fleet management with substantial benefits in the use of such information for management decision making. This section will address the research questions of this study.

They are restated below for convenience.

- What has been the effect of the GPS in reducing the rate of accidents?
- What has been the effect of GPS in improving fleet availability?
- How has the GPS assisted in reducing the fleet operations costs?
- How has the GPS assisted in reducing the average vehicle break downs?
- What has been the effect of GPS in minimising theft of vehicles?
- What benefits have resulted from using IT solutions in fleet management?

### *5.3.1. A Generalised Review of the most Important Findings: Summary of the Results*

The comparative analysis conducted was based on the sample data collected for the period before the installation of the GPS and the actual status at the end of 2010 after the completion of the implementation exercise for 1,200 vehicles. The findings of study have shown the following notable improvements in key service performance indicators since the adoption of GPS enabled solutions in the fleet management:

- The accident rate drastically reduced by approximately 57% to an average of below 6.0 from about 14 accidents per million kilometres.
- In terms of fleet availability, the results show an overall achievement of about a 2% improvement annually, which translates to more vehicles being available for use.
- The data collected showed great improvements in both maintenance and the fuelling processes. The reduction in maintenance cost is 16% in maintenance costs and 17% in fuel costs a significant saving in costs was 9,056,222 km.
- The frequency of vehicle breakdowns reduced within the period by about 25%, which translates into a lesser number of vehicles being referred to the workshop for repairs and a shorter turnaround time for any vehicle under repairs.
- The reported cases of stolen fleet units have drastically reduced since the installation of the GPS tracking system which provides for the increased recovery of any stolen vehicle.
- The data shows reduced cases illegal journeys resulting in more efficient resource utilisation levels while controlling service-related costs. This has consequently increased fleet availability and led to the more efficient utilisation of fleet.
- The overall approval rating of 87% in the implementation and adoption of the fleet management system is a strong indicator of the benefits arising from modern technologies in increasing efficiency in service delivery at KPLC.

Further detailed discussions have been undertaken on the key results obtained from the research work in an attempt to highlight the significance of the achievement and their relevance in direct applications. The significance of the research findings in the light of different research undertaken on the impacts of ICT on transport and logistics at a conceptual and theoretical level has also been considered.

*5.3.2. What is the Effect of GPS in Reducing the Rate of Accidents?*

The initial question on the survey was on the effect of the GPS on reducing the rate of accidents. A reduction of 57% in the rate of accidents, as evidenced by the survey results, with a corresponding reduction in actual accidents from 14 accidents to below 6 accidents per million kilometres confirms the effectiveness of the GPS fleet management system installed in KPLC. This has a positive impact in the company's provision of safe and timely services at reduced operational costs. Interestingly, within the period under study there was a marked reduction in speeding by about 72% which shows some relationship between speed and accident risk.

This finding corroborates the notion of Kleodon, Mclean, Moore and Ponte (1997:35) that a higher speed increases the likelihood of an accident, as shown in figure 5.16 below.

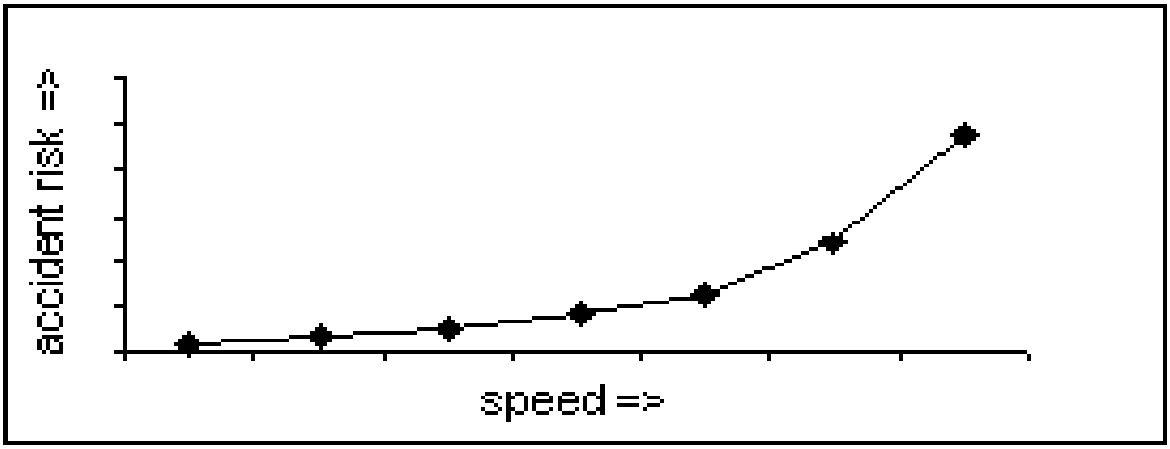



Figure 5.16: Higher speed increases the likelihood of an accident
Source: Kloeden et al., 1997

Strong correlations have been established between speed and accident risk. A similar relationship is assumed in Britain, based on empirical studies conducted by Taylor, where changes in the accident numbers associated with a 1 km/h change in speed have been shown to vary between 1 and 4% for urban roads and 2.5 and 5.5% for rural roads, with the lower value reflecting good quality roads and the higher value poorer quality roads. High speed reduces the possibility of responding in time when necessary. People need time to process information, to decide whether or not to react and, finally, to execute a reaction. At high speed the distance covered in this period is longer. At high speeds the distance between starting to brake and coming to a complete standstill is longer. The braking distance is

proportional to the square of speed (v2) and, therefore, the possibility of avoiding a collision becomes smaller as speed increases.

With increasing speed, the accident risk increases more as the absolute speed is higher. Surprisingly there is very little research work available on the actual rate of reduction in accidents through the use of a GPS. Most of the statistics given are based on proprietors' marketing data which may not always be reliable. However, in one case study on the Markstein Sales Company, based in Antioch, California, a wholesale beer distributor which had installed a wireless fleet management system using GPS tracking and an engine diagnostic monitoring system, it was found that the reduced speeding and drivers driving more safely resulted in a 50% reduction in accidents from 2010 to 2011.

The research findings in this study compare well with the case study above in reinforcing the fact that the achievement realised as a result of implementing a GPS fleet management system in transport logistics is valid and confirm the positive effect of the system on the reduction of accidents.

### *5.3.3. What is the Effect of a GPS on Improving Fleet Availability?*

The second question in this research study was on the effect of GPS on improving fleet availability. The study result showed an improvement in fleet availability with a positive overall achievement of 2% from an average of 93.2 to 95.2%. The revenue generated as result of the higher mileage covered grew by 20% from Ksh.375M to Ksh.460M. This represents a direct financial contribution arising from the effect of a more efficient logistical process. The comparison of the result of 95.2% in fleet availability and revenue growth of 20% in this study with similar figures though different rating which were used in a case study conducted in Willard Batteries, a South African company based in Port Elisabeth, where the implementation of a modern fleet management solution resulted in a vehicle utilisation improvement from 50 to 60% to over 90% (Opsi Systems, 2007a).

The increased fleet availability and revenue generated in this study corroborate the earlier findings in other research findings published by the Aberdeen Group (Marketwire, 2009:1), showing the following improvements in key service performance indicators since the adoption of GPS enabled solutions:

- 41% increase service related productivity
- 16% extended life of service vehicles.

This study confirms reduced cases of misuse or illegal journeys resulting in increased fleet availability and the more efficient utilisation of the fleet. Sanders (2007) states that "GPS generated data improves service planning and develops increased productivity because of better management decisions" (Sanders, 2007:1332). As mentioned in the literature review, the GPS provides online information on the driving habits of workers and it is possible to find wasteful drivers and give them instruction of how to drive in a more efficient manner, for instance, by reducing speeding and idling time (King, 2011:1).

*5.3.4. How has the GPS Assisted in Reducing the Fleet Operations Costs?*

- The third question in this research was on whether the GPS had assisted in reducing the fleet operations costs. The reduction is 16% in maintenance costs and 17% in fuel costs, resulting in a significant saving in overall operating costs.

The above figures compare well with the research findings published by the Aberdeen Group (Marketwire, 2009:1) showing leading organisations were able to reduce fleet related operating costs by 46% while a 22% decrease in fuel costs were recorded in those researched service organisations. Surprisingly, in another case study conducted on ABI, one of the Coca-Cola bottlers in South Africa in 2001, which decided to implement Roadshow routing and scheduling software throughout all its large depots, a savings of 23.6% for diesel and 13.9% for petrol were realised (SAB, 2001).

This finding corroborates those of Taniguchi and Shimamoto (2004:235), who found that the total operational cost decreased by implementing the dynamic vehicle routing and scheduling model with real-time information. Prior studies by Nietermayer (2010:2) indicate other advantages including:

- employee accountability moves to the forefront of daily operations
- fuel savings of 10% to 15% can be achieved and labour costs can be saved in the form of overtime
- vehicle maintenance costs drop significantly
- employee safety can be managed
- Monitoring and correction of poor vehicle speeds and driving habits are enhanced.

The results of this study show that the adoption of GPS-enabled solutions enabled higher customer satisfaction levels and better resource utilisation while controlling service-related costs.

### *5.3.5. How has the GPS Assisted in Reducing the Average Vehicle Breakdowns?*

The fourth question in this research was on whether the GPS had assisted in reducing the average vehicle breakdowns. The overall reduction of 28% in the average frequency of vehicle breakdowns increased service reliability in the supply process for both the operational and distribution systems which are critical in meeting the required customer satisfaction levels in the company. The findings of this study are consistent with the research findings based on the proprietors' survey data published by TrackNet, where fleet managers who used GPS fleet tracking software reported an almost 25% reduction in downtime and costs from maintenance management (PRWEB, 2011). In the literature review, research findings published by the Aberdeen Group (Marketwire, 2009:1) showing improvements in key service performance indicators since the adoption of GPS enabled solutions, where there was a 41% increase in service-related productivity and a 16% extended life of service vehicles.

A case study conducted in Willard Batteries, a South African company, showed that vehicle utilisation went up from 50 to 60% to over 90% (Opsi Systems, 2007). This result is also consistent with those of other studies conducted in a beer distribution company, Gate City Beverage Distributors, based in San Bernardino, California, where the company achieved an improvement in on-time deliveries of 50%, and reduced transportation costs by 5% (Avocus Group LLC, 2004:2). This finding corroborates those of previous studies on the same subject. However, this result has not previously been described in any independent research other than findings based on the proprietors' survey data for marketing purposes. It is therefore clear from the findings that GPS does reduce downtime and, thus, increase vehicle productivity.

### *5.3.6. What is the Effect of GPS in Minimising Theft of Vehicles?*

The fifth question in this research was on the effect of the GPS on minimising the theft of vehicles. The current study found that the implementation of the GPS vehicle tracking in company fleet vehicles increased fleet security and control with the increased recovery of stolen vehicles. Online GPS technology allows real-time tracking and, if a vehicle is stolen, there are alerts to signal the beginning of visual tracking. Using the "ping" feature regular updates on the stolen vehicle location appear on the dashboard screen which may be used to disable a vehicle in operation, if necessary, in the course of security recovery. This ensures the security of the vehicle. This has enhanced the control of the fleet and the ability to recover stolen or route diverted vehicles and reduce the chances of lost or stolen vehicle. The use of the live tracking ability to locate lost or stolen property with exact

location details and geographical positioning provides the security personnel with direct assistance and support. With this feature in place, it enables a prompt response to support efficient customer service.

These findings are consistent with Nietermayer (2010:2), who states that "[o]nline GPS technology allows real-time tracking and, if a vehicle is stolen, the vehicle is almost guaranteed to be recovered. GPS systems also have alerts that can be set for each vehicle in the fleet". Examples of the alerts include hours of normal operation, off hours and out-of-zone alerts. This technology has a "ping" feature that enables a viewer to "ping" the vehicle and receive location updates in 45 seconds or less. A user may view the screen, ping the vehicle and inform the police where the vehicle is located. Likewise, the improved efficiency of traffic data collection and storage results in the enhancement of security and the safety of operators due to the use of the GPS tracking system (Li & Qin Zhu, 2003:6).

### *5.3.7. What Benefits arose from the Use of IT Solutions in Fleet Management?*

The sixth question in this research was on the benefits that arose from IT solutions in fleet management. The results of the study show an overall approval rating of 87% as regards the adoption of IT solutions in the fleet management system as a critical tool for providing the logistical efficiency necessary in offering the best customer service, which is as a major organisational service delivery agenda. The successful implementation of the GPS fleet management system has had very significant impact on the level of the effectiveness and efficiency in the logistics processes in KPLC. It is relatively easy to change technology or to create new business processes, but the most difficult part in any change initiative is the people. Changing people's attitudes and behaviours is the greatest challenge in implementing new software systems.

Regan and O'Connor (2002:369) state that "successful implementation of new technology within an organization is a time-consuming process involving several interplaying variables. The benefits are realized only when people are willing and able to use them". The realised benefits of the implementation are supported by Noton (2011:1), who says:

GPS fleet management is becoming an indispensable tool of any business that has a fleet of vehicles. With a real-time fleet tracking system, a business can go online and view the delivery status and real-time location of all their vehicles. As well, they will have better communication with the entire fleet of vehicles allowing them to re-route drivers in an instant. It also gives them the ability to increase their response time for customer requests

regarding the status of their delivery. As a result, it can reduce the number of customer inquiry service calls. The overall outcome is a very satisfied customer.

Lai et al. (2000:1) also indicate that the successful implementation of ICT to support the several logistics processes is expected to bring a number of benefits to firms. Closs and Xu (2000:869) also showed that ICT capabilities significantly influence the overall competence of transport logistics. In addition, Sanders (2007:1332) asserts that GPS improves service planning and enables increased productivity because of better safety of management decisions There has been a growing requirement in recent times for stronger cost control and a demand for higher returns in businesses (Milis & Mercken, 2003:87). The use of (ICT) to gain competitive advantage has become a key strategic issue amongst organisations in the fast globalising environment (Kakabadse et al., 2005:55), as ICT plays a strategic role in the management of organisations. Rastrict and Corner (2010:311) and Lin and Lin (2006:246), among others, reveal that there is a growing support for the positive relationship between ICT and its benefits. Thus, this implies that ICT brings about organisational advantage. The ICT applications in transportation and logistics are huge. Various studies reveal many types of application, each one contributing to the transportation and logistics system in different way.

The results of this study show a positive impact on the company's business processes in two critical areas, namely, operational and also strategic. Chan (2000:224) states "IT creates need for change in the job routines on an operational level but also leads to strategic changes such as organizational transformation". Today's IT solutions can enable an organisation to break old patterns and create new ways of working. This reengineering of the company business processes as a result of the implementation of the fleet management system is expected to trigger further innovative and radical changes in the logistics process.

## 5.4. Limitations of the Study

Having discussed the major achievements of this research, some issues that are considered as limitations of the work will now be highlighted. Research will always have some shortcomings (Hofstee, 2006). Each research strategy can lead to unique results, depending on how the research methodology was pursued. If the chosen research methodology were to be carried out under different circumstances, different results would most probably emerge. Of course, these limitations also provide the grounds for further research by scholars in the future.

The GPS tracking facility is extremely versatile but its own inherent limitations and operational drawbacks pose many challenges to the quality of data and the reliability of the system. The noted GPS limitations and other operational challenges are factors that had various implications for each of the key variables and influenced the study results as follows:

### *5.4.1. GPS Errors*

There are several different types of error that can occur when using a GPS receiver, including the jamming of communication lines due to overload and cellular services not being available in remote areas and these can lead to a disruption in service. Signal loss may arise from an unstable GSM network system which is required for the transmission of data. GPS satellite coverage can also be weaker during certain parts of the day, lowering the number of satellites the machine's system can use. Due to such limitations the tracking data may not be continuous on many occasions, resulting in several gaps in trip data.

### *5.4.2. Restrictive Satellite Signals*

The GPS satellite signals can only be received in a unobstructed view of the sky with the exception of clouds. However, large parts of the travel paths came under dense tree covers, flyovers and bridges; between clusters of high-rise buildings, or while parked under shelters. High-voltage power-lines can also create dead zones when working underneath them.

### *5.4.3. Server Breakdown*

Frequent breakdowns of company servers and disruptions during maintenance activities contribute to data loss during these off-periods. Defects on the GPS units during accidents render the system ineffective and, consequently, no more data is transmitted and this may compromise the accident investigations resulting from a lack of the much-needed snapshot reports.

### *5.4.4. Damage to the GPS*

Physical damage such as dismantling the external GPS antennae placed on top of the vehicle and cutting the connecting cables from the vehicle battery to the GPS unit disables its functioning completely and live tracking will be rendered useless since recovery of a vehicle depends solely on the availability of a continuous signal to assist in the follow-up on the web-based software mapping.

### *5.4.5. Limited Scope*

The research scope was limited to one company only while the overriding concern in this research was to provide a generalised conclusion on the impact of modern IT solutions and its consequences to companies that have implemented the GPS fleet management system.

## 5.5. Recommendations

The major outcome from this empirical study is the demonstration of the benefits of using a GPS vehicle tracking system within the context of transport logistics. The research findings therefore provided a unique opportunity to better understand the practical challenges involved in the implementation process but inevitably uncovered a range of complexities associated with the implementation of the system and, at the same time, provided an opportunity to identify areas which, if exploited, could result in additional benefits as recommended below:

- The installation of the units in the remaining fleet which includes the motorcycles that are used in the manual meter reading exercise in residential areas. The use of the GPS will enhance the mapping and scheduling of the meter reading itinerary. This, in turn, will greatly reduce the billing costs in the meter reading coverage and improve overall operational efficiency
- All mechanised mobile plant and equipment should be installed with the GPS devices which are capable of providing asset location, tracking movements and maintenance records of usage, especially where hiring charges are based on hours.
- The automation of transport mileage returns downloaded from GPS online system to reduce paper work and also to improve fleet usage in curbing unnecessary travel. The training of operators in “green band driving” habits should be done continuously with a view to improving driving performance and efficiency with the resultant reduction in accidents and loss of life.

## 5.6. Further Research Recommendations

An important outcome of this research is that implementing a real-time IT logistics solution can yield great benefits for the organisations involved and it considered that this work may be employed by other scholars to conduct more research, especially in the areas noted where very scanty research information is available. This would provide a deeper understanding and, perhaps, enable a more generalised result on the effects and consequences

when implementing a real-time IT logistics solution. Further studies are, therefore, required to establish the following:

- How can the implementation of GPS fleet management systems change the internal processes of the transport and logistics service providers in Kenya and other developing countries within the East African community?
- To what extent does GPS contribute to a reduction in road accidents, particularly in urban transportation applications where great damage resulting from public transport vehicles occurs every day with a high number of fatalities?
- Other business applications where real-time fleet management systems can be used to increase operational efficiency.
- Other business applications such as couriers (new customer requests for pickup or delivery), as well as taxi cab services (requests for the transportation of persons), where real-time fleet management systems may be used to increase their operational efficiency.
- To what extent does GPS contribute to a reduction in the theft of motor vehicles and the resulting impact on insurance premiums**?**

The desired outcome of this research study was to evaluate the effects of the GPS fleet management system implemented on the logistics of transporting staff, goods and materials. The study therefore underscores the logistical advantage of leveraging leading-edge technologies and adopting best practice to provide real-time logistics support that guarantees effectiveness and efficiency in the transportation processes in KPLC. The key results are summarised in the light of various research which has been undertaken into the impacts of ICT on transport and logistics at a conceptual and theoretical level. It is interesting to note that the survey results in all six cases of this study show a positive impact on the company's provision of safe and timely services to its clients at reduced operational costs and, thus, strengthening the company's competitive edge in the market.

It is worth noting that the implementation of fleet management with its accrued benefits has had major effects on the business processes in two critical areas; namely, the operational and the strategic level, which is are consistent with the findings of Chan (2000:224), who says IT creates need for change in the job routines on an operational level but also leads to strategic changes such as organisational transformation. Today's IT solutions can enable an organisation to break old patterns and create new ways of working.

This reengineering of the company business processes as a result of the implementation of the fleet management system is expected to trigger further innovative and radical changes in the logistics process.

The survey research strategy (Saunders et al., 2003:89) adopted in this study was aimed at enabling the collection of data which allowed in-depth examination, as well as the gathering of information that explained the relationships between constructs, in particular, cause-and-effect relationships. There is little researched information available on the usage of the fleet management systems in Kenya or other developing countries within the East African community. However, the use of wireless technology is rapidly growing and such projects are becoming more common in Kenya. There is information readily available on the marketing of different options of GPS equipment and software systems but there is a lack of conclusive research evidence of how the implementation of GPS fleet management system changes the internal processes in firms.

This research study recognises the emerging IT solutions as an indispensable tool for any organisation in building effectiveness and efficiency in its business processes. The research evidence from the survey results epitomises how the successful implementation of modern management systems in today's transport and logistics service providers may lead to greatly improved logistical performance, cost efficiency and customer satisfaction. The overriding concern in this research was to provide a generalised conclusion on the impact of modern IT solutions and the consequences to the various major elements of the transport logistics processes. However, a lack of adequate researched material on specific changes in the various service components of the logistical system is a major challenge in arriving at the comparative, overall impact of the implementation process on business process.

Little research work is available on the actual rate of reduction in accidents through the use of GPS. Most of the statistics given are based on proprietors' marketing data which may not always be reliable. Information on the extent of achievement in the reduction of theft of motor vehicles when GPSs are installed remains scanty for reference purposes. This research gap is noted and it is believed that the work documented in this study will provide the necessary impetus for more research in areas where well researched information is lacking. However, this study will greatly benefit KPLC in appreciating the impact of the implementation of fleet management on its operations and also both the public and government institutions in Kenya which, by a cabinet decision, have been instructed to initiate the implementation of GPS fleet management in their respective fleets.

## 5.7. Outlined Implications of the Research for Academic Understanding

The research findings in this study confirm the increased effectiveness and efficiency in the logistical processes in KPLC as a result adopting and implementing modern fleet management systems, a true case of "leveraging technology for business fleet applications". The study results show an improvement in the logistics of transporting staff, goods and materials for the maintenance and construction of power lines in the country. Generally, the study was able to investigate the organisational impact of implementing a real-time IT logistics solution and the research findings provide a clear description of the effects on the business and the related consequences when a real-time solution has been implemented.

It is noteworthy that the survey results of this study shows the positive impact on the delivery of service at reduced operational costs and, thus, an increased competitive edge in the market. A drastic reduction in the accidents per million kilometres and the increase in fleet availability represent a direct financial contribution to the company revenue and a more efficient logistical process. The noted improvements in both the maintenance and fuelling processes made a very significant contribution to the control of the operational budget which translates into improved fleet serviceability and reliability in both operational and distribution activities. Incorporating modern information technology and adopting new technology equipment in fleet management leads to enhanced fleet security and greater effectiveness and efficiency in service delivery, resulting in lower unit costs and increased revenue income from the operations. It is notable that the survey results of this study show the positive impact on the delivery of service at reduced operational costs and, thus, an enhanced competitive edge in the market by providing a fast response to customer needs. The research findings, therefore, prove that transportation companies require modern fleet management systems for real-time monitoring and interaction with fleet vehicles to attain high operational efficiency.

## 5.8. Chapter Summary

The research findings in this study confirm the increased effectiveness and efficiency in the logistical processes at KPLC as a result adopting and implementing modern fleet management systems, a true case of "leveraging technology for business fleet applications". The study undertook to investigate the effectiveness of the GPS fleet management system installed in improving the logistics of transporting staff, goods and materials for the maintenance and construction of power lines in the country.

Generally, the study was able to investigate the organisational impact of implementing a real-time IT logistics solution and the research findings provide a clear description of the effects on the business and the related consequences when a real-time solution has been implemented.

It should be noted that the survey results of this study show the positive impact on the delivery of service at reduced operational costs and, thus, an increased competitive edge in the market.

A drastic reduction in accidents per million kilometres and an increase in fleet availability represent a direct financial contribution to the company revenue and a more efficient logistical process.

The noted improvements in both the maintenance and fuelling processes made a very significant contribution to the control of the operational budget which translates into improved fleet serviceability and reliability in both operational and distribution activities.

Incorporating modern information technology and adopting new technology equipment in fleet management lead to enhanced fleet security and greater effectiveness and efficiency in service delivery, thus resulting in lower unit costs and increased revenue income from the operations.

It should be noted that the survey results of this study show the positive impact on the delivery of service at reduced operational costs and, thus, an enhanced competitive edge in the market by providing a fast response to customer needs. The research findings, therefore, prove that transportation companies require modern fleet management systems for real-time monitoring and interaction with fleet vehicles to attain high operational efficiency.

**CHAPTER SIX**

**Stage in Dissertation**

| | | |
|---|---|---|
| CHAPTER 1: Introduction | Provides an introduction to the general context for the research problem and also covers in brief the research objectives and methodology for the proposed study | |
| CHAPTER 2: Literature Review | Presents a review of literature and examines the historical development of the fleet management systems in respect to the research topic. | |
| CHAPTER 3: Research Methodology | Describes the design, target population, sample and sampling procedure used, research instruments, piloting of the instruments, data collection and data analysis. | |
| CHAPTER 4: Data Collection and Data Analysis | Describes the findings derived from the results of the data analysis carried out on the impact of the implementation of fleet management | |
| CHAPTER 5: Discussion on Research Findings and Recommendations | Describes in detail the research output and presents recommendations derived from the obtained results | |
| **CHAPTER 6: Research Summary and Conclusions** | 6.1 | Introduction |
| | 6.2 | Research Summary |
| | 6.2.1 | Overview of Chapter 1 |
| | 6.2.2 | Overview of Chapter 2 |
| | 6.2.3 | Overview of Chapter 3 |
| | 6.2.4 | Overview of Chapter 4 |
| | 6.2.5 | Overview of Chapter 5 |
| | 6.3 | Conclusions |
| | 6.4 | Concluding Remarks |

# 6. Research Summary and Conclusions

## 6.1. Introduction

This chapter presents a summary of the study conclusions and recommendations for present and future research. The research presented sought to contribute to the field of real-time fleet management systems in a way that can provide tangible results as well as practical assistance to those who wish to implement such systems in their transport logistics department.

The starting point of this dissertation was the need for an evaluation of how the effective adoption of modern IT solutions in the KPLC transport logistics department has impacted on its service delivery through the use of the GPS fleet management system. The research process therefore designed appropriate techniques and instruments to establish whether the use of information technology is feasible in the organisation and to explain the possible obstacles and challenges that were encountered and the major advantages arising from its full implementation. The recommendations and conclusions of this study are therefore based on the research output and on previous work conducted by other researchers in similar studies. The challenges and experiences encountered during the study have prompted a number of suggestions for consideration in further studies.

## 6.2. Research Summary and Overview of the Chapters

The desired outcome of this research study was therefore an evaluation of the effects of the implemented GPS fleet management system on the logistics of transporting of staff, goods and materials in KPLC. The study presents the logistical advantage that leveraging leading edge technologies and adopting best practices can provide to real-time logistics support to guarantee effectiveness and efficiency in transportation processes. The study underscores the critical demand for information technologies and their complex roles within an organisation and provides a valuable understanding of and possible answers to the research questions which were important in achieving the research objectives.

The study also sought to contribute to the field of real-time fleet management systems in a way that can provide tangible results as well as practical assistance to those who wish to implement such a fleet management system. As a result of the challenges encountered in transport logistics, various components of fleet management such as motor accident and driver management, fleet operations and its economic utility, effective maintenance programmes and the management of related security issues had to be drawn upon for a comprehensive and coherent theoretical and practical understanding of such problems. In this section, a brief summary highlighting the focal points of each chapter is provided with the key research findings and conclusions drawn. The concluding remarks succinctly summarise the outcomes of the study.

### *6.2.1. Chapter One: Introduction*

This chapter provided an introduction to the dissertation and the general context for the research problem on the fleet management systems implemented in KPLC and briefly

covers the research background, objectives and methodology of the proposed study. It introduces the scope and research objectives in a way that captures the challenges experienced in the organisation in managing the transport function. The chapter encapsulates the main purpose of the dissertation as the need to establish whether the use of information technology is feasible in transport industries and explain what possible obstacles may be encountered in its implementation.

In terms of the theoretical aspect, the study underscores the critical demand for information technologies and their complex roles within an organisation, noting that, over the years, the transportation systems have developed and become extremely complex, transportation options are growing, additional suppliers have entered the market and the number of products available has mushroomed so that it is no longer possible to effectively manage them without the assistance of modern technology. It encapsulates transport and logistics as key components of a successful economy in terms of which governments worldwide seek to increase competitiveness through new or replacement infrastructure. The chapter underlines the major role the transport and logistics sector plays in the world economy, how significant its contribution is at both the national and local levels in any country and how it underpins the economy as the enabler of the movement of goods, services and people as efficiently as possible.

The chapter also presents a broad view of the problem statement and introduces specific research questions on the impact of the online tracking on the fleet planning and management systems in KPLC if implemented and its viability in addressing the root cause of the operational challenges identified. The research methodology and specific research instruments for the study are also presented in summarised form.

### *6.2.2. Chapter Two: Literature Review*

The chapter presented a review of literature in respect of the aim the study and provided an understanding and knowledge of the research topic in the light of the characteristics of the various types of fleet management applications in use. The chapter underlined the many challenges faced in the modern transportation process, including congestion growth; lower costs; improved customer service; heightened terrorism/theft/security; information-sharing; regional multi-modal logistical growth; and the proliferation of new and complex tools with which to optimise/schedule routes.

In this chapter, each concept was briefly discussed in general and then a more focused perspective was used to explore the existing literature in the area of fleet management systems and, more specifically, the main characteristics of the various types of fleet management applications in use. A critical examination of the historical development of the fleet management systems in transportation and some of the proven research concepts, principles and applications in GPS technology were used to provide an understanding and knowledge of the economics of the operations of the fleet as a result of utilising the intelligent fleet tracking systems.

The various drawbacks and weaknesses involved in the use of GPS fleet management are discussed. It is recognised that, although the GPS is highly accurate, it does incorporate certain limitations that may, potentially, degrade its performance. The literature reviews the ability of the GPS to calculate location and to provide readings and the conditions for obtaining signals from the satellites. The chapter concluded with the need to consider different approaches to implementation, mainly because the factors of alignment between technology and business processes vary from company to company and between different solutions. The resultant organisational impact on the various aspects of fleet operations is underlined and the need for real-time fleet management in transport and logistics service providers expressed. The benefits of implementing the fleet management systems in a business with a vehicle fleet to significantly improve safety records and to protect the business from undue costs are discussed.

### *6.2.3. Chapter Three: Research Methodology*

In this chapter the choice of the research methodology, which is the underlying foundation of the entire research process, is described. The research methodology was depicted in the form of an adapted research process onion. The research design catered specifically to the needs of this study so as to ensure the required data would be collected and validated for reliability. Further details on the target population, sample and sampling procedure used, research instruments, data collection and data analysis adopted are explained.

The study adopted the survey research strategy to provide the necessary techniques and instruments to enable the collection of data which would allow an in-depth examination while gathering information that would explain the relationships between constructs, in particular, cause-and-effect relationships. Both cross-sectional and longitudinal research time horizons were adopted since the data collection took place in a given period and was also

taken from snapshots of the time before and after installation of the GPS. The sampling procedure adopted in this study was one-stage cluster sampling due to the fact that the elements contained in the clusters represented the heterogeneity of the population being studied and were homogeneous among them. Then, random sampling technique was used to select the required clusters that would provide a sufficient representative sample for the study.

The sampling techniques that were adopted to select a sample size of 349 units picked to represent a fleet population size of 1,200 units and which was higher than the 291 units given as a minimum in the "Guide to Minimum Sample Size" (Krejcie & Morgan, 1970:30). Since the sample size was drawn from different geographical regions with a well spread coverage for the research study, it was deemed sufficiently representative of the whole population. The descriptive study approach adopted for the data analysis method for investigating the resultant effect of implementing a real-time IT logistics solution and the interpretive research philosophy were chosen to provide the required interpretation of and meaning to the findings.

A distinction was made between the qualitative and quantitative methods with the study employing the quantitative method based on the deductive reasoning approach which was deemed more appropriate for studying the phenomena in question and for describing the nature of the effects and consequences identified. The research process ensured the validity and reliability of the resultant findings by using structured and established procedures. The chapter explained the descriptive technique and the content analysis method adopted to enhance understanding to promote the accurate and concise presentation of the results obtained in a way that answered the study questions.

#### *6.2.4. Chapter Four: Data Collection, Analysis and Findings*

The chapter presents the data collection, data analysis and the findings derived from both the literature review and the results of the data analyses which were carried out on the impact of the implementation of fleet management on KPLC operations. Research study data was collected from the three geographical areas randomly selected for sampling and analysed to determine to what extent the GPS fleet management system had improved effectiveness and efficiency in KPLC. The three selected clusters with a total sample size of 349 units represented a fleet population size of 1,200 which was fitted with the GPS fleet management system. This sample size was deemed to be sufficiently representative of the whole

population because the elements contained in the clusters represented the heterogeneity of the population being studied and was homogeneous among themselves.

The chapter explains the survey approach utilised and the data collection used a survey questionnaire as well as quantitative research techniques, particularly the Likert scale, in order to evaluate the effects of the GPS fleet management system implemented. The descriptive technique and the content analysis method of handling the data collected and its analysis were employed in this study to enhance the understanding for the accurate and concise presentation of the results obtained. A comparative analysis was conducted on the sample data collected for 2008, before the installation of the GPS, and the actual status at the end of 2010 after the completion of the implementation exercise for 1,200 vehicles provided extremely clear and meaningful results that enhanced understanding.

The chapter presented the results on the key performance parameters analysed which showed notable improvements in the key service performance indicators since the adoption of GPS enabled solutions in the fleet management and operations in the company. Finally, the key results obtained and conclusions on the impact of ICT on transport and logistics at a conceptual and theoretical level were presented accurately and concisely in a way that answered the study questions.

#### *6.2.5. Chapter Five: Discussions on Research Findings and Recommendations*

This chapter presented the discussion on the research findings which provided a synthesis of all the findings. The key results obtained by the research work are discussed in detail in an attempt to highlight the significance of achievements and their relevance to direct applications. The significance of the research findings in the light of research undertaken on the impacts of ICT on transport and logistics at a conceptual and theoretical level were considered.

Generally, the study was able to evaluate the organisational impact of implementing a real-time IT logistics solution and the research findings provide a clear description of the effects on the business and the related consequences when a real-time solution has been implemented. The results of this study present a positive impact on the company's business processes in two critical areas, namely, the operational and strategic levels, which is are consistent with Chan, (2000) who says "IT creates need for change in the job routines on an operational level but also leads to strategic changes such as organizational transformation".

It is noted in this chapter that implementation had increased the effectiveness and efficiency of the logistical processes in KPLC as a result of adopting modern fleet management systems, a true case of leveraging GPS technology for business fleet applications. The positive impact on the delivery of service at reduced operational costs has enabled the organisation to break old working patterns and strengthen its competitive edge in the market. This reengineering of the company business processes as a result of the implementation of the fleet management system is expected to trigger further innovative and radical changes in the logistics process. Finally, the chapter discussed the fact that the research findings gathered and discussed not only supported the research objectives and the questions addressed in this study but supported the literature that focuses on modern fleet management systems. The findings of this study, in the light of previous work by other researchers, conclude that transportation companies require modern fleet management systems for real-time monitoring and interaction with fleet vehicles to attain high operational efficiency.

## 6.3. Conclusions

The study employed an in-depth methodological approach and, therefore, the research output is based on the findings derived from both the literature review and the results of the data analyses carried out on the impact of the implementation of fleet management on KPLC operations. The key results and conclusions on the impact of ICT on transport and logistics at a conceptual and theoretical level are presented accurately and concisely in a way that answers the study questions and are summarised below:

### *6.3.1. What is the Effect of GPS on Reducing the Rate of Accidents?*

Before the installation of GPS fleet management system the company had previously had an accident rate of approximately 14 accidents per million kilometres with grievous consequences which included direct and other indirect costs. Direct costs may include payouts for accidents, traffic violations and associated costs such as medical treatment costs, lost time on accident investigations, lost revenue due to absence from work, associated police and insurer costs and damage to property. The procedure for accident investigation may sometimes be complicated due to lack of pre-accident data on the speed and direction of a vehicle. The research findings show that the assessment and monitoring of the operators become possible through regular reports from the GPS fleet monitoring system regarding each trip taken by a vehicle so that the relevant data may be reviewed and discussed with the

driver concerned. This has improved the general driver's driving habits, ensuring greater safety which, in turn, reduces the chance of an accident happening.

The data shows that the accident rate reduced drastically by about 59% to an average of below 6 accidents from about 14 accidents per million kilometres. This finding is corroborated by the findings of Kloeden et al. (1997) that a higher speed increases the likelihood of an accident. Very strong relationships have been established between speed and accident risk. The research findings compare well with the case study cited above in reinforcing the fact that the achievement realised as a result of implementing a GPS fleet management system in transport logistics are valid and confirms the positive effect of the system on the reduction of accidents.

### *6.3.2. What is the Effect of the GPS in Improving Fleet Availability?*

The implementation of the GPS fleet management system was intended to mitigate the low fleet availability which, among other factors, had led to a failure to fill orders or meet deadlines in the transportation activities. The greatest advantage has been the real-time monitoring and interaction with fleet vehicles to attain high fleet operation and provide a fast response to customer needs. The study results showed that enforcing speed limits and good driving habits contributed to increased productivity because of better safety and operational management decisions – an important feature of the GPS technology. There was a remarkable improvement in fleet availability from an average of 92.9 to 95.2% and this created additional vehicles available for the prompt transportation of staff and materials to various customer sites.

The attendant result is a higher payload transported which results in higher revenues and better customer service. The revenue generated as a result of the higher mileage covered grew by 20% from Ksh.375M to Ksh.460M, which is a direct financial contribution from the effect of a more efficient logistical process. The objective of improving fleet availability is one way in which to gain a competitive edge by providing superior customer service with improved efficiency and closer customer and supplier relationships. The greatest advantage has been the real-time monitoring and interaction with fleet vehicles to attain high fleet operation efficiency and provide a fast response to customer needs.

This positive improvement in fleet availability is corroborated by Sanders (2007) who says “GPS generated data improves service planning and develop increased productivity because of better management decisions”. The company is now able to determine how fast

drivers are going and the usage of any fleet vehicle through the GPS "virtual time-card" for each employee as it indicates exact start/end times and actual work and overtime hours. A comparison of the results achieved shows a similarity with the research findings from a case study conducted in Willard Batteries, a South African company based in Port Elisabeth, where the implementation of a modern fleet management solution resulted in a vehicle utilisation improvement from 50 to 60% to over 90% (Opsi Systems, 2007a). The reduced cases of misuse resulting in the greater efficiency in fleet utilisation confirm the effectiveness of the GPS in increasing fleet availability.

### *6.3.3. How has the GPS Assisted in Reducing the Fleet Operations Costs?*

The company overall transport expenditure on pool vehicles escalated to a peak of US$7 million annually at about 47 US cents per kilometre and a high rate of 20 accidents per million kilometres. The major contributing factors to these high fleet operating costs were the maintenance and fuel costs resulting from the lack of a proper fleet management system to ensure an effective maintenance programme and efficient fuelling process for the company vehicles. These were coupled with incomplete information on vehicle location and records of driving speeds which led to poor driving behaviour by the operator drivers and vehicle misuse e.g. wasting time or taking unscheduled breaks and detours which increase maintenance and running costs. The GPS fleet management system provides accurate online data which enables complete details on the location of every single vehicle and allows for easier and effective personnel management. As mentioned in the literature review, obtaining information on the driving habits of workers makes it is possible to find wasteful drivers and give them instruction on how to drive in a more efficient manner, for instance, by reducing speeding and idling time (King, 2011).

The study results show the use of that data in fleet management has led to increased effectiveness and efficiency in the service delivery. The data collected showed great improvements in both the maintenance and fuelling processes. The reduction is 16% in maintenance costs and 17% in fuel costs, resulting in a significant saving in overall operating costs. This translates into significant savings on the overall maintenance budget. In terms of fuel consumption efficiency there was an improvement of about 28% and in terms of the fuel consumption rate in kilometres per litre from an average of 5.97 to 7.61.

The recorded improvement of 16% in maintenance costs and 17% in fuel costs compares with the research findings published by the Aberdeen Group (Marketwire , 2009)

showing leading organisations were able to reduce fleet related operating costs by 46% and increase service related productivity by 41%. In addition, a 25% reduction in idle times and 22% decrease in fuel costs were recorded in those service organisations.

The results from this study show the adoption of GPS enabled solutions enabled higher customer satisfaction levels and better resource utilisation while controlling service-related costs. Krishnaveni and Meenakumari (2010:282) assert that ICT has played a major role in reducing operational inefficiency and improving decision-making in many areas of governance. Cordella (2006:195) emphasises that the diffusion of ICT in the present era is associated with an increased amount of information becoming available. Furthermore, Hengst and Sol (2001:3) affirm that ICT enables organisations to decrease costs, increase organisational capabilities and also assist to shape inter-organisational coordination.

### *6.3.4. How has the GPS Assisted in Reducing the Average Vehicle Breakdowns?*

The poor driving behaviour and culture of impunity on the part of fleet operators increases the frequency of vehicle breakdowns as well as premature engine failure resulting from high speeds on rough roads, harsh braking and over-revving of the engine. The implementation of the GPS fleet management system was meant to mitigate the high frequency of breakdowns by installing a tracking system which monitors the driving behaviour of each operator and maintains records of any speeding, extended engine idling time and fuelling malpractices through online GPS generated reports for monitoring purposes. The lack of ability to retrieve the historical records of a vehicle's previous movements compounded the management of the fleet, resulting in poor servicing and maintenance which, in turn, increased the fleet breakdowns.

The GPS function to track and trigger an alert when a vehicles reaches the manufacturer suggested mileage points and also the preventive maintenance schedule which helps to prevent the premature vehicle breakdowns. The study showed an overall reduction of vehicle breakdowns from an average of 20 vehicles in a month to about 15 vehicle breakdowns in a month (25%), which translates into a lesser number of vehicles being referred to the workshop for repairs and a shorter turnaround time for any vehicle under repairs. In addition, the GPS fleet management system comes with a dynamic vehicle routing and scheduling model with the real-time information based on variable travel times compared with that of the forecast model.

The findings of this study are consistent with the research findings based on the proprietors' survey data published by TrackNet, where fleet managers who used GPS fleet tracking software reported an almost 25% reduction in downtime and costs from maintenance management (PRWEB, 2011). It is conclusive from the findings that there was a noticeable reduction on downtime, thus increasing vehicle productivity, through use of the GPS fleet management system. The results of this study corroborate the findings of Taniguchi and Shimamoto (2004:235) who found out that the total operational cost decreased by implementing the dynamic vehicle routing and scheduling model with the real-time information. Mason-Jones and Towill (1999) and Sauvage (2003:236) state that firms improve their operation efficiency through the continuous implementation of information or automation technologies according to their business characteristics. Other prior studies have also noted the importance of the GPS mapping and scheduling function that increases the utility of the vehicles through the effective route planning of the intended vehicle trips for operations. The findings of this study are consistent with those of Bekiaris and Nakanishi (2004:60) who found that managers at the dispatch centre are able visualise in real-time the entire fleet, usually in digital maps, allowing them to obtain data on vehicle status, traffic updates, and so forth.

#### *6.3.5. What is the Effect of the GPS on Minimising the Theft of Vehicles?*

This study found that the implementation of the GPS vehicle tracking in company fleet vehicles has increased fleet security and control. The reported cases of stolen motor vehicles and motor cycle have drastically reduced since the installation of the GPS tracking system which provides very good chance for of any stolen vehicle being recovered. The data collected shows reduced cases of misuse or illegal journeys, resulting in more efficient resource utilisation levels while controlling service-related costs. This has consequently increased the fleet availability and the more efficient utilisation of the fleet. The use of the GPS live tracking ability to locate lost or stolen property with exact location details and geographical positioning provides the security personnel with direct assistance in the case of a stolen vehicle. The remote shutdown function ensures the ability to disable a stolen vehicle while in operation. This has acted as a deterrent to theft of company vehicles and enhanced the security of the operators.

Online GPS technology allows real-time tracking and, if a vehicle is stolen, there are alerts to signal the beginning of visual tracking. Using the "ping" feature regular updates on the stolen vehicle location appear on the dashboard screen which may be used to disable a

vehicle in operation, if necessary, in the course of security recovery. This ensures the security of the vehicle. This, in turn, has enhanced the control of the fleet and the ability to recover stolen or route diverted vehicles and reduce the chances of lost or stolen vehicle. The use of the live tracking ability to locate lost or stolen property with exact location details and geographical positioning provides the security personnel with direct assistance and support. With this feature in place, it enables a prompt response to support efficient customer service.

These findings are consistent with Nietermayer (2010:1) who says online GPS technology allows real-time tracking and, if a vehicle is stolen, the vehicle is almost guaranteed to be recovered. The GPS fleet security and control function ensures the security of the vehicle, enhancing the control of the fleet and the recovery of any stolen vehicle. Technology is offering an answer to the business operational challenges such as motor vehicle theft, fuel consumption or loss of goods in transit in Kenya (Okuttah, 2009:1). Kenyan entrepreneurs have found the fleet management systems useful, particularly in the wake of increasing cases of car break-ins and thefts, for example, according to the police records, more than 600 vehicles were stolen in 2008 alone in Kenya (Karen, 2010:1).

### *6.3.6. Benefits that Arose as a Result of the Use of IT Solutions in Fleet Management?*

The company used manual systems in the management of its transport and operations process before the implementation of the GPS fleet management. Monitoring and the realisation of the process as well as documentation handling were mainly paper based and, therefore, transport officers spent endless time compiling records manually that were irretrievable, making any form of data analysis impossible. As the fleet size grew it became even more difficult to deal with anomalies in fleet operations such as vehicle misuse and bad driving habits, while accidents and maintenance costs were harder to monitor and control on an individual vehicle basis and for the entire fleet.

The study showed that an overall approval rating of 87% in the implementation and adoption of fleet management system is a strong indicator of the benefits of modern technologies in increasing efficiency in service delivery in KPLC. According to the survey results, the implementation of GPS has drastically changed the transport processes as follows:

- Written documentation was replaced by electronic data handling and the use of GPS web-based generated reports save time and human resource.
- The availability of update information about the location of the vehicle, which consequently enabled the enhanced transport planning and scheduling of vehicles.

- The faster retrieval of the historical records of a vehicle's previous movements through the use of the trip replay function for accurate pre-accident data access for investigation.
- Reduced theft of motor vehicles and the quicker recovery of any stolen vehicle through the use of the online GPS locater.

The results above show a positive recognition of the benefits arising from the implementation of the GPS and this is corroborated by Sanders (2007) who asserts that the GPS improves service planning and results in increased productivity because of better control and the availability of information for management decision making. Changing people's attitudes and behaviours is the greatest challenge in implementing new software systems. Regan and O'Connor (2002) stated that successful implementation of new technology within an organization is a time-consuming process involving several interplaying variables. The benefits are realized only when people are willing and able to use them.

In the literature review, Arvanitis and Loukis (2009:43) also indicated that the use of ICT has direct implications for firms. ICT helps in areas such as information gathering and dissemination, inventory control and quality control. More specifically, ICT in transportation fleet and freight management applications has been essentially defined as decision support tools in transportation planning, optimisation and execution. Applications help planners to choose the transportation modes and also manage freight consolidation operations and coordinate company shipments. However, it is also beings being used as a reporting tool by logistics managers who need to know vehicle travel times, service times, and the delivery points that were visited.

## 6.4. Concluding Remarks

The research findings demonstrate that the great improvement in KPLC service delivery through the use of the GPS fleet management system has given impetus to adopting modern IT solutions, the faster integration of IT knowledge in new products and the constant improvement of IT systems to provide a platform for offering efficient customer service and improving on the bottom line. This proves that real-time monitoring and interaction with fleet vehicles are necessary to optimal fleet operation and provide a fast response to customer needs. The implementation of a new technology system is a delicate interplay of various organisational factors but clearly these kinds of solutions may be a source of competitive

advantage which improves the delivery of service to the customers. Fleet management systems, therefore, can be looked in terms of how they may benefit companies in terms of efficiency and profitability. In the knowledge-based economy, the rapidly changing and uncertain environment means that transport firms are facing the challenge of how to break the current situations and capture their competitive advantage.

The research findings from the investigation carried out on the organisational impact of implementing a real-time IT logistics solution provide a clear description of the effects on the business and the related consequences of such an implementation. It is significant that the survey results of this study confirm an increased effectiveness and efficiency in the logistics processes and show the positive impact on the delivery of service at reduced operational costs. In today's competitive marketplace which is filled with rapidly changing business requirements, modern fleet management systems are now a must in leveraging leading edge technologies and adopting best practices to provide sound logistical support that guarantees effectiveness and efficiency in the transportation processes.

The conclusions made are drawn from the finding on the effects and the related consequences of these effects and may be generalised since the population sampling was adequate and representative of a real-time fleet management system implementation. There are considerable advantages to be gained from implementing real-time IT logistics solutions, including reduced accident rates, increased fleet availability, reduced operational costs and improved data management system for better management decision making process. The findings of this study are supported by Stroh (2001:101), who maintains that the transport logistics department was among the last to join the personal computer trend. The main reason for this is that, in general, the logistics department had the tendency to be pushed to the corporate back seat, and therefore, it was thought that it had no need for such high-priced perks. However, as times have changed and the corporate powers began to realise that the distribution department could save a sizable sum of money by utilising the power of the computer, these departments have become equipped with the latest technologies.

It is expected therefore that this study will greatly benefit KPLC in deepening the impact of the fleet management system implemented in its operations and also provide a practical framework document for reference by companies in Kenya who wish to initiate the implementation of the GPS fleet management in their respective fleets. This research study recognises the emerging IT solutions as an indispensable tool for any organisation in building effectiveness and efficiency in its business processes. The research evidence from the survey

results epitomises how the successful implementation of modern management systems in today's transport and logistics service providers may lead to a greatly improved logistical performance, cost efficiency and customer satisfaction. Firms need to integrate several logistics activities by including distribution, warehousing and fleet management in order to guarantee effectiveness and efficiency in their transportation processes.

Transport enterprises, in particular, should embrace the modern technological advancements that enable the efficient, safe and cost-effective use of manpower and improve the time management of processes in order to have greater impact and also retain relevance in service delivery. The overriding concern in this research was to provide a generalised conclusion on the impact of modern IT solutions and its consequences for the various major elements of the transport logistics processes. Generally, this empirical study has imparted valuable perspectives that may contribute immensely to the research domains of real-time IT logistics technology. It is therefore expected that the work documented in this study will provide the necessary impetus for more research in areas in which well-researched information is lacking.

## BIBLIOGRAPHY


Abbott, E., Powell, D., Signal, A. & Redmond, W.A. 1999. Land-vehicle navigation using GPS. *Proceedings of the IEEE,* 87(1): 145–162.

Aberdeen Group. 2006. A benchmark report on what companies want in their next-generation supply chain solution by Aberdeen Group, May 2006. Boston Massachusetts. Available at http://www.infor.com/content/analyst/supplychain.pdf/ accessed 17th Nov 2012.

Admiral, A.S. 2013. *Different types of auto navigation systems*. Available online at: http://www.pinscribd.com/2013/07/different-types-of-auto-navigation-systems/ accessed 12th Aug 2013

Adriansen, H.K. & Nielsen T.T. 2005. The geography of pastoral mobility: A spatio-temporal analysis of GPS data. *GeoJournal*, 64(3): 177–188.

Ahmad, S. & Schroeder, R.G. 2001. The impact of electronic data interchange on delivery performance. *Production and Operations Management*, 10(1): 16–30.

Alam, S.S. & Noor, M.K. 2009. ICT adoption in small and medium enterprises: An empirical evidence of service sectors in Malaysia. *International Journal of Business and Management*, 2(4): 112–125.

Allen, S. 2001. Leveraging procurement; the quiet e-business. *Logistics and Transport Focus*, May: 29–30.

Apulu, I. & Latham, A. 2010. Benefits of information and communication technology in small and medium sized enterprises: a case study of a Nigerian SME. Proceedings of the 15th Annual Conference on UK Academy for Information Systems, Oriel College, University of Oxford, March 23–24.

Arunkumar, T. & Sivanandam, S.N. 2007. Location identification and vehicular tracking for vehicular ad-hoc wireless networks. *IEEE Explorer*, 1(2): 112–116 (February).

Arvanitis, S. & Loukis, E. 2009. Information and communication technologies, human capital, workplace organization and labour productivity: A comparative study based on firm-level data for Greece and Switzerland. *Information Economics and Policy*, 21(1): 43–61.

Asgarkhani, M. & Young, A. 2010. Industry view of ICT roles and skills in Canterbury. 1st Annual Conference of Computing and Information Technology Research and Education, New Zealand.

Avgerou, C. 2000. Information systems: What sort of science is it? *Omega: The International Journal of Management Science*, Vol. 28: 567–579.

Avocus Group LLC. 2004. Customer success story. Gate City Beverage: California beer distributor taps into transportation savings and service improvements. Available from https://www.descartes.com/content/documents/cs_gatecity_beverage.pdf (Accessed 19 August 2011).

Azevedo, S.G., Ferreira, J.M. & LeitÃˇco, J. 2007. “The role of logistics’ information and communication technologies in promoting competitive advantages of the firm”. MPRA Paper 1359, University Library of Munich, Germany.

Babbie, E. 2004. *The practice of social research* (10th ed.). Belmont, CA: Thomson Learning/Wadsworth.

Banister D. & Stead D. 2004. Impact of information and communications technology on transport. *Transport Reviews*, 24(5): 611–632.

Barker, B. & Huser, S. 1998. Protect yourself! Navigation payload anomalies and the importance of adhering to ICD-GPS-200. *Proceedings of ION GPS-98*. Nashville, Tennessee.

Bartlett, J.E., Kotrlik, J.W. & Higgins, C.C. 2001. Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal*,19(1): 43.

Bazeley, P. 2002. Issues in mixing qualitative and quantitative approaches to research. Paper presented at the 1st International Conference on Qualitative Research in Marketing and Management, University of Economics and Business Administration, Vienna.

Bekiaris, E. & Nakanishi, Y.J. 2004. Innovation and case studies. *Economic Impacts of Intelligent Transportation Systems*, Vol. 8: 60.

Benitez-Amado, J., Llorens-Montes, F.J., & Perez-Arostegui, M.N., 2010. Information technology-enabled intrapreneurship culture and firm performance. *Industrial Management & Data Systems*, 110(4): 550–566.

Bertolini, M., Bottani, E., Rizzi, A. & Bevilacqua, M. 2007. Lead time reduction through ICT application in the footwear industry: A case study. *International Journal of Production Economics*, Vol. 110: 198–212.

Bisdikian, C., Boamah, I., Castro, P., Misra, A., Rubas, J., Villoutreix, N. & Simonds, C. 2002. Intelligent pervasive middleware for context-based and localized telematics services: In *Proceedings WMC"02*, Atlanta, GA, USA, September 28: 15–24.

Bloom, N., Garicano, L., Sadun, R., & Reenen, J. 2009. *The distinct effects of information technology and communication technology on firm organization.* NBER Working Paper Series, Working Paper 14975, National Bureau of Economic Research. Available: http://www.stanford.edu/~nbloom/w14975.pdf. (December 14, 2010).

Bodamer, D. 2001. Technology: GPS systems more accurately track quake potential in California. *Civil Engineering Magazine*, 71(9): 31.

Boughton, N. & Kehoe, D. 2001. Internet based supply chain management: A classification of approaches to manufacturing planning and control. *International Journal of Operations & Production Management*, 21(4), 516–524.

Bowersox, D.J. & Daugherty, P. 1995. Logistics paradigms: The impact of information technology. *Journal of Business Logistics*, 16(1): 65–81.

Bowersox, D.J., Daugherty, P.J., Droge, C.L., Rogers, D.S. & Wardlow, D.L. 1989. *Leading edge logistics: Competitive positioning for the 1990s.* Oak Brook, IL: Council of Logistics Management.

Boyce, D.E., Hicks, J. & Sen, A. 1991. *In-vehicle navigation requirements for monitoring link travel times in a dynamic route guidance system.* Urban Transportation Centre, University of Illinois at Chicago

Brown, M., Allen, J. & Woodburn, A. 2006. Developments in Western European logistics strategies in global logistics. In *New directions in supply chain management* edited by D. Waters. London: Kogan Page, pp. 353–373.

Bryman, A. & Bell, E. 2007. *Business research methods* (2nd ed.). Oxford University Press, USA.

Bryman, A. & Burgess, R.G. 1999. *Qualitative research.* London: Sage.

Brynjolfsson, E. & Hitt, L. 2003. Computing productivity: Firm-level evidence. *Review of Economics and Statistics*, (85): 793–808.

Bueno, S. & Salmeron, J.L. 2008. TAM-based success modeling in ERP. *Interacting with Computers*, 20(6): 515–523.

Buhalis, D. 2003. Airlines: Strategic and tactical use of ICTs in the airline industry. *Information and Management*, Vol. 41: 805–825.

Buonanno, G., Faverio, P., Pigni, F., Ravarini, A., Sciuto, D. & Tagliavini, M. 2005. Factors affecting ERP system adoption: A comparative analysis between SMEs and large companies. *Journal of Enterprise Information Management*, 18(4): 384–426.

Cantor, D.E. & Macdonald, J.R. 2008. Decision-making in the supply chain: Examining problem solving approaches and information availability. Journal of Operations & Production Management, 28 (4), 360-. 379.

Carr, A. 2002. Jung, archetypes and mirroring in organizational change management: Lessons from a longitudinal case study. *Journal of Organizational Change Management*, 15(5): 447–489

Castellacci, F. 2006. Innovation, diffusion and catching up in the fifth long wave. *Futures*, 38(7): 841–863.

Central Bank of Kenya (CBK) Forex Rates. http://www.centralbank.go.ke/forex/default.aspx. (Accessed July, 2011).

Chaharbaghi, K., Feurer, R., Wargin, J. & Weber, M. 2002. Aligning strategies, processes, and information technology: A case study. In Ayers, J.B. (Ed.), *Making supply chain management work.* Boca Raton, FL: CRC Press, pp. 219–236.

Chan, P.S. & Land C. 1999. Implementing re-engineering using information technology. *Business Process Management Journal*, 5(4): 311–324.

Chan, P.S. & Peel D. 1998. Causes and impact of reengineering. *Business Process Management Journal*, 4(1): 46–55.

Chan, S.L. 2000. Information technology in business processes. *Business Process Management Journal*, 6(3): 224–237.

Charney, D. (1996). Empiricism is not a four-letter word. *College Composition and Communication*, 567–593.

Churchill, G.A. 1979. A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, Vol. 16: 64–73.

Clark, D., Lotto, L. & Astuto, T. 1984. Effective schooling and school improvement: A comparative analysis of two lines to inquiry. *Educational Administration Quarterly*, Vol. 20: 41–68.

Clarke, R. 2001. Person location and person tracking. *Information Technology & People*, 14(2): 206–231.

Closs, D. & Xu, K. 2000. Logistics information technology practice in manufacturing and merchandising firms: An international benchmarking study versus world class logistics firms. *International Journal of Physical Distribution & Logistics Management*, 30(10): 869–886.

Cobb, H.S., Lawrence, D., Christie, J., Walter, T., Chao, Y. C., Powell, J.D. & Parkinson, B. 1995. Observed GPS signal continuity interruptions. *Proceedings of ION GPS-95*. Palm Springs, California.

Connolly, C. 2007. Technological improvements in position sensing. *Sensor Review*, 27(1): 17–23.

Cook, T.D. & Campbell, D.T. 1979. *Quasi-experimentation: Design & analysis issues for field settings*. Chicago, IL: Rand McNally.

Cooper, D.R. & Schindler, P.S. 2003. *Business research methods* (8th ed.). USA: McGraw-Hill.

Cordella, A. 2006. Transaction costs and information systems: Does IT add up? *Journal of Information Technology*, 21(3): 195–202(8). Available: www.ccsenet.org/ibr. International Business Research 4(3) July 2011.

Cornford, T. & Smithson, S. 1996. *Project research in information systems: A student's guide*. Hampshire, UK: Palgrave Macmillan.

Creswell, J. 2003. *Research design*. Thousand Oaks, CA: Sage.

Creswell, J.W. 1994. *Research design: Qualitative & quantitative approaches*. Thousand Oaks, CA: Sage.

Dana, P.H. 1997. Global positioning system (GPS) time dissemination for real-time applications. *Real-Time Systems*, 12(1): 9–40.

Davies, I., Mason R. & Lalwani, C. 2006. Assessing the impact of ICT on UK general haulage companies. *International Journal of Production Economics*, Vol. 106: 12–27.

Dawe, R.L. 1994. An investigation of the pace and determination of information technology use in the manufacturing materials logistics system. *Journal of Business Logistics*, 15(1): 229–250.

De Jong, G., Algers S., Papola A. & Burg R. 2006. *Impact of the e-economy on traffic and traffic-related indicators in urban areas.* Transportation Research Board, National Research Council, National Academy of Sciences, USA.

Department for Transport. 2003. *Telematics Good Practice Guide: 341*. London: Stationery Office.

Devlin, G.J., Mcdonnell, K.P. & Ward, S.M. 2007. Performance accuracy of low-cost dynamic non-differential GPS on articulated trucks. *Applied Engineering in Agriculture*, 23(3): 273–279.

Durr, G. & Giannopoulos, G.A. 2003. SITS: A system for uniform intermodal freight transport information exchange. *International Journal of Transport Management*, 1(3): 175–186.

Easterby-Smith, M., Thorpe, R. & Lowe, A. 1991. *Management research: An introduction*. London: Sage.

Egbert, R.I. & King, J.E. 2003. *The GPS handbook: An outdoorsman's guide*. Canada: Burford Books.

Ellinger, A.E., Lynch, D.F., Andzulis, J.K. & Smith, R.J. 2003. B-To-B E-commerce: A content analytical assessment of motor carrier websites. *Journal of Business Logistics*, 24(1): 199–220.

El-Rabbany, A. 2006. Introduction to GPS: The global positioning system (2nd ed.). United States of America: Artech House.

Enge, P.K. 1994. The global positioning system: Signals, measurements, and performance. *International Journal of Wireless Information Networks*, 1(2): 83–105.

Esker Document Delivery. 2006. Best practice order management by Advantage technologies. Available at http://www.managingautomation.com/sponsors/advantage_tech/ati_dw.pdf (Accessed 13 May 2012).

European Commission DG Energy and Transport. 2009. Freight transport, thematic research summary. Transport Research Knowledge Centre.

Evangelista, P. & Sweeney, E. 2006. Technology usage in the supply chain: the case of small 3PLs. *The International Journal of Logistics Management*, 17(1): 55–74.

Fetterman, D.M. 2010. *Ethnography: Step-by-step* (3rd ed.). Thousand Oaks, CA: Sage.

Finn, K.M. 2002. Electronic filing trends in 2002: The paperless law practice. Knowledge and Information Services November 25. Available from: http://www.ncsconline.org/WC/Publications/KIS_ElFile_Trends02_Pub.pdf. (Accessed August 2011).

Fleischmann, B., Gnutzmann, S. & Sandvoss, E. 2004. Dynamic vehicle routing based on on-line traffic information. *Transportation Science*, 38(4): 420–433.

Frazelle, E. 2002. *Supply chain strategy*. USA: McGraw Hill.

Ganz, N. & Ryzin, G. 1999. Dynamic vehicle dispatching: Optimal heavy traffic performance and practical insights. *Operations Research*, 47(5): 675–692.

Glaser, B. & Strauss, A. 1967. *The discovery of grounded theory: Strategies in qualitative theory*. London: Wiedenfeld and Nicholson.

Goetschalckx, M. 1988. A decision support system for dynamic truck dispatching. *International Journal of Physical Distribution and Materials Management*, 18(6): 34–42.

Gonzalez, A. 2006. *On demand TMS: Transforming the inbound process*. Available from http://www.leanlogistics.com/leanlogistics_documents/On-Demand-TMS-Transforming-the-Inbound-Process.pdf. (Accessed 13 March 2012).

Gustafsson, J. & Norrman, A. 2001. *Network managed supply: Execution of real time replenishment in supply networks*. Lund: MA-system AB.

Gutiérrez, G. & Duran, A. 1997. Information technology in logistics: A Spanish perspective. *Logistics Information Management*, 10(2): 73–79.

Haghani, A. & Jung, S. 2004. A dynamic vehicle routing problem with time-dependent travel times. *Computers & Operations Research*, 32(11): 2959–2986.

Hair, J.F. Jr, Babin, B., Money, A.H. & Samouel, P. 2003. *Essentials of business research methods*. USA: Leyh.

Hallenbeck, M.E., Boyle, T. & Ring, J. 1992. *Use of automatic vehicle identification techniques for measuring traffic performance and performing incident detection*. Report No. WA-RD-273.1 (TNW 91-11), Washington State Transportation Centre, University of Washington, Seattle, Washington

Halvorsen, K. 1992. *Samhällsvetenskaplig metod*. Lund: Studentlitteratur.

Hammant, J. 1995. Information technology trends in logistics. *Logistics Information Management*, 8(6): 32–37.

Hanna, N. 2003. *Why national strategies are needed for ICT-enabled development*. Information Systems Group (ISG) Staff Working Paper, No. 3, June.

Harvey, R. 2006. Research methods in anthropology: Qualitative and quantitative approaches (4th ed.). Rowman & Littlefield Altamira, New York.

Hengst, M. & Sol, H. G. 2001. The impact of information and communication technology on interorganizational coordination: Guidelines from theory. *Informing Science, Special Series on Information Exchange in Electronic Markets*, 4(3).

Henry, G.T. 1990. *Practical sampling, Vol. 21*. London: Sage Publications.

Herselman, M.E. & Hay, H.R. 2003. Challenges posed by information and communication technologies (ICT) for South African higher education institutions. *Informing Science*, Vol. 9: 31–43.

Hesse, M. 2002. Shipping news: the implications of electronic commerce for logistics and freight transport. *Resources Conservation and Recycling*, Vol. 36: 211–240, Elsevier.

Hidalgo, A. & Lopez, V. 2009. Drivers and impacts of ICT adoption on transport and logistics services. *Asian Journal of Technology Innovation*, 17(2): 27–47.

Hipp, C. & Grupp, H. 2005. Innovation in the service sector: The demand for service specific innovation measurement concepts and typologies. *Research Policy*, Vol. 34: 517–535.

Hitachi Data Systems. 2006. *Business continuity: A blueprint of business resilience and operational efficiency.* Solutions Brief for January. Retrieved from http://www.storagelab.it/soluzioni/documents/HDS_business_continuity_BP.pdf.

Hoffman, R. 2000. *Radio channel impulse response measurement systems*. Retrieved from http://flattop.its.bldrdoc.gov/rcirms/. Last Accessed: 05 June 2011.

Hofstee, E. 2006. *Constructing a good dissertation: a practical guide to finishing a masters, MBA or PhD on schedule*. Sandton: EPE.

Holton, E.H. & Burnett, M.B. 1997. *Qualitative research methods*. In R.A. Swanson, & E.F. Holton (Eds.), *Human resource development research handbook: Linking research and practice*. San Francisco: Barrett-Koehler.

Hong, D., Chiu, D.K.W., Shen, V.Y., Cheung, S.C. & Kafeza, E. 2007. Ubiquitous enterprise service adaptations based on contextual user behavior. *Information Systems Frontiers*, 9(4): 43–358.

Howell, J. & Wei, J. 2010. Value increasing model in commercial e-banking. *Journal of Computer Information Systems*, 51(1): 72–81.

Huang, Z. & Palvia, P. 2001. ERP implementation issues in advanced and developing countries. *Business Process Management*, 7(3): 276–284.

Ichoua, S., Gendreau, M. & Potvin, J.Y. 2003. Vehicle dispatching with time-dependent travel times. *European Journal of Operational Research*, Vol. 144: 379–396.

Illa, X.B., Franch, X. & Pastor, J.A. 2000. Formalising ERP selection criteria. Paper presented at the 10th International Workshop on Software Specification and Design, San Diego, California.

Irvine, W. & Anderson, A.R. 2008. ICT (information communication technology), peripherality and smaller hospitality businesses in Scotland. *International Journal of Entrepreneurial Behaviour & Research*, 14(4): 200–218.

Iskanius, P., Halonen, R. & Möttönen, M. 2009. Experiences of ERP use in small enterprises. Paper presented at the ICEIS 2009 11th International Conference on Enterprise Information Systems, Milan, Italy.

Jani, A. 2006. *Managing the mini supply chain: How SMBs can better manage their condensed supply chains for competitive advantage*. Retrieved from http://www.sdcexec.com/article/10289812/managing-the-mini-supply-chain?page=3. (accessed 12 December 2011).

Jayaraman, V., Ross A. & Agarwal A. 2008. Role of information technology and collaboration in reverse logistics supply chains. *International Journal of logistics Research and Applications*, Vol. 11: 409–425.

Jiang, B. & Li S. 2002. Measuring and analyzing vehicle position and speed data at work zones using Global Positioning System. *Institute of Transportation Engineers: ITE Journal*, 72(3): 6.

Jiménez-Zarco, A.I., Martínez-Ruiz, M.P. & Llamas-Alonso, M.R. 2006. Analysis of ICTs opportunities on firm's success: An innovation process. *Problems and Perspectives in Management*, 4(4): 84–94.

Kakabadse, N. K., Kakabadse, A. & Kouzmin, A. 2005. After the re-engineering: Rehabilitating the ICT factor in strategic organizational change through outsourcing. *Problems and Perspectives in Management*, Vol. 1: 55–71.

Kapurubandara, M. & Lawson, R. 2006. *Barriers to adopting ICT and e-commerce with SMEs in developing countries: An exploratory study in Sri Lanka*. University of Western Sydney, Australia. Retrieved from <http: //www.collecter.org/archives/2006_December/07.pdf.> [Accessed on December 10, 2012]

Karen, J. 2010. *GPS Tracking services in Kenya: Kenya Police Report*. Retrieved from http://mashamugs.wordpress.com/2010/10/07/gps-tracking-in-kenya/. (Accessed on 15 April 2012).

Kent, J.L. & Flint, D.J. 1997. Perspectives on the evolution of logistics thought. *Journal of Business Logistics*, 18(2): 15–30.

Kim, S, Lewis, M.E. & White C.C. 2003. *Optimal vehicle routing with real-time information*, Working Paper, University of Michigan.

King Mob, 2011. Fleet management tools, ideal for business. Engineering management 17 January, 2011. Retrieved on [September 07, 2011]. Retrieved from http://www.king-mob.com/fleet-management-tools-ideal-for-business

Kish, L. 1965. *Survey sampling*. New York: Wiley.

Klein, H.K. & Myers, M.D. 1999. A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, 23(1): 67–93.

Kleodon, C.N., Mclean, A.J., Moore, V.M. & Ponte, G. 1997. *Travelling speed and the risk of crash involvement*. Report CR 172. Federal Office of Road Safety, Canberra.

Klie. L. 2006. The value of information: Frozen food age. *ABI/INFORM Trade & Industry* January, 54(6): 26.

Knox, K. 2004. A researcher's dilemma: Philosophical and methodological pluralism. *Electronic Journal of Business Research Methods*, 2(2): 119–128.

Kolbe R.H. & Burnett, M.S. 1991. Content-analysis research: An examination of applications with directives for improving research reliability and objectivity. *Journal of Consumer Research*, 18(2): 243.

Kollberg, M. & Dreyer, H. 2006. *Exploring the impact of ICT on integration in supply chain control: a research model.* Department of Production and Quality Engineering, Norwegian University of Science and Technology, Norway.

Kothari, C.R. 2005. *Research methodology methods and techniques* (2nd ed.). India: New Age.

KPLC annual Report 2009. Retrieved from <http://www.kplc.co.ke/fileadmin/user_upload/Reports/annualrep2009.pdf>

Krejcie, R.V. & Morgan, D.W. (1970). Determining sample size for research activities. *Educational and Psychological Measurements*, Vol. 30: 607–610.

Krishnaveni, R. & Meenakumari, J. 2010. Usage of ICT for information administration in higher education institutions: A study. *International Journal of Environmental Science and Development*, 1(3): 282–286.

Lai, K-H., Ngai, E. & Cheng, T. 2000. Information technology adoption in Hong Kong's logistics industry. *Transportation Journal*, 44(4): 1–10.

LaMance, J., DeSalas, J. & Jarvinen, J. 2002, Assisted GPS: A low infrastructure approach. *GPS World* (Online).

Langley, R.B. 1991: Time, clocks and GPS. *GPS World*, 2(10), November/December 1991, pp.38-42.

Laporte, G. & Crainic, T.G. (Eds). 2000. *Fleet management & logistics*. Boston, MA: Kluwer.

Laukkanen, S., Sarpola, S. & Hallikainen, P. 2000. Enterprise size matters: Objectives and constraints of ERP adoption. *Journal of Enterprise Information Management*, 20(3): 319–334.

Levans, M. 2007. *Why IT has become central to logistics and supply chain strategy*. Logisticsmanagement.com. Retrieved from <www.Logisticsmanagement.com> [Accessed 15th November 2012].

Leveine, S.Z., McCasland, W.R. & Smalley, D.G. 1993. *Development of a freeway traffic management project through a public-partnership in transportation.* Research Record 1394, Transportation Research Board, National Research Council, Washington, DC, pp. 26–31.

Li, S. & Qin Zhu, K. 2003. Addressing issues with GPS data accuracy and position update rate for field traffic studies. *Institute of Transportation Engineers: ITE Journal*, 72(2): 6.

Li, Z., Kumar, A. & Lim, Y.G. 2000. Supply chain modelling: A co-ordination approach. *Integrated Manufacturing Systems*, 13(8): 551–561.

Liang, H. & Xue, Y. 2004. Coping with ERP-related contextual issues in SMEs: A vendor's perspective. *The Journal of Strategic Information Systems*, 13(4): 399–415.

Liang, T.P., You, J.J., & Liu, C.C., 2010. A resource-based perspective on information technology and firm performance: A meta-analysis. *Industrial Management & Data Systems*, 110(8): 1138–1158.

Light, B. 2005. Going beyond 'misfit' as a reason for ERP package customisation. Computers in Industry, 56(6): 606–619.

Lin, W.T. & Lin, H.J. 2006. International productivity paradox of IT in commercial banking: A cost efficiency analysis. *The Business Review*, 5(1), 246–252.

Lincoln, Y.S. & Guba, E. G. 1985. *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Liu, T.K. 1994. Field tests of travel time survey methodologies and development of a standardized data processing and reporting system. In the Proceedings of the National Traffic Data Acquisition Conference, Hartford, Connecticut.

Loh, T.C. & Koh, S.C.L. 2004. Critical elements for a successful enterprise resource planning implementation in small-and-medium enterprises. *International Journal of Production Research*, 42(17): 3433–3455.

Lundahl, U. & Skärvad, P-H. 1999. *Utredningsmetodik för samhällsvetare och ekonomer* (3rd ed.). Lund: Studentlitteratur.

m.logistics 2008. A quarter of fleets now using vehicle tracking. Issue 34, April/May 2008, available at <http://www.mlogmag.com/magazine/34/A of_fleets.shtml.>

Malladi R. & Agrawal, D.P. 2002. Current and future applications of mobile and wireless networks. *Communications of the ACM*, 45(10) October.

Manecke, N. & Schoensleben, P. 2004. Cost and benefit of Internet-based support of business processes. *Int. Journal of Production Economics*, Vol. 87: 213–229

Marchet, G., Perego, A. & Parotti, S. 2006. *An explanatory study of ICT adoption in the Italian freight transportation industry*. Italy: Department of Management, Economics and Industrial Engineering.

Marjanovic, O. 2000. Supporting the “soft” side of business process reengineering. *Business Process Management Journal*, 6(1): 43–55.

Mark, R. 1996. *Research made simple: A handbook for social workers*. Thousand Oaks, CA: Sage.

Marketwire 2009. Retrieved from http://www.marketwire.com/press-release/Aberdeen-Group-NYSE-HHS-1020560.html

Markus, M.L. & Tanis, C. 2000. The enterprise systems experience: From adoption to success. In R.W. Zmud (Ed.), *Framing the domains of IT research: Glimpsing the future through the past*. Cincinnati, OH: Pinnaflex Educational Resources.

Mason-Jones, R. & Towill, D. R. 1999. Using the information decoupling point to improve supply chain performance. *The International Journal of Logistics Management*, 10(2): 13–26.

McKinnon, A.C. 2006. *Road transport optimization*. In Walters, D. (Ed), *Global logistics*. London: Kogan Page.

McKinnon, A.C. & Ge, Y. 2004. Use of a synchronized vehicle audit to determine opportunities for improving transport efficiency in a supply chain. *International Journal of Logistics: Research and Applications*, 7(3): 219–238.

Mcneill, P. & Chapman, S. 2005. *Research methods*. London: Routledge.

Melville, N., Kraemer, K.L. & Gurbaxani, V. 2004. Information technology and organizational performance: An integrative model of IT business value. *MIS Quarterly*, 28(22): 283–322.

Meredith, J.R., Raturi, A., Amoako-Gyampah, K. & Kaplan, B. 1989. Alternative research paradigms in operations. *Journal of Operations Management*, 8(4): 297–326.

Michigan State University. Available from http://www2.lib.msu.edu/. ( Accessed January 2008) .

Milis, K. & Mercken, R. 2003. The use of the balanced scorecard for the evaluation of information and communication technology projects. *International Journal of Project Management*, 22(2): 87–97.

Miller, D. 1983. *Handbook of research design and social measurement* (4th ed.). London: Longman.

Mintsis, G., Basbas, S., Papaioannou, P., Taxiltaris, C. & Tziavos, I.N. 2004. Applications of GPS technology in the land transportation system. *European Journal of Operational Research*, 152(2) 16 January: 399–409.

Moberg, R.C., Cutler, D.B., Gross, A. & Speh, T.W. 2002. Identifying antecedents of information exchange within supply chains. *International Journal of Physical Distribution & Logistics Management*, 32(9): 755–770.

Mogey, N. 1999. *So you want to use a Likert scale?* Retrieved 03 May 2010, from <http://www.icbl.hw.ac.uk/ltdi/cookbook/info_likert_scale/>

Mohinder S., Angus P.A. & Bartone, C.G. 2013. "Global Navigation Satellite Systems, Inertial Navigation, and Integration", 3rd Ed. John Wiley and Sons, Inc., Hoboken, New Jersey.

Mokhtarian P. 2004. A conceptual analysis of the transportation impacts of B2C e-commerce. *Transportation*, Vol. 31: 257–284

Molla, A. & Bhalla, A. 2006. ERP and competitive advantage in developing countries: The case of an Asian company. *The Electronic Journal on Information Systems in Developing Countries*, 24(1): 1–19.

Mondragon Coronado, A.E., Lalwani, C.S., Mondragon Coronado, E.S. & Mondragon Coronado, C.E. 2009. Facilitating multimodal logistics and enabling information systems connectivity through wireless vehicular networks. *International Journal of Production Economics*, vol. 122: 229–240.

Motwani, J. & Kumar, A. 1998. Business process re-engineering. *International Journal of Operations & Production Management*, 18(9/10): 964–978.

Mouelhi, R.B. 2009. Impact of the adoption of information and communication technologies on firm efficiency in the Tunisian manufacturing sector. *Economic Modelling*, Vol. 26: 961–967.

Murakami, E. & Wagner, D.P. 1999. Can using global positioning system (GPS) improve trip reporting? *Transportation Research Part C*, 7(2–3): 149–165.

Murphy, S. 2004. How to choose a GPS fleet management system: What features are right for you? *Management Quarterly*, Vol. 45.

Muscatello, J.R, Small, M.H. & Chen, I.J. 2003. Implementing enterprise resource planning (ERP) systems in small and midsize manufacturing firms. *International Journal of Operations & Production Management*, 23(8): 850–871.

Nachmias, C.F. & Nachmias, D. 2008. *Research methods in the social sciences* (7th ed.). New York: Worth.

Nandhakumar, J. & Jones, M. 1997. Too close for comfort? Distance and engagement in interpretive information systems research. *Information Systems Journal*, 7(2): 109–131.

Neuman, W.L. 2000. *Social research methods: Qualitative and quantative approaches*. 4th ed. Boston: Allyn & Bacon.

Nisner, P.D. & Johannessen, R. 2000. Ten million datapoints from TSO-approved GPS receivers: Results and analysis and applications to design and use in aviation. Journal of the Institute of Navigation 47(1) 43-50, Fairfax, VA.

Nietermayer, L. 2010. GPS tracking systems on company vehicles can save fuel, labor costs, and correct bad driving habits. Pioneer Well Services. Posted on 24 March 2010. Retrieved from <http://www.drillingcontractor.org/gps-tracking-systems-on-company-vehicles-can-save-fuel-labor-costs-correct-bad-driving-habits-4712 >

Nixon, M. 2001. Innovations in logistics technology: Generating top-line value and bottom line ROI. *World Trade*, Vol. 14: 62–64.

Noton, A. 2011. Ezine articles: Better customer service due to GPS fleet tracking. GPS fleet management is becoming an indispensable tool of any business that has a fleet of vehicles. With a real-time fleet tracking system. Retrieved on 23 Feb 2011 from <http://ezinearticles.com/?Better-Customer-Service-Due-to-GPS-Fleet-Tracking&id=5983651>

Oates, B.J. 2006. *Researching information systems and computing*. SAGE Publications London.

Okuttah, M. 2009. *Business daily supplement: Fleet managers turn to technology for security*. Retrieved August 06, 2009 from <http://www.businessdailyafrica.com/blob/view/-/635460/data/92916/-/p93qscz/-/Digital-Biz.pd>

Olsen, K.A. & Sætre, P. 2007. ERP for SMEs: Is proprietary software an alternative? *Business Process Management*, 13(3): 379–389.

Olugbenga, F.I. 2006. Strategic application of information and communication technology for effective service delivery in an organization. 6th Global conference on Business and Economics, October 15–17, Gutman Business Center, USA.

Opsi systems, 2007. OPTIMA. Demo presentation: (Opsi Primary Transport Information Management) Available at <http://www.opsi.co.za/product_optima.htm> (Accessed 19 May 2007).

Paulsson, U., Nilsson, C-H. & Tryggestad, K. 2000. *Flödesekonomi* [Supply chain management]. Lund: Studentlitteratur.

Perkinson, D.G.1994. Using automated vehicle location data to monitor congestion: Fuzzy set theory. *ITE Journal.* Institute of Transportation Engineers, Washington D.C., pp.35-40.

Peterson, R.T. 1998. The portrayal of children's activities in television commercials: A content analysis. *Journal of Business Ethics*, 17(14): 1541–1549.

Piplani, R., Pokharel, S. & Tan, A. 2004. Perspectives on the use of information technology at third party logistics service providers in Singapore. *Asia Pacific Journal of Marketing and Logistics*, 16(1): 27–41.

Pivotal Corporation. 2006. Managing quotes, contracts and pricing for higher profits. Available from <www.pivotal.com> (Accessed 13 April 2012).

Pokharel, S. 2005. Perception on information and communication technology perspectives in logistics. *The Journal of Enterprise Information Management*, 18(2): 136–149.

Pokharel, S. & Lee, CKM. 2009. Analyzing the use of information systems in logistics industry. Information systems research methods, epistemology, and applications, 225-246. Singapore, Hershey, PA : Information Science Reference.

Porter, M.E. 1990. The *competitive advantage of nations*. London: Macmillan.

Powell, W.B. 1990. Real-time optimization for truckload motor carriers. *OR/MS Today* Vol. 18: 28–33

PRWEB. May 03, 2011. Retrieved from <http://www.prweb.com/releases/2011/5/prweb8368752.htm>

Psaraftis, H.N. 1995. Dynamic vehicle routing: Status and prospects. *Annals of Operations Research*, Vol. 611: 143–164.

Pullen, S., Xie, G. & Enge, P. 2001. Soft failure diagnosis and exclusion for GBAS ground facilities. *Proceedings of RIN NAV*, London, UK.

Quinn, M. 2002. *Qualitative research & evaluation methods* (3rd ed.). USA: Sage.

Ram Mohan, L. 2006. Supply chain all the way: strengthening the weakest link, the strength of a chain lies in its weakest link. 21 December Available at <www.supplychainexecutive.com> [Accessed 13 May 2012].

Ramamoorthy, A. 2004, New approaches in GPS based location systems. *Proceeding of Map India Conference*.

Ramsey, E., Ibbotson, P., Bell, J. & Gray, B. 2003. E-opportunities of service sector SMEs: An Irish cross-border study. *Journal of Small Business and Enterprise Development*, 10(3): 250–264.

Rastrict, K. & Corner, J. 2010. Understanding ICT based advantages: A techno savvy case study. *Interdisciplinary Journal of Information, Knowledge and Management*, vol. 5.

Regan, E.A. & O'Connor, B.N. 2002. *End-user information systems: Implementing individual and work group technologies* (2nd ed.). New Jersey: Prentice-Hall.

Repstad, P. 1999. *Närhet och distans: Kvalitativa metoder i samhällsvetenskap* (3rd ed.). Lund: Studentlitteratur.

Robert, A. 1999. Applied Technology Institute (ATI) the global positioning system: A national resource. Available from <http://www.aticourses.com/global_positioning_system.htm> [Accessed 2 April 2012].

Robert Jacobs, F. & Ted Weston, J.F.C. 2007. Enterprise resource planning (ERP): A brief history. *Journal of Operations Management*, 25(2): 357–363.

Robinson, J.R., Ewald, R.C., Gravely, T.B. & Carter, E. 1993. Capital IVHS operational test. Proceedings of the 63rd Annual ITE Meeting, Institute of Transportation Engineers, Washington DC.

Ruppel, C. 2004. An information systems perspective of supply chain tool compatibility: The roles of technology fit and relationships. *Business Process Management Journal*, 10(3): 311–324.

Rwashana, A.S. & Williams, D.W. 2008. Enhancing immunization healthcare delivery through the use of information communication technologies. *International Journal of Education and Development Using ICT*, 4(2): 144–156.

SAB. 31 March 2001. Corporate citizenship review. Available at: <http://www.sabmiller.com/NR/rdonlyres/31D75D83-9CB2-48C8-B4E3-68197710840D/0/SABMiller_CAR_2001.pdf> [Accessed March 2012].

Sanders, N.R. 2007. An empirical study of the impact of e-business technologies on organizational collaboration and performance. *Journal of Operations Management*, 25(6): 1332–1347.

Sanders, N.R. & Premus, R. 2002. IT Applications in supply chain organizations: A link between competitive priorities and organizational benefits. *Journal of Business Logistics*, 23(1): 65–84.

Sarac, A., Absi, N. & Dauzere-Peres S. 2009. *A literature review on the impact of RFID technologies on supply chain management*. Working paper ENSM-SE CMP WP.

Sarantakos, S. 2000. Social research. Sydney: Macmillan.

Saunders, M., Lewis, P. & Thornhill, A. 2003. *Research methods for business students* (3rd ed.). Harlow, UK: Prentice Hall.

Sauvage, T. 2003. The relationship between technology and logistics third-party providers. *International Journal of Physical Distribution & Logistics Management*, 33(3): 236–253.

Savelsbergh, M.W.P. & Sol, M. 1991. Drive: Dynamic routing of independent vehicles, *Operations Research*, vol. 46: 474–490

Savitsikie, K. 2007. Internal and external logistics information technologies. Department of Marketing and Supply Chain Management, University of Memphis, Memphis, USA.

Schware, R. 2003. Information and communications technology (ICT) agencies: Functions, structures, and best operational practices. *Info*, 5(3): 3–7.

See, W.B. 2007. Wireless technologies for logistic distribution process. *Journal of Manufacturing Technology Management*, 18(7): 876–888.

Sekaran, U. 2003. *Research methods for business: A skill building approach* (4th ed.). New York: Wiley.

Selwyn, N. 2002. *Defining the digital divide: Developing a theoretical understanding of inequalities in the information age*. Cardiff School of Social Sciences Occasional Paper, 49. School of Social Sciences, Cardiff University, Cardiff. [online] Available: www.cf.ac.uk/socsi/ict/definingdigitaldivide.pdf (March 3, 2011).

Shanker, D. 2008. ICT & tourism: Challenges and opportunities. Conference on Tourism in India: Challenges Ahead, 15–17 May, IIML. [online] Available at: <http://dspace.iimk.ac.in/bitstream/2259/536/1/50-58.pdf> [Accessed March 3, 2011].

Shugan, S.M. 2004. The impact of advancing technology on marketing and academic research. *Marketing Science*, 23(4): 469–475.

Skinner, L.R., Bryant, P.T. & Richey, R.G. 2008. Examining the impact of reverse logistics disposition strategies. *International Journal of Physical Distribution & Logistics Management*, 38(7): 518–539.

Slater, A. 2002. Specification for a dynamic vehicle routing and scheduling system, *International Journal of Transportation Management*, vol. 1: 29–40.

Somuyiwa, A.O. & Adewoye, J.O. 2010. Managing logistics information systems: Theoretical underpinning. *Asian Journal of Business Management*, 2(2): 41–47.

Somuyiwa, A.O. & Oyesiku, O.O. 2010. Analysis of performance of collaborative sharing cost in outbound logistics. *Current Research of Social Sciences*, 2(3): 181–186.

Spanos, Y.E., Prastacos, G.P. & Poulymenakou, A. 2002. The relationship between information and communication technologies adoption and management. *Information and Management*, vol. 39: 659–675.

Srivastava, S.K. 2006. Logistics and supply chain practices in India. *Vision: The Journal of Business Perspective*, 10l(3) July September.

Ssewanyana, J.K. 2009. ICT usage in microfinance institutions in Uganda. *The African Journal of Information Systems (AJIS)*, 1(3): 5–28.

StatTrek. 2012. Random number generator.

Retrieved from <www.stattrek.com/statistics/random-number-generator.aspx>

Stock, J.R. 1990. Managing computer, communication and information technology strategically: Opportunities and challenges for warehousing. *Logistics and Transportation Review*, 25(2): 133–48.

Stopher, P. 2004. GPS, location, and household travel survey. In D.A. Hensher et al. (Eds), *Handbook of transport geography and spatial systems*, pp. 440–447. Oxford publishers, London

Stopher P., FitzGerald, C. & Xu, M. 2007. Assessing the accuracy of the Sydney household travel survey with GP. *Transportation*, 34(6): 723–741.

Stroh, M.B. 2001. *A practical guide to transportation and logistics*. USA. The Logistics Network.

Taniguchi, E. & Shimamoto, H. 2004. Intelligent transportation system based dynamic vehicle routing and scheduling with variable travel times. *Transportation Research Part C*, vol. 12: 235–250.

Ticehurst, G.W. & Veal, A.J. 1999. *Business research methods: A managerial approach*. Australia: Addison Wesley/Longman Australia.

Thill, J.C. 2000. Geographic information systems for transportation in perspective. *Transportation Research Part C*, 8(1–6): 3–12.

Thomas, P, 2010. Modern fleet management solutions & benefits to business. Jul 30, 2010. Retrieved September 07, 2011 from <http://electronics-sky.net/2010/07/modern-fleet-management-solutions-and-benefits-to-business/>

Thurgood, G.S. 1994. Development of a freeway congestion index (FCI) using an instrumented vehicle. *Proceedings of the 74th Annual Meeting of the Transportation Research Board*, Washington DC.

Trochim, W. 1999. *The research methods knowledge base* (2nd ed.). Ithaca, NY: Cornell.

Trochim, W. & Donnelly, J.P. 2007. *The research methods knowledge base* (3rd ed.). Mason, OH: Thomson.

Tsai, M-C. 2006. Constructing a logistics tracking system for preventing smuggling risk of transit containers. *Transportation Research Part A*, 40: 526–536.

Turner, S.M. 1996. *Advanced techniques for travel time data collection*. Transportation Research Record 1551, Transportation Research Board, Washington, DC, pp. 51–58.

Ustundag A. & Tanyas, M. 2009. The impacts of radio frequency identification (RFID) technology on supply chain costs. *Transport Research Part E,* Vol. 45: 29–38.

UNISA © 2007. Policy on research ethics - Unisa Online www.unisa.ac.za/contents/research/docs/ResearchEthicsPolicy_apprvCounc_21Sept07.pdf

Verville, J., Bernades, C. & Halingten, A. 2005. So you are thinking of buying an ERP? Ten critical factors for successful acquisitions. *Journal of Enterprise Information Management*, 18(6): 665–677.

Vollmann, T.E., Berry, W.L., Whybark, C.D. & Jacobs, R.F. 2005. *Manufacturing planning and control systems for supply chain management* (5th ed.). New York: McGraw-Hill.

Volpe Report. 2001. *Vulnerability assessment of the transportation infrastructure relying on the Global Positioning System*. John A. Volpe National Transportation Policy, August 29.

Walsh, D. & Daly, P. 2000. *Definition and characterization of known and expected GPS anomaly events.* Final Report to the UK CAA (Safety Regulation Group).

Walsham, G. 1995. Interpretive case studies in IS research: nature and method. *European Journal of Information Systems*, vol. 4: 74–81.

Wang L.C., Lin, Y.C. & Lin, P.H. 2007. Dynamic mobile RFID-based supply chain control and management system in construction. *Advanced Engineering Informatics*, 377–390.

Warungu, J., 2007. Kenya: nowhere to hide. Free online content from BBC Focus on Africa magazine. [Accessed 15 March, 2007]. Available at <http://www.bbc.co.uk/worldservice/africa/features/focus_magazine/news/story/2007/03/printable/070313_kenya_digitaxis.shtml>

Waters, D., Richmond, B. G., Parkes, J. & Wright, P.C. 2006. Future Trends in the supply chain management. In Waters, D. (Ed.), Global logistics (5th ed.). London: Kogan Page.

Wells, D.E. 1987. *Guide to GPS positioning*. Fredericton, New Brunswick: Canadian GPS Associates.

Wigblad, R. 1997. *Karta över vetenskapliga samband: Orientering i den samhällsvetenskapliga metoddjungeln* (2nd ed.). Lund: Studentlitteratur.

Wills, J.W. 2007. *Foundations of qualitative research: Interpretive and critical approaches*. Thousand Oaks, CA: Sage.

Yeung, J.H.Y., Shim, J.P. & Lai, A.Y.K. 2003. Current progress of e-commerce adoption: Small and medium enterprises in Hong Kong, *Communications of the ACM*, 46(9): 226–232.

Yin, R.K. 2003. *Case study research: Design and methods* (3rd ed.). Applied Social Science Method Series. Thousand Oaks, CA: Sage.

Yu, E. 2011. Information and communications technology in food assistance. [Online] Available at: <http://home.wfp.org/stellent/groups/public/documents/newsroom/wfp225972.pdf> [Accessed January 15, 2011].

Zeimpekis, V. & Giaglis, G.M. 2006. Urban dynamic real-time distribution services: Insights from SMEs. *Journal of Enterprise Information Management*, 19(4): 367–388.

Zikmund, W.G., Babin, B.J., Carr, J.C. & Griffin, M. 2010. *Business research methods* (8th ed.). Canada: South-Western/Cengage Learning.

# APPENDICES

## APPENDIX I: GPS FM questionnaire

### Part A: Demographic data

1. What is your gender?

   Male ( )

   Female ( )

2. State your highest level of education?

   Master's degree ( )

   Undergraduate ( )

   Diploma ( )

   Certificate ( )

3. How long have you been working in the KPLC?

   Less than 5 years ( )

   Between 5 and 10 years ( )

   Between 10 and 15 years ( )

   Over 15 years ( )

4. Office location

   Central office ( )

   Region ( )

   Name of Sub-Region …….

**Part B – Reduction in Motor fleet accidents between year 2009 and 2010**

1. Indicate the number of accidents that occurred in the periods indicated below:

   ☐ January – December 2009 ……

   ☐ January – December 2010 ……

2. Indicate the average rate of accidents per one million km in the periods indicated below:

   ☐ January – December 2009 ……

   ☐ January – December 2010 ……

3. Has there been any reduction of Accident rate between 2009 and 2010?

   ☐ Great extent …….☐moderate…….☐low extent……

   ☐Not at all…….

**Part C – Improvement in fleet availability between year 2009 and 2010**

1. Indicate the average fleet availability in your area in the periods indicated below:

   ☐ January – December 2009 ……

   ☐ January – December 2010 ……

2. Has the Fleet availability increased in the same Period?

   ☐ High…….☐moderate …..☐low …….☐negligible……..

3. How would you rate the importance of GPS fleet tracking system in the improvement of efficiency in vehicle operations?

   ☐ High……..☐ Moderate ……☐low…… ☐ None…

**Part D – Reduction in the fleet costs between year 2009 and 2010**

1. Indicate the monthly vehicle fuel and maintenance costs in the periods indicated below:

   a) Fuel & Oils Consumed in km/per Litre

   ☐ January – December 2009 ……

   ☐ January – December 2010 ……

b) Maintenance costs in Ksh/km

☐ January – December 2009 ……

☐ January – December 2010 ……

2. How would you rate the contribution of the GPS fleet tracking system in the reduction of vehicle operational costs?

☐ High……..☐ Moderate ……☐low……☐ None….

**Part E – Reduction in frequency of vehicle breakdowns between year 2009 and 2010**

1. Indicate the number of vehicles broken down in the periods indicated below:

☐ January – December 2009 ……

☐ January – December 2010 ……

2. Has the number of vehicle break downs reduced in the same period above?

☐ High……..☐ Moderate ……☐low……☐ None…….

3. How would you rate the contribution of the GPS fleet tracking system in the reduction of vehicle breakdowns?

☐ High……..☐ Moderate ……☐low……☐ None…….

**Part F. Reduction in vehicle theft between Jan 2009 and Dec 2010**

1. Indicate the vehicle stolen in your area in the periods indicated below:

☐ January – December 2009 ……

☐ January – December 2010 ……

2. Has the number of vehicle thefts reduced in the same period above?

☐ High……..☐ Moderate ……☐low……☐ None…….

3. Has the implementation of the GPS fleet tracking system contributed in prompt recovery of any stolen motor vehicle?

☐ High……..☐ Moderate ……☐low…… ☐ None…….

**Part G – Perceptions of staff towards the GPS implementation**

To what extent do you agree with the following statements as they relate to implementation of GPS Tracking in KPLC?

| **5**=strongly agree, **4**= agree, **3**=neutral, **2**=disagree and **1**= strongly disagree | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| 1- Adoption of modern information technology in fleet management has led to improved efficiency in service delivery at KPLC | | | | | |
| 2- Adopting new technology equipments is a necessary tool for efficiency in service delivery. | | | | | |
| 3- Increased use of modern IT solutions will result in longer term relationships with prospective customers | | | | | |
| 4- Organizations must be able to integrate knowledge from Information technology to deliver new products or service efficiently | | | | | |
| 5- In a fast moving world constant improvement on IT is essential for survival and success in efficiency in service delivery | | | | | |

**Any further comments that will help understand the impact of the installed GPS fleet management System in the transportation of staff, goods and materials**

**……**

**……**

**……**

**……**

**Thank you for your cooperation**

## APPENDIX II: Letter to respondents

Dear Sir/Madam,

**RE: ASSISTANCE IN COLLECTING RESEARCH DATA IN KPLC**

I am a student in the Department of Transport Economics, Logistics & Tourism at the University of South Africa (UNISA) pursuing a master's degree in Transport Economics.

Kindly fill the attached questionnaire as accurately as possible. The information being sought is purely for academic purposes and all responses are strictly confidential.

Thank you for your co-operation.

Yours Sincerely,

Edward C. Waiyaki

**APPENDIX III: Commissioning Report by M/S (BCS).**

1. **IMPLEMENTATION PLAN FOR INSTALLATION OF GPS UNITS by M/S Binary Computer Systems Limited**

| **JUNE 2008** | **Week 1** | **Week 2** | **Week 3** | **Week4** |
|---|---|---|---|---|
| **TASKS** | | | | |
| LPO/Contract Signing | | | | |
| Training | | | | |
| Website creation / Meetings/Specs Discussion | | | | |
| Device Programming and Testing- Nairobi area | | | | |
| Device Installation Nairobi Area | | | | |
| Integrated Software with devices & Testing | | | | |
| Google Earth Installation Nairobi Area & Testing | | | | |
| Monitor/ Place marking/Tracking Devices | | | | |
| | | | | |
| | | | | |
| **JULY 2008** | **Week 1** | **Week 2** | **Week 3** | **Week4** |
| **TASKS** | | | | |
| Device Programming & Testing | | | | |
| Device installation – Nairobi Area | | | | |
| Device installation – Kisumu /Eldoret | | | | |
| Device Installation – Nyeri/Thika/Nakuru | | | | |
| Device Installation – Mombasa – Coast | | | | |
| | | | | |
| G/Earth installation & Testing Kisumu | | | | |
| G/Earth installation & Testing Nyeri/Thika/Nakuru | | | | |
| G/Earth Installation Mombasa – Coast | | | | |
| **Monitor/Place marking/Tracking** | | | | |

## 2. PRODUCT DESCRIPTION

**RoverV9 Advanced Vehicle Tracker**

**a) Introduction:**

GPS Vehicle Tracker has designed with SoC (System On Chip) solution to bring more reliability and stability to the over whole performance Indeed, GPS Vehicle Tracker has been ranking as premium car alarm system by insurance companies across the world.

**b) Applications:**

1. Security & fleet management
2. Car Navigation
3. Marine Navigation
4. Vehicle Tracking & Location Base Service.

**c) Firmware Feature:**

1. SOC solutions
2. SMS mode/GPRS mode/SMS+GPRS mode
3. Upload/download settings, locations, and OS via GPRS.
4. Open platform for two way communication between control center and MDT
5. Special protocol for GPRS with hand shaking. Minimise communication cost and data package lost.
6. MCU dead lock protection

**d) GPS Integrated provides some extra Features for users for easy working with the system:**

1. Status on Maps: All vehicles/ devices in an account will be displayed on maps with its last know location.
2. Email Services: Snap shot of dashboard will be mailed to email id of the person at time stated. All detailed activity of vehicles will be shown in mail.
3. Email Alerts: All email alerts will be mailed to user who is registered for respective account. Snaps for the same are attached in next slides
4. WAP-enabled Service: WAP enabled service for tracking devices/ vehicles on Handset without using laptop/ PC. High level Authorities can easily view where the vehicles are in emergency cases.
5. Multiple Geo-fencing facility: Multiple geo fencing facility is now provided for better performance of your vehicles.
6. Geo-fencing areas can be marked on server so that you will get alerts for the same. This can be used for time punctuation.

## 3. TECHNICAL DESCRIPTION

| | | | | |
|---|---|---|---|---|
| **1.** | | **GPS Specifications :** | | |
| | | | **SiRF STAR III chipset version** | **Nemerix chipset version** |
| | **A)** | **General** | | |
| | 1) | Frequency | L1, 1575.42 MHz. | L1, 1575.42 MHz |
| | 2) | C/A code | 1.023 MHz chip rate | 1.023 MHz chip rate |
| | 3) | Channels | 20 | 16 |
| | **B)** | **Accuracy (Open Sky)** | | |
| | 1) | Position | 10 meters, 2D RMS. | 7 meters CEP (90%) horizontal, SA off. |
| | 2) | Time | 1 microsec synchronized to GPS time. | 1 microsec synchronized to GPS time. |
| | 3) | Velocity | | 0.1 meters/second |
| | **C)** | **Datum** | | |
| | 1) | Default | WGS-84. | WGS-84. |
| | 2) | Other | Support different datum by request. | Support different datum by request. |
| | **D)** | **Acquisition Rate (Open sky, stationary requirements)** | | |
| | 1) | Reacquisition | 0.1 sec., average. | 0.1 sec., average. |
| | 2) | Hot start | 1 sec., average. | 10 sec, average |
| | 3) | Warm start | 38 sec., average. | 38 sec, average |
| | 4) | Cold start | 42 sec., average. | 45 sec, average |
| | 5) | Snap start | | 2 sec, average |
| | **E)** | **Dynamic Conditions** | | |
| | 1) | Altitude | 18,000 meters (<60,000 feet) Max | 18,000 meters (60,000 feet) max |
| | 2) | Velocity | 736 m/s (<1,000 knots) max | 515 m/s (1000 knots) max |
| | 3) | Acceleration | 4 G, max | 4g, max |
| | 4) | Jerk | 20 meters/second, max | 20 meters/second, max |
| | **F)** | **RF interface** | | |
| | 1) | RF interface | Minimum signal tracked: -159dBm | |
| **2.** | | **GSM Modem Specifications :** | | |
| | 1) | Power Supply | Power supply Single supply voltage 3.4V – 4.5V<br>Power saving Typical power consumption in SLEEP mode to 3mA | |
| | 2) | Frequency bands | Tri-band: EGSM 900, DCS 1800, PCS 1900 or<br>Tri-band: EGSM 850, DCS 1800, PCS 1900<br>Compliant to GSM Phase 2/2+<br>GSM class Small MS | |

| | | | |
|---|---|---|---|
| | 3) | Class | Transmit power Class 4 (2W) at EGSM900<br>Class 1 (1W) at DCS1800 and PCS 1900<br>GPRS connectivity |
| | 4) | Temp. range | Operating temp. : -25°C to +70°C<br>Storage temp. : -40°C to +80°C |
| **3.** | | **Electrical Characteristics :** | |
| | 1) | Input Voltage | +9~37 Volt DC regulated / 2A-MAX (GSM Transmit) |
| | 2) | Power Consumption | 12 Volt – 100~320 mA (GPS On Line, GSM/GPRS On Line)<br>12 Volt – 60 mA (GPS on line, GSM standby)<br>12 Volt – <20 mA (GPS in Power Down Mode, GSM Standby) |
| | 3) | Backup Power | Nickel Metal Hydride Battery – 700 mA |
| | 4) | Memory Backup | Flash Memory – Data retention – 200 Years.<br>64 Kbyte (64000 * 8 Bits data) |
| **4.** | | **Case Environmental Characteristics :** | |
| | 1) | Op. Temp. | -25°C to +70°C (board temperature) |
| | 2) | Output | 4 digital outputs (200mA max) |
| | 3) | Digital Inputs | 5 |
| | 4) | Analog Inputs | 1 |
| | 5) | RJ Ports | a) 1 RJ11 port for serial RS232 (low speed 9600 Baud) and Direct GPS output RS232 (4800 or 9600 Baud – depending on GPS module) |
| **5.** | | **Physical Characteristics :** | |
| | 1) | Dimension | 95mm * 77mm * 30mm |
| | 2) | Weight | 220 g |
| | 3) | Case | Aluminum case |
| | | | |

## 4. FLEET DESCRIPTION

The total number of vehicle that we were offered to install Gps tracking devices is 500 and the vehicles are located all over the country in different towns. Below is a breakdown of how they are grouped as per towns.

| **Town** | **Number of Vehicles** |
|---|---|
| Nairobi | *230* |
| Malindi | *7* |
| Mombasa | *49* |
| Ukunda | *8* |
| Voi | *6* |
| Meru | *15* |

| | |
|---|---|
| Nanyuki | *4* |
| Thika | *30* |
| Embu | *16* |
| Isiolo | *2* |
| Kamburu | *6* |
| Kerugoya | *2* |
| Nyeri | *33* |
| Kisumu/Kakamega/Kericho/Bungoma | *53* |
| Eldoret/Kitale | *19* |
| Naivasha/Nakuru/Molo | *20* |
| ***Total*** | ***500*** |

The fleet is composed of the following models of vehicles

- Land Cruisers
- Nissan UD
- Toyota Hilux
- Isuzu TFR30
- Isuzu 4.3
- Ford Ranger
- Mitsubishi Fuso
- Toyota Hiace
- Daihatsu Terios J210
- Nissan Sahara
- Mini Bus

KPLC has different departments and vehicles are allocated as per department/functions which the vehicles are used for.

## 5. CUSTOMISATION PROGRAMME

The following are steps involve in the GPS tracking system

- Device/hardware preparation and testing

Here the tracking device is connected to a computer using com port, Firmware (Device operating system) together with configuration/settings are uploaded into the device. Devices are also given Identification tags for inventory purposes, all are well documented.

- Device installation

Binary Computers has big number of Technicians, Each of them is capable of working independently, and this enabled the installation of 500 units to take shorter duration of time. Since KPLC fleet is scattered country wide, Each Technician was assigned to a specific region; this enabled the installation to run simultaneously in all the regions country wide. Installation takes approximately 40 minutes to 1 hour depending on the type of vehicle. The tracking devices are hidden into the dashboard where they are not easily accessible.
After the installation our technicians fill a completion form with the relevant details;

- Device registration into server.

At the end of each day, our technicians submit their details of all the vehicles installed and then vehicle are registered into the server according to the regions they belong to.

- How the system works

To access the system you need a

1. PC/laptop with internet connection
2. Google earth application
3. Tracking website
4. Login details

- System snapshots

1. Dashboard login screen
2. Start stop report
3. Speed violation report
4. Fleet summary report
5. Detailed activity report.

**1. Dashboard Login Screen**


## 2. Start Stop Report


The start-stop report gives detailed information about vehicle Start time and Stop time. It also gives details about max speed through which vehicle has travelled during the journey.

This gives detailed information about the vehicle's start time and stop time.

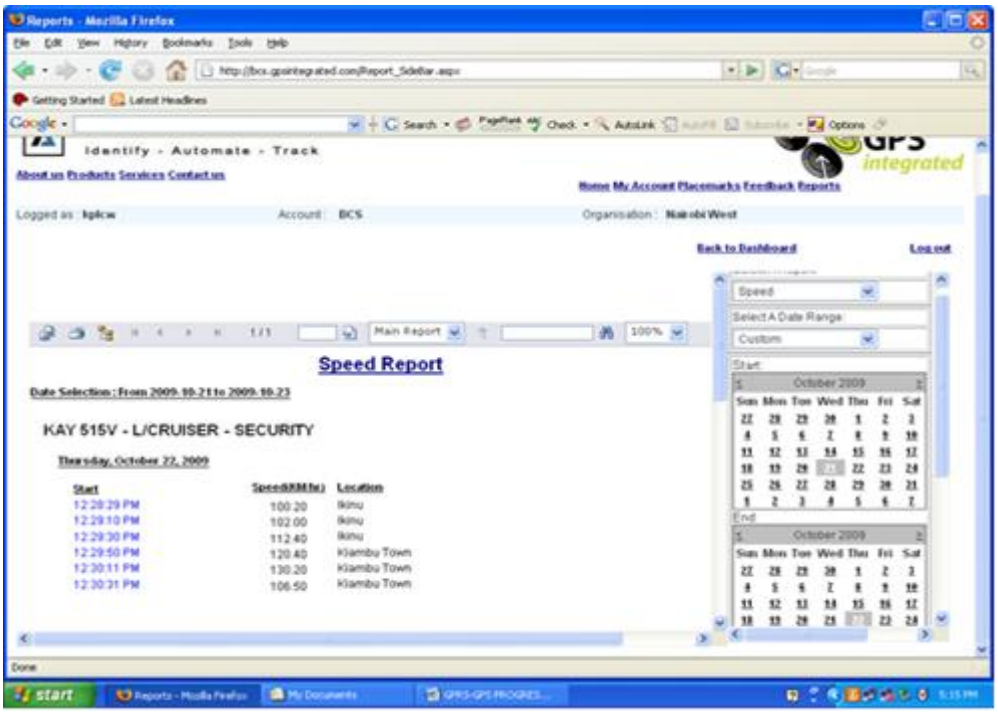
It also gives details about maximum speed through which the vehicle has travelled during the journey.

The start times and stop times indicated in blue colour also serves as a link, upon which when selected (mouse clicked), will move the user to Google map, where the exact location of the vehicle can be viewed or/and the route taken by the vehicle can also be replayed.

### 3. Speed Violation Report

This report gives detailed information about vehicle start time, speed of the vehicle at a particular time and its location details.

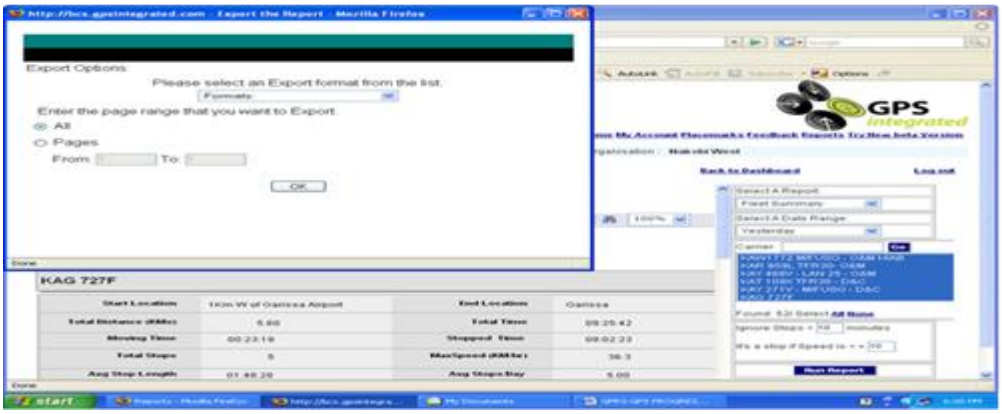
The speed violation is also shown on the dashboard as an alert with a red arm of the clock on the right hand side as shown on the second caption below:




In this report, the minimum speed the threshold of the maximum speed limit is selected at 100 kph. This is meant to cater for all the vehicle types as per the road traffic act (chapter 403) requirements in Kenya. .

### 4. Fleet Summary Report.

This report gives detailed information about vehicle start location, total distance covered by the vehicle, total stops taken, number of geofence In and Out, vehicle Max speed, number of emergency alerts. All the reports are usually exported to a suitable office format for further customization for a better understanding as shown for the fleet summary report below:




5. **Detailed Activity Report.**

This report gives vehicle wise and date wise report for vehicle start time, its location details, speed in kilometres per hour, and distance travelled by the vehicle. This report comes in handy for investigative purposes.


**<u>Project Commissioning Report presented by M/s Binary Computer System Ltd. After completion of the installation and activating the units.</u>**

## APPENDIX IV: Commissioning Report by M/s FTS Ltd.

FTS Africa Limited
Total Transit Control ™

### *KPLC GPS FLEET TRACKING PROJECT* COMMISSIONING REPORT – 2010


- Contents
- Introduction
- Implementation plan
- Project Updates
- System Support
- System Data & Integrity
- Benefits of the system
- Suggestions on System Usage
- Server Status - KPLC Mirror Server (http://kplc.ftsafrica.com)

- Some Technical Specs
- User Training

## 1. Introduction

FTS Africa Limited is a subsidiary company of PoweredByIT in South Africa which consists of a team of people that collectively have 25 years experience in the Information Technology (IT) industry. We consist of a 66% BEE partnership.

Our key areas of expertise include:

- Satellite tracking solutions
- Telemetry system development
- Website design
- All software development to client specification
- Value-add services for websites e.g. online ordering systems, data capture, conversion, analysis and presentation, etc
- Implementation of content management systems to enable self-maintenance of website content
- Website and email hosting

## 2. Implementation Plan for Supply, Install, and Commissioning of 700 GPS Fleet Tracking Units

**KPLC Tentative Implementation Schedule**

| | | Start | Finish |
|---|---|---|---|
| Contract Formalization | Completed | -- | Fri 10 July |
| Data Collection & Survey (Imp. & Del. of units 1st Batch) | 20 | Mon 13 July | Fri 7 Aug |
| Installation | 60 | Mon 10 Aug | Tue 3 Nov |
| Customization (report) | 15 | Wed 4 Nov | Tue 24 Nov |
| O&M Training | 8 | Wed 25 Nov | Mon 7 Dec |
| Testing & Commissioning | 12 | Tue 8 Dec | Wed 23 Dec |
| Post-implementation review | 4 | Thu 24 Dec | Wed 30 Dec |
| Project Close-out & Handover | 0 | Thu 31 Dec | Thu 31 Dec |

## 3. Project Update

**a) Installation & Firmware Customization**

- Motor vehicles fitted – 695
- Moving plant fitted – 5
- Driver staff nos. / vehicle relocations

**b) KPLC mirror Server done**

**c) Training**

- Done regionally upon completion of installation
- Transport Officers & Assistants
- N/Rift, Central Rift, West Kenya, Mt Kenya (N&S), Coast
- Nairobi Region @ Ruaraka on 23 March, 2010
- Training of other users by KPLC e.g. BBHs

**d) Customisation**

- Firmware upgrading exercise
- Reports e.g. speeding, OWH (Night/Wknd)
- KPLC visit to software provider in RSA

**e) Hand Over – Dec. 2010**

**f) 3 Year SLA – ongoing**

## 4. System Support

**a)Locally hosted servers:**

- Server status: CPU, Memory, Hard Disk
- Internet link status: Uptime & Latency, Capacity
- GPRS service status
- Software Upgrades & Maintenance

**b) Vehicle Monitoring & Reporting: some of the cases**

- Track & trace: KBG 461C, KBG 807C, KBJ 669U
- Misuse: KAY 922V, KAY 919V, KBB 832S, KAH 514F

- Investigations: KBG 585C, KBG 970C , KAR 313L
- Accidents: KBB 723S, KAG 868F, KBG 593C, KAT 227X

**c) Status:**

- Depot allocation updates
- Follow-up of inactive vehicles: repair work; user feedback
- Maintenance (SLA)
- "Fault" Troubleshooting: Weak Batteries, Alarm, Speed Governor
- Upgrades: Firmware – Cumulative Mileage, Home Depot,
- Scheduling (Nights, Weekends), Power Mgmt.

**d) Place marking: Points of Interest for KPLC**

- Offices, Depots & Yards
- Sub stations & major transformers
- Fuelling Stations
- Contracted Garages & Workshops
- Staff Quarters
- Major Landmarks
- User Input required: Long. / Lat.

**5. <u>System data & integrity</u>**

**a) Data protected against data loss or corruption due to simultaneous update**

- ACID (Atomic, Consistent, Isolated, and Durable)
- InnoDB storage engine with commit, rollback, and crash recovery capabilities.
- Data validation rules: monitor, control and safeguard info.
- Unit: Flash Memory – 250,000 logs & Backup Battery 24 – 72 hrs
- Servers: H/W RAID 1+0; RPS

**b)Monitoring of system health parameters**

- Automatic Daily Backups: local & remote; replication – KPLC Server.
- Redundant Links to Internet Gateways: Fiber & VSAT
- GPRS: Public & Private APNs
- Power Backup System : Inverter & Generator

## 6. Benefits of the system

### a) Dependent on usage

- Intranet Access enabled
- User friendly: Fast, Allocations, Vehicle Details (Type / Function), Operator Staff No.

### b) Tracking:

- Driver awareness ⇒ Discipline
- ⇓ Over speeding (159 kph); Speed governors
- ⇓ Misuse and Abuse ⇒ ⇓ maintenance costs; ⇑ Life
- (>15%; 9,000 km over 3 weekends in Oct. 2010)

### c) Reporting

- Investigation of Misconduct
- Accidents
- Fleet Utilisation ⇒ Accountability

## Usage requirements

### a) Functional Heads to monitor:

- Trips and identify Unauthorised Trips / routes
- Mileage tallying
- Over speeding
- Outside Working Hours Usage (Night time & Weekends)
- Idling
- Caution Drivers and report to Transport dept.

### b) TPT/Maintenance Staff:

- Report vehicle status to FTS
- Monitor repairs done by Contracted Garages
- Vehicle Annual Inspection Schedule

## Server Status

### a) KPLC Mirror Server Setup – March 2010

- Email: whitelist ftsafrica domain, allow attachments
- URL on FQDN: http://kplc.ftsafrica.com
- Access via Intranet & Internet
- Access to FTS Server maintained.
- Hourly Data replication from Master Servers @ FTS
- Users created & Fleet assigned.
- KPLC Network User Access Rights: Proxy, Internet, Server
- CRAM Upgrade: data size 5GB; heavy swapping
- Migration to KPLC GPRS Internet Link: Router, IPs33
- Format for data export to TMS

## 7. Technical Features & Specifications

### a) Application

- GPS based; SIRF Star III Chipset
- On-board Computer automatically monitors vehicle
- GPRS WAN comm. interactive (rx / tx) - Private APN
- Online Password Controlled Web based System – KPLC Mirror Server

### b)FMS & Vehicle Tracking Solutions

Our tracking system follows a unique model which enables the client to customise it to their specifications. Often the software provided with the hardware does not fulfil all the functionality required by the client. This leads to insufficient data being provided that not only decreases maximum efficiency for the fleet, but also causes costly running expenses.

With our system the client is able to take full control by administering the system themselves – no need for third party intervention. This greatly increases company security in protecting sensitive data and streamlines the running of the fleet by enabling company efficiency guidelines and rules to be enforced. Once customisation is complete powered by IT. will act in a support role to aid clients in training and any further customisations that may be needed at a later stage.

Some of the features of our tracking system:

- secure access requiring username and password authentication
- group and individual vehicle details views

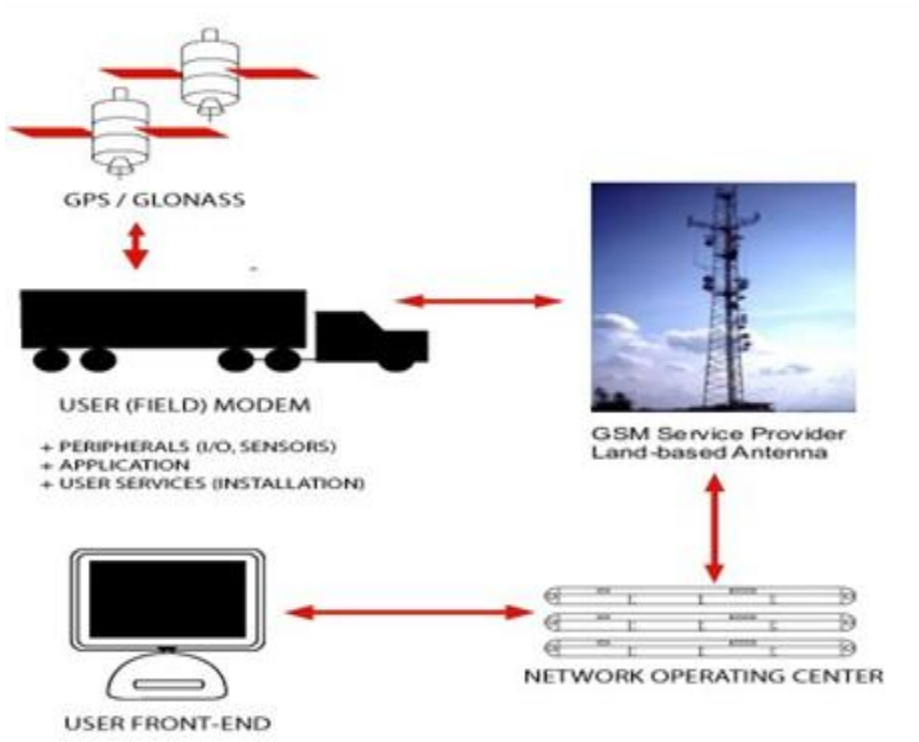
- group and individual positional plotting of vehicles utilising Google Earth or Mapping data
- track and trace - animated track trails
- server-side geofencing capability with ability to plot own geofencing areas
- alarm alert management via sms and email to specified alarm groups
- standard and customisable reporting - text-based or graphical graph views
- exception email reporting
- various setup options: control room LAN-based system, Web-based remote access system, standalone system, combination of these.

**c) Hardware Support**

The system currently offers full support for the PBIT-SAT Satellite unit and the PBIT-GSM SMS/GPRS unit. We are currently working to extend this support to other tracking hardware enabling clients not to be restricted in their hardware choice for various applications.

**d) Communication via GSM Technology**

This method makes use of the land-based antennas of the various GSM Service Providers to communicate data from the vehicle to the control centre. Once a vehicle moves out of the GSM coverage area, there is no way it can communicate its position and will be untraceable until it enters the coverage area again. For vehicles that do cross-border travelling, communication costs could prove to be high due to roaming charges.




## 8. Training

### a) Log in / Log Off (idle time out)

- System Requirements (Mozilla, JRE, Google Earth)
- FTS Server (http://tracking.ftsafrica.com) on Internet
- KPLC Server (http://kplc.ftsafrica.com) on Intranet
- Login Credentials: Co. Code: KPLC001; Time Zone: GMT+3

### b) Vehicle Views:

- List Group View: depot wise listing
- Detailed Individual View
- Graphical View: mapping options

### c) Current Data:

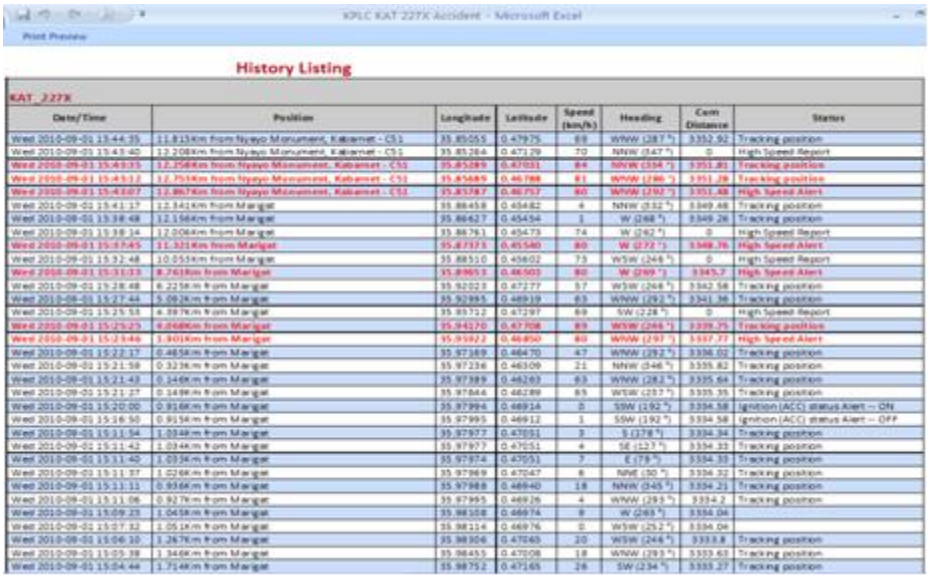
- Text : Location, Speed,
- Graphical – Digital & Google Maps, Google Earth
- Live Tracking (JRE)

### d) Historical Data

- Short (last 20 Points) :
- Text: Location, Speed, Mileage, Direction
- Graphical: Track Trails: Digital & Google Maps, Google Earth

## 9.<u>Standard System Generated Reports</u>

- History: Location, Speed & Filter, Direction, Mileage, Status

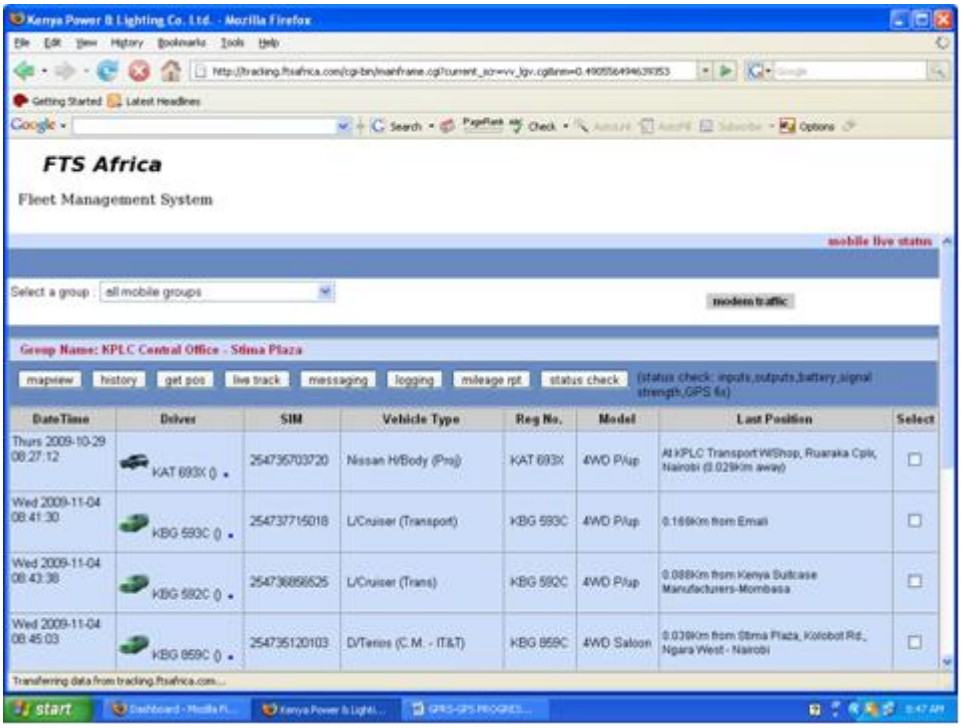


History Listing

KAT_227X

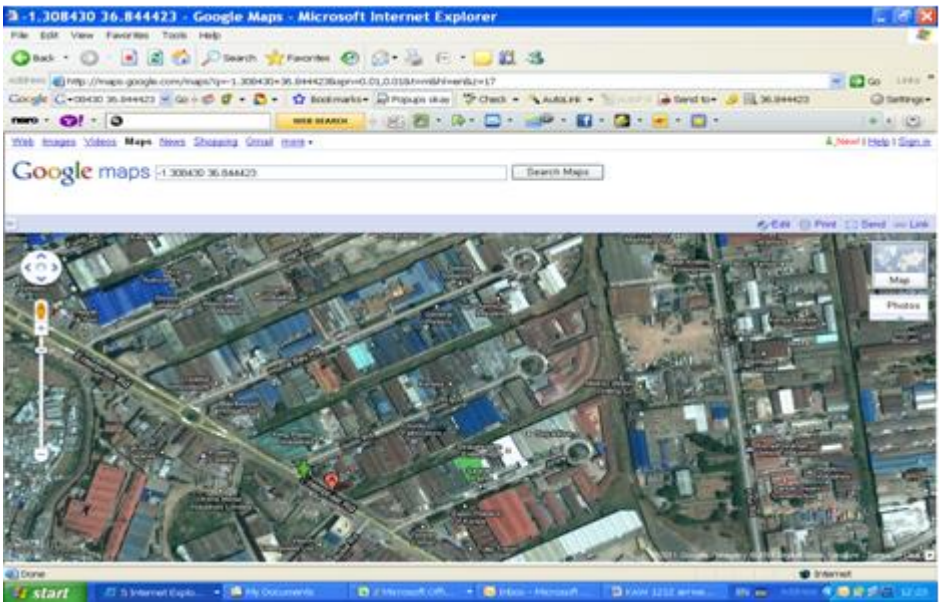
| Date/Time | Position | Longitude | Latitude | Speed (km/h) | Heading | Cum Distance | Status |
|---|---|---|---|---|---|---|---|
| Wed 2010-09-01 15:44:35 | 11.813Km from Nyayo Monument, Kakamet - C51 | 35.85055 | 0.47975 | 69 | WNW (287 °) | 3352.92 | Tracking position |
| Wed 2010-09-01 15:43:40 | 12.208Km from Nyayo Monument, Kakamet - C51 | 35.85284 | 0.47129 | 70 | NNW (347 °) | 0 | High Speed Report |
| Wed 2010-09-01 15:43:35 | 12.258Km from Nyayo Monument, Kakamet - C51 | 35.85289 | 0.47031 | 84 | NNW (354 °) | 3351.81 | Tracking position |
| Wed 2010-09-01 15:43:12 | 12.751Km from Nyayo Monument, Kakamet - C51 | 35.85689 | 0.46788 | 81 | WNW (286 °) | 3351.28 | Tracking position |
| Wed 2010-09-01 15:43:07 | 12.867Km from Nyayo Monument, Kakamet - C51 | 35.85787 | 0.46757 | 80 | WNW (292 °) | 3351.48 | High Speed Alert |
| Wed 2010-09-01 15:41:17 | 12.341Km from Mariget | 35.88458 | 0.45482 | 4 | NNW (332 °) | 3349.48 | Tracking position |
| Wed 2010-09-01 15:38:48 | 12.156Km from Mariget | 35.88627 | 0.45454 | 1 | W (248 °) | 3349.26 | Tracking position |
| Wed 2010-09-01 15:38:14 | 12.006Km from Mariget | 35.88761 | 0.45473 | 74 | W (242 °) | 0 | High Speed Report |
| Wed 2010-09-01 15:37:45 | 11.321Km from Mariget | 35.87373 | 0.45540 | 80 | W (272 °) | 3348.76 | High Speed Alert |
| Wed 2010-09-01 15:32:48 | 10.055Km from Mariget | 35.88510 | 0.45602 | 73 | WSW (248 °) | 0 | High Speed Report |
| Wed 2010-09-01 15:31:33 | 8.761Km from Mariget | 35.89653 | 0.46503 | 80 | W (269 °) | 3345.7 | High Speed Alert |
| Wed 2010-09-01 15:28:48 | 6.225Km from Mariget | 35.92023 | 0.47277 | 57 | WSW (248 °) | 3342.58 | Tracking position |
| Wed 2010-09-01 15:27:44 | 5.092Km from Mariget | 35.92995 | 0.48919 | 63 | WNW (292 °) | 3341.38 | Tracking position |
| Wed 2010-09-01 15:25:53 | 4.897Km from Mariget | 35.93712 | 0.47297 | 69 | SW (228 °) | 0 | High Speed Report |
| Wed 2010-09-01 15:25:25 | 4.048Km from Mariget | 35.94170 | 0.47708 | 89 | WSW (248 °) | 3339.75 | Tracking position |
| Wed 2010-09-01 15:23:46 | 3.901Km from Mariget | 35.95922 | 0.46850 | 80 | WNW (297 °) | 3337.77 | High Speed Alert |
| Wed 2010-09-01 15:22:17 | 0.465Km from Mariget | 35.97169 | 0.46470 | 47 | WNW (292 °) | 3336.02 | Tracking position |
| Wed 2010-09-01 15:21:59 | 0.323Km from Mariget | 35.97236 | 0.46509 | 21 | NNW (346 °) | 3335.82 | Tracking position |
| Wed 2010-09-01 15:21:43 | 0.146Km from Mariget | 35.97389 | 0.46263 | 83 | WNW (283 °) | 3335.64 | Tracking position |
| Wed 2010-09-01 15:21:27 | 0.148Km from Mariget | 35.97844 | 0.46289 | 85 | WSW (257 °) | 3335.35 | Tracking position |
| Wed 2010-09-01 15:20:00 | 0.816Km from Mariget | 35.97994 | 0.46914 | 0 | SSW (192 °) | 3334.58 | Ignition (ACC) status Alert -- ON |
| Wed 2010-09-01 15:16:50 | 0.915Km from Mariget | 35.97995 | 0.46912 | 1 | SSW (192 °) | 3334.58 | Ignition (ACC) status Alert -- OFF |
| Wed 2010-09-01 15:11:54 | 1.034Km from Mariget | 35.97977 | 0.47051 | 3 | S (178 °) | 3334.34 | Tracking position |
| Wed 2010-09-01 15:11:42 | 1.034Km from Mariget | 35.97977 | 0.47051 | 4 | SE (127 °) | 3334.33 | Tracking position |
| Wed 2010-09-01 15:11:40 | 1.033Km from Mariget | 35.97974 | 0.47051 | 7 | E (78 °) | 3334.33 | Tracking position |
| Wed 2010-09-01 15:11:37 | 1.026Km from Mariget | 35.97969 | 0.47047 | 8 | NNE (30 °) | 3334.32 | Tracking position |
| Wed 2010-09-01 15:11:11 | 0.936Km from Mariget | 35.97988 | 0.46940 | 18 | NNW (345 °) | 3334.21 | Tracking position |
| Wed 2010-09-01 15:11:06 | 0.927Km from Mariget | 35.97995 | 0.46926 | 4 | WNW (293 °) | 3334.2 | Tracking position |
| Wed 2010-09-01 15:09:23 | 1.045Km from Mariget | 35.98108 | 0.46974 | 8 | W (263 °) | 3334.04 | |
| Wed 2010-09-01 15:07:32 | 1.051Km from Mariget | 35.98114 | 0.46976 | 0 | WSW (252 °) | 3334.04 | |
| Wed 2010-09-01 15:06:10 | 1.267Km from Mariget | 35.98306 | 0.47065 | 20 | WSW (248 °) | 3333.8 | Tracking position |
| Wed 2010-09-01 15:05:38 | 1.346Km from Mariget | 35.98455 | 0.47008 | 18 | WNW (293 °) | 3333.63 | Tracking position |
| Wed 2010-09-01 15:04:44 | 1.714Km from Mariget | 35.98752 | 0.47165 | 26 | SW (234 °) | 3333.27 | Tracking position |

- Drive Time: Start/Stop Duration, Mileage/Day Speed, Max. Speed

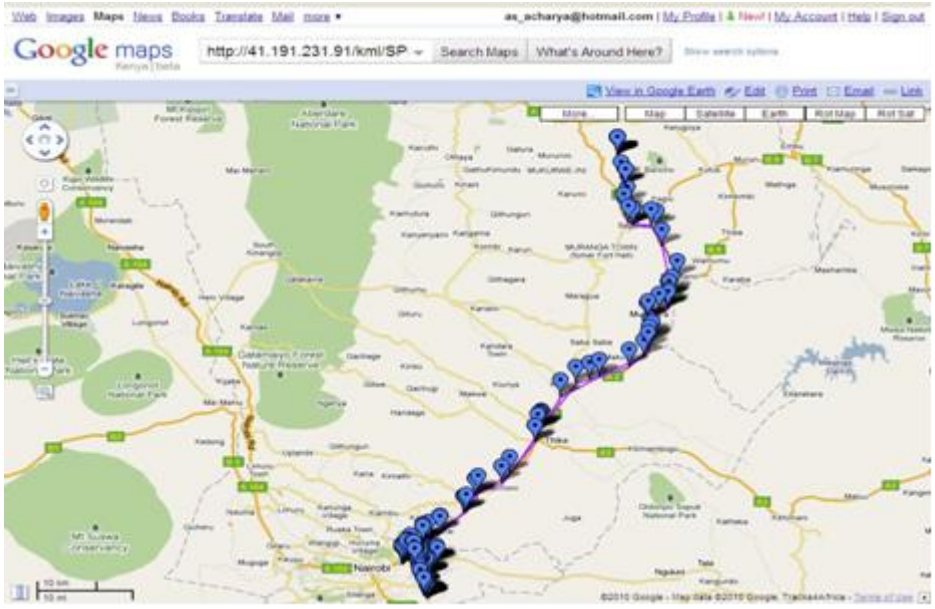



a) Idle Time: Stop Duration

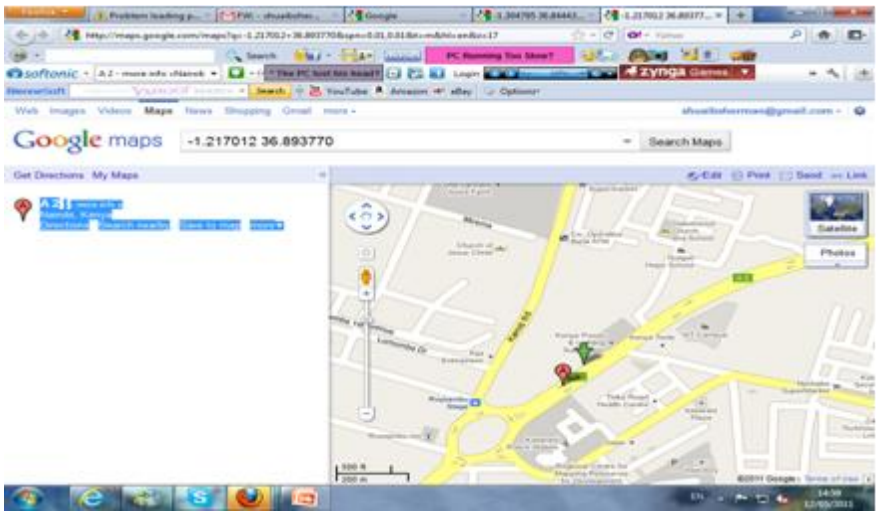
Green arrow shows the location (junction of Isiolo Rd and Enterprise Rd) where KAW 121Z stopped for 1 hr and 4 minutes before to Isiolo Rd depot. Stopped from 06.4am to 07.9 am 29.4.11



b) Custom: User selectable fields




c) Investigation Report




The project implementation is now deemed complete and the next process of the Service Level Agreement (SLA) is requested to commence.

**Signed completed by M/s FTS Africa Limited**

## APPENDIX V: Memo on GPS Fleet Management System Implementation in KPLC

KPLC

*From:* **MANAGING DIRECTOR & CHIEF EXECUTIVE OFFICER**

*To:* **ALL STAFF**

*Our Ref:* ***KPLC1/9BB/2/10/JNM/mwk***

20th August, 2008

**IMPLEMENTATION OF THE GPS FLEET MANAGEMENT SYSTEM**

The company operates one of the largest fleet in the Country comprising of 1580 Units, 971 Motor vehicles, 515 Motor cycles and 94 Plant / Equipment. To operate the fleet, the Company has 629 designated drivers and 951 non-designated drivers / Motor cycle riders. Annual recurrent expenditure is about 570 million. In addition to the above fleet, the company has financed 1278 cars under the Private Scheme operated by staff. This scheme has an annual recurrent expenditure of Ksh. 464 Million.

The Company has continued to modernize the fleet to ensure high availability and reliability in order to enhance service delivery to our customers. We believe in the use of technology to improve the efficiency of our operations and in this regard, the Company is currently implementing a GPS (Global Positioning System) for the effective management, monitoring and control of the fleet. The system comprises of on board computers installed in each vehicle, which communicate with computers making it possible to obtain various reports automatically. For example, reports available include vehicle location, speed, idle time, fueling etc.

Once the system is installed, benefits will be realized in higher operational efficiency, improved driving behaviour, reduced accident rate, lower operation & maintenance costs, enhanced security of vehicles and improved customer service. The Fleet Management System will therefore benefit the Company tremendously.

I urge all of you, to fully support the implementation of the GPS system in all aspects. I further take this opportunity to request all fleet operators to utilize the fleet effectively in serving our customers and only for legitimate Company business. Additionally, all operators should use the units according to the laid down standards, rules and regulations in order to contribute towards improved safety and efficiency of our operations.

**Eng. JOSEPH NJOROGE**
**MANAGING DIRECTOR & CHIEF EXECUTIVE OFFICER**

THE KENYA POWER & LIGHTING Co. LTD. RECEIVED 21 AUG 2008 MANAGING DIRECTOR

## APPENDIX VI: Random Number Generator

Use the Random Number Generator to create a list of random numbers, based on your specifications. The numbers you generate appear in the Random Number Table.

For help in using the Random Number Generator, read the Frequently-Asked Questions or review the Sample Problems.

- Enter a value in each of the first three text boxes.
- Indicate whether duplicate entries are allowed in the table.
- Click the Calculate button to create a table of random numbers.

Note: The seed value is optional. Leave it blank to generate a new set of numbers. Use it to repeat a previously-generated set of numbers.

| | |
|---|---|
| How many random numbers? | 10 |
| Minimum value | 01 |
| Maximum value | 10 |
| Allow duplicate entries | False |
| Seed (optional) | |

Calculate

Random Number Table generated on 8/6/2012.

| 10 Random Numbers |
|---|
| 08 01 07 09 04 10 03 06 02 05 |

Specs: This table of 10 random numbers was produced according to the following specifications: Numbers were randomly selected from within the range of 1 to 10. Duplicate numbers were not allowed.

## APPENDIX VII: Certification of language edit


# Alexa Barnby

*Language Specialist*

Editing, copywriting, indexing, formatting, translation

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6 June 2013

To whom it may concern

This is to certify that I, Alexa Kirsten Barnby, ID No. 5106090097080, a language practitioner registered with SATI and in the fulltime employ of the Language Services Directorate of the University of South Africa, have edited Edward Waiyaki's masters dissertation entitled "Leveraging technology for business fleet applications: a case study of a fleet management system implemented in Kenya Power & Lighting Company Limited".

The onus is, however, on the author to effect the corrections and changes suggested.

Signed: