FACTORS AFFECTING REVENUE COLLECTION ON PETROLEUM PRODUCTS IN NAIROBI COUNTY KENYA

(A CASE OF TRANSIT, YARDS AND PETROL STATIONS)

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF ECONOMICS,ACCOUNTING AND FINANCE,SCHOOL OF BUSINESS IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF POSTGRADUATE DIPLOMA IN CUSTOMS ADMINSTRATION AT JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY.

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DECLARATION

Declaration by the Student:

This research study is my original work and has not been presented to any other examination body. No part of this research should be reproduced without my consent or that of Kenya School of Revenue Administration

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Declaration by the Supervisor:

This research has been submitted with my approval as Kenya School of Revenue AdministrationSupervisor.

Sign: ______________________________Date: _______________________

Cyrus Mutuku

DEDICATION

I wish to dedicate this work to the almighty God for seeing me throughout my studies and to my family for the support and understanding accorded to me.

ACKNOWLEDGEMENT

This acknowledgement goes to Almighty God for enabling me pursue my studies at Kenya School of Revenue Administration with humility. .

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ABBREVIATIONS AND ACRONYMS

HC Hydrocarbon

HPLC High Pressure Liquid Chromatography

KEBS Kenya bureau of standards

KPC Kenya Pipeline Company

MIBK Methyl Isobutyl Ketone

MON Motor Octane Number

MTBEMethyl Tertiary Butyl Ether

NOx Oxides of Nitrogen

PAHs Polyaromatic Hydrocarbons

ASTM: American Society for Testing Materials

KRA: Kenya Revenue Authority

ERC: Energy Regulatory Commission

GC/MS: Gas Chromatography Mass Spectrometry

ABSTRACT

In Kenya expensive petroleum products are adulterated deliberately by adding a component of cheaper low quality product with similar physical and chemical properties. This in turn will result in low quality petrol and diesel products leading to losses in revenue collection. Adulteration of automotive gas oil and petrol is widespread in Kenya. It takes toll both in air pollution and losses in tax revenue from petroleum products Increase in prices of fuels and fuel intermediates is often cited as a cause for adulteration. Adulterated fuels deprive the consumers of assured quality fuels thus leads to increased tail pipe emissions of hydrocarbons (HCs), carbon monoxide (CO), oxides of nitrogen (NOX), particulate matter (PM) and emissions of air toxins such as benzene, methylbenzene and polyromantic hydrocarbons which are well known carcinogenic compounds. This study is aim to investigate the effect adulteration of gasoline and gas oil adulteration on revenue collection in Kenya. The study was guided by the following specific objectives:- to determine the effect of blending of kerosene into petrol on revenue collection in Kenya, to analyze the effect of diversion of export fuel on revenue collection in Kenya and to assess effect of dumping of petroleum products on revenue collection in Kenya.This study targeted whether regular gasoline and petrol sold in petrol stations in Kenya mostly within Nairobi are within the Standard specification as set out by ERC.The study considered taking samples from various petrol stations within Nairobi and the Neighboring counties and subject the samples to laboratory analysis by GC/MS analytical method. In addition data collected from PMU to assess the revenue implication of petroleum product adulteration in Kenya.Thestudy foundthatBlending kerosene into petrol, blending kerosene into diesel and blending amount of gasoline into gasoline automotive were significantlyinfluences revenue collection.Basedonstudyfinding,thisstudyrecommendsthere is need for Kenya Revenue Authority to put mechanisms in order to prevent adulteration of petrol, diesel and gasoline to enhance revenue collection,

CHAPTER ONE

INTRODUCTION

1.1Background of the study

This study is about investigating the levels of gasoline and gas oil adulteration and and its impact on revenue collection in Kenya. This chapter will deal with the background of the study, statement of the problem, purpose of the study research objectives and research questions.

1.1.1Global perspective

As early as 14th century, some surface deposits were being distilled to obtain lubricants and medicinal products, but the real exploitation of crude oil did not begin until the 19th century (Manning et al., 1991). (Speight, 2002), reported that in 1852 Canadian physician and geologist Abraham Gessner obtained a patent for producing clean-burning, affordable lamp fuel called kerosene from crude oil. In 1855 an American chemist, Benjamin Silliman, published a report indicating the wide range of useful products that could be derived through the distillation of crude oil (Manning et al., 1991). The petroleum industry began 11 with the successful drilling of the first commercial oil well in 1859 by Colonel Edwin L. Drake who drilled an oil well near Oil Creek, Pennsylvania (Manning et al., 1991). Drake’s success marked the beginning of the rapid growth of the modern petroleum industry (Manning et al., 1991). This was followed by the opening of the first refinery two years later to process the crude into kerosene (Potter, 1987). The original requirement was to produce kerosene as a cheaper and better source of light than whale oil. The first refinery, opened in 1861, produced kerosene by simple atmospheric distillation. Its by-products included tar and naphtha (Potter, 1987). It was soon discovered that high-quality lubricating oils could be produced by distilling petroleum under vacuum. However, for the next 30 years kerosene was the product consumers wanted. Two significant events changed this situation which was the invention of the electric light which decreased the demand for kerosene and the invention and development of the internal combustion engine which created a demand for diesel fuel and gasoline (Kovarik et al., 2005). Since 19th century, when automotives were invented, diesel and gasoline have been used as the primary source of energy for the vehicles though many alternate fuels like compressed natural gas, Liquefied Petroleum Gas, methanol, ethanol, dimethylether and biodiesel fuel are emerging in the market (Dutta, 2003). Petroleum refining has evolved continuously in response to changing consumer demand for better and different products. Automobile engines demand for larger amounts of petroleum led to the discovery of better processes in the late 1930's and early 1940's in order to produce higher-octane gasoline with better antiknock characteristics that were required by higher-compression gasoline engines (Kovarik et al., 2005). Following the Second World War, various reforming processes improved gasoline 12 quality, yield and produced higher-quality products. (Kovarik et al., 2005). Present-day refineries produce a variety of products including many required as feedstock for the petrochemical industry (Dutta, 2003). A variety of products from the refineries are being used by a few people in the society for selfish interests hence tampering with the quality of the fuels. Cases of places where this practice has been carried out are Kenya where Kenya broadcasting cooperation (KBC Business, 2006) published a document on adulteration of fuel highlighting on the increase of cases of adulteration of petroleum products since the liberalization of the petroleum subsector in 1994. The Government of Kenya, according to this document was concerned that adulteration of either gasoline or diesel by kerosene was wreaking automobile engines apart from denying it the much needed revenue. In Tanzania adulteration of fuels has been reported to be increasing to alarming proportions. The problem is mostly due to mixing of petrol or diesel with kerosene (Charles, 2007). In New Zealand, unscrupulous firms exceeded “acceptable” limits when they added too much of the off specification toluene to gasoline as a cheap source of octane and caused many car fires (Chang, 2001). The centre for science and environment (CSE, 2002) reported that in south Asia adulteration of automotive gasoline and diesel fuels was wide spread. A report prepared by CSE on gasoline and adulteration in Delhi has provided a good overview of the scope of the problem and some technical and economic data on the subject. In Uttar Pradesh in the city of Meerut in India, an authorized transport company was caught with adulterated stock. This transport agency had the authority to transport both 13 petrol and diesel to retail outlets and solvents for industrial use. The agency was supposedly using its workplace for adulterating diesel with kerosene (Dutta, 2003).

The failure of a fuel to meet any of its specifications is referred to as a nonconformity, which means the fuel is not fit for use. Nonconformity is not always due to adulteration, which is the deliberate and illegal addition of lower-cost substances to a fuel, usually with tax evasion, all with the purpose of increasing the profit margin by illicit means, resulting in reduced tax revenues, unfair competition, harm to the environment, and increased wear and tear of vehicle engines]. In fact, a fuel may be adulterated and yet stay within its specifications, in which case the only detrimental effect is on tax revenues . In fact, a fuel may be adulterated and yet stay within its specifications, in which case the only detrimental effect is on tax revenues [6]. It is a challenge to detect the adulteration of fuels because adulterants usually include compounds that are already present in the fuels themselves

Crude oil is a complex mixture containing many different hydrocarbons that vary in appearance and composition from one oil field to another (Schremp, 2005). It is found in large quantities below the surface of Earth and is used as a fuel and as a raw material in the chemical industry (Schremp, 2005). Crude oil is formed under Earth's surface by the decomposition of marine organisms. The remains of tiny organisms that live in the sea and those of land are carried down to the sea by rivers (Cedre, 2006). Plants that grow on the ocean bottoms are immersed by fine sands and silts that settle to the bottom in sea basins. As additional deposits pile up, the pressure and temperature rises enormously (Manning et al., 1991). The mud and sand harden into shale and sandstone, carbonate precipitates and skeletal shells harden into limestone. The remains of the dead organisms are transformed into crude oil and natural gas (Speight, 2002). The deposits which are rich in organic materials become the source rocks for the generation of crude oil. This process began millions of years ago and it continues to this day. Crude oils are generally classified as paraffinic, naphthenic, or aromatic, based on the predominant proportion of similar hydrocarbon molecules (Cranmore et al., 2000). 1.1.1 Refinery operations Petroleum refining is the process of separating the many compounds present in crude petroleum (Potter, 1987). The basic refinery operations include; distillation process, 2 thermal cracking, catalytic process, treatment, formulation and blending (OTM, 2003). The major refinery products are;

1.1.1 Gasoline

Gasoline is a mixture of hundreds of hydrocarbons many of which have different boiling points. Gasoline boils and distills over a range of temperatures, unlike a pure compound, water, for instance, that boils at a single temperature. Gasoline boils between 30°C and 202°C for one to obtain a distillation curve (Speight, 2002). A gasoline distillation curve is the set of increasing temperatures at which it evaporates for a fixed series of increasing volume percentages 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95 and 98.5-99% as the final endpoint (Al-Ghouti et al., 2008). Gasoline also referred to as motor spirit premium contains many substances, such as antiknock agents, antioxidants, metal deactivators, antirust additives, anti-icing agents, preignition additives, upper cylinder lubricants and dyes (ASTM., 1983). The major hydrocarbon components in gasoline include alkanes, isoalkanes, cycloalkanes, alkenes and aromatics (MacFarland et al., 1984). Commercial gasoline contains mainly C5 to C8 paraffins (60 to 80%), with much smaller quantities of aromatic compounds (14 to 33%) and olefins (6.4 to 13%) (ASTM., 1983). The density of gasoline is reported to be about 0.700-0.740 Kg/l at 20oC, and its vapour pressure is estimated to be 93.3 kPa at 25°C (MacFarland et al., 1984). Gasoline is highly flammable with a flash point of -45°C and minimum and maximum explosion limits in air of 1.3 and 6% by volume respectively (Cesars., 1984). The important qualities for gasoline are motor octane number (MON), 3 research octane number (RON), volatility (starting and vapor lock), and vapor pressure (environmental control) and copper corrosion test. Additives such as ethyl tertiary butyl ether (ETBE), methyl tertiary butyl ether (MTBE), tertiary amyl methyl ether (TAME), and other oxygenates improve gasoline octane ratings as well as enhance performance, provide protection against oxidation and rust formation and reduce carbon monoxide emissions (Larissa et al., 2005). Gasoline is classified as a spirit and finds its most important use as a fuel for internal combustion engines, principally automobile. It has also been used as a solvent for rubber adhesives and as a finishing agent for artificial leathers (Jeltes et al., 1967).

1.1.2 Kerosene

Kerosene is the name for the lighter end of a group of petroleum streams known as the middle distillates (Klimisch et al., 1997). Kerosene is known as dual purpose kerosene which may be obtained either from the distillation of crude oil under atmospheric pressure known as the straight-run kerosene or from catalytic, thermal or steam cracking of heavier petroleum streams which is referred to as cracked kerosene (Klimisch et al., 1997). Kerosene is further treated by a variety of processes including hydrogenation to remove or reduce the level of sulfur, nitrogen or olefinic materials. The precise composition of kerosene will depend on the crude oil from which it was derived and on the refinery processes used for its production (API, 1997). Irrespective of this, kerosene consists predominantly of C9 to C16 hydrocarbons and boils in the range 145°C to 300°C (API, 1997). The density of dual purpose kerosene is reported to be about 0.760-0.800Kg/l at 4 20oC. The major components of dual purpose kerosene are branched and straight chain paraffins and naphthenes and these normally account for 70% of the material. Aromatic hydrocarbon, mainly alkyl benzenes and alkylnaphthalenes do not normally exceed 25 % of kerosene streams. Olefins do not normally account for more than 5% of the kerosene (API, 1997). Kerosene finds considerable use as a jet fuel and as a domestic heating fuel (Klimisch et al., 1997). When used as an ingredient in jet fuel, some of the critical qualities such as freeze point, flash point, and smoke point are monitored (OTM, 2003). Commercial jet fuel has a boiling point range of about 190°C-273.5°C, and military jet fuel 54.4°C-287.8°C. Kerosene, with less-critical specifications, is used for lighting, heating and as a solvent (OTM, 2003).

1.1.3 Diesel

Diesel is known as automotive gas oil, is produced from petroleum, and is usually referred to as petro diesel to distinguish it from diesel obtained from other sources such as biodiesel (Cedre, 2006). Automotive gas oil is classified under distillates and is a hydrocarbon mixture obtained from fractional distillation of crude oil between 250°C-350°C. Diesel has a density of about 0.820-0.850 kg/l (Cedre, 2006). Petroleum-derived diesel is composed of about 75% saturated hydrocarbons which are primarily paraffins and 25% aromatic hydrocarbons which includes naphthalenes and alkylbenzenes (Cooke et al., 1985). The average chemical formula for common diesel fuel is C12H26, ranging from approximately C10H22 to C15H32 (Cooke et al., 1985). The desirable qualities required for diesel fuels 5 include controlled flash and pour points, clean burning, no deposit formation in storage tanks, and a proper diesel fuel cetane rating for good starting and combustion. Other types of diesel fuels known are synthetic diesel obtained from wood, hemp, straw, corn, garbage, food scraps, and sewage-sludge through the Fischer-Tropsch process. Synthetic diesel may also be produced out of natural gas in the gas-to-liquid process or out of coal in the coal-toliquid process. Such synthetic diesel has 30% less particulate emissions than conventional diesel. Biodiesel is another example obtained from vegetable oil or animal fats. Biodiesel is a non-fossil fuel alternative to petro diesel. Diesel fuel is important as a transportation fuel because it offers a wide range of performance, efficiency and safety features. Diesel fuel contains between 18 and 30 percent more energy per gallon than gasoline. Diesel technology also offers a greater power density than other fuels. In agriculture, diesel fuels are used in more than two-thirds of all farm equipment in the Kenya, because diesel engines can perform demanding work. In addition, it is the most widely used fuel for public buses and school buses. Diesel fuels are however not used for private vehicles due to high costs required for the maintenance of the engines. 1.1.1.4 Other Refinery Products Other refinery products are residual fuels, asphaltines, resins, solvents, petrochemicals and lubricants. 1.2 Adulteration Adulteration can be defined as the introduction of a foreign substance into gasoline or diesel, illegally or unauthorized with the result that the product does not conform to the 6 requirements and specifications of the product (OTM, 2003). The foreign substances are called adulterants which when introduced alter and degrade the quality of the fuels (Kulathunga et al., 2004).

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Analytical methods for monitoring gasoline and diesel adulteration were the target of a recent review , emphasizing the determination of their different properties, such as density, distillation curve, octane rating, vapor pressure, etc., using physicochemical methods and chromatographic and spectroscopic techniques. Nondestructive analytical methods for identifying off-spec levels of biodiesel in diesel-biodiesel blends and adulteration of the blend have also been covered in a recent review [20], focusing on first-order multivariate calibration models.

Diesel is combusted in a compressionignition engine where the fuel is atomized and sprayed into the hot compressed air. It has a boiling range of 180-370 °C and contains 10-19 carbon atoms in the form of paraffins, naphthenes, and aromatics in different proportions .There are several processes (distillation, catalytic cracking, hydro-cracking etc.) through which diesel fuel is obtained from the crude oil. There are several processes (distillation, catalytic cracking, hydro-cracking etc.) through which diesel fuel is obtained from the crude oil. The adulteration of automotive fuels is prevalent in the different parts of the developing world including India and has erupted as a result of dishonest profit-making practices, negligence on the part of regulators, limited resources for its verification and weak policies to curb it. In the case of diesel, adulteration often leads to the non-conformance of its regulatory requirements, thereby implying degradation in its quality which eventually leads to the economic losses, increased tailpipe emissions, deterioration of engine performance and wear of engine parts.

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The existing international diesel oil purity measurement standards such as ASTM D1298, ASTM D4052 (density), ASTM D86 (distillation), ASTM D445 (kinematic viscosity), and EN 14078 (mid-Infrared spectrometry), ASTM D4808 (hydrogen content) are laboratory-based measurement methods that cannot be applied for rapid detection of variability and adulteration of diesel oils in field conditions . Moreover, the sensitivity of refractive index measurements which are also applied for fuel purity measurements fail for the case of diesel oil-kerosene mixtures, because of chemical interactions [1,4], cannot be utilized for rapid screening of adulteration and smuggling.

Moreover, the sensitivity of refractive index measurements which are also applied for fuel purity measurements fail for the case of diesel oil-kerosene mixtures, because of chemical interactions, cannot be utilized for rapid screening of adulteration and smuggling. Recently multivariate analysis has been intensively applied for biodiesel oil studies utilizing the NIR region . However, these methods have not previously been applied for the case of petrol diesels adulterated by kerosene. ...

Liquid fuel adulteration is a serious problem in developing countries but also in some parts of Europe, and it is also one reason for air pollution. The illegal practice of mixing either diesel and kerosene or gasoline and kerosene tends to be the most typical method of fuel adulteration in many parts of developing countries.

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Financial incentives arising from differential taxes are generally the primary cause of fuel adulteration. In South Asia, gasoline carries a much higher tax than diesel, which in turn is taxed more than kerosene. Industrial solvents and recycled lubricants are other materials with little or no tax. Adulteration of gasoline & diesel is indulged primarily due to the significant price difference between these products and the adulterant. Various estimates have been made of the extent of financial loss to the national exchequer and the oil companies as a result of diversion of PDS kerosene, use of offspec, low value hydrocarbons mixed with petrol/diesel, evasion of sales tax, etc. There have been several independent studies conducted by private agency vis-à-vis the quality of petrol and diesel that gets dished out from the outlets to the ultimate consumer. A study by the Tata Consultancy Services concluded that more than 30% of Kerosene distribution intended for household consumption through PDS outlets flowed back to industry in one form or the other. Most developing country governments have not yet established a monitoring regime and system of fines that can act as a strong deterrent to fuel adulteration. There are number of reasons for this, including poor governance, a lack of political will, lack of public awareness, weak regulatory agencies and a shortage or even 4 absence of technical staff & equipment for designing and conducting monitoring. Given these limitations, identifying and dealing with this abuse will require addressing problems on multiple fronts. The primary factors encouraging the practice of adulteration are the following: ϖ Existence of differential tax levels amongst the base fuels, intermediate products and byproducts. The adulterants being taxed lower than the base fuels give monetary benefits when mixed with replacing a proportion of the base fuels. ϖ Differential pricing mechanism of fuels and adulterants and easy availability of adulterants in the market. ϖ Lack of monitoring and consumers awareness. ϖ Lack of transparency and uncontrolled regulations in the production-supply & marketing chain for intermediates and byproducts of refineries. ϖ Non-availability of mechanism and instruments for spot-checking the quality of fuels.

Tax rates on automotive fuels vary markedly from country to country, ranging from heavy subsidies for all fuels in Nigeria and Iran to high taxes in Europe. Most developing countries tax gasoline – considered consumption good of the rich- more heavily than diesel or kerosene, a consumption good of the poor. Many countries realizing the problems of air pollution and the need for infrastructure developments generate funds by levying higher tax on automobile fuels. 5.1 Objectives of Fuel Taxes Taxes on transport fuels typically seek to satisfy multiple objectives including the following: ϖ Raising government revenue for general (non-transport) expenditure purposes. ϖ Efficiently allocating resources to and within the transport sector. ϖ Financing road infrastructure and maintenance. ϖ Reducing encroachments, congestions and environmental externalities of road transport. ϖ Redistributing income and meeting related expenses. It is not possible to achieve all these objectives simultaneously through fuel tax policies alone. Most governments complement fuel taxation with other policy instruments – in particular to correct the externalities. In determining the levels and structure of fuel taxation, important compromises have to be made for the effects on government revenue generation, income distribution, the efficient use of roads and environmental pollution. In so doing, the attention must be accorded to the relative importance of each objective. 5.2 Problems of Differential Fuel Taxes 5 The problem with differential fuel taxation concerns the effects of interfuel substitution. The effect of differential taxation on consumption of nontransport fuels further complicates the matter. Imposing very different tax rates on close substitutes, and subsidizing certain fuels used by poor households, invites diversion of low priced fuel to other sectors and creates an incentive for fuel adulteration. For example, the diversion of rationed, low priced kerosene to transport uses (as an adulterant in diesel and gasoline) reduces the amount of kerosene available for the poor, who need it for lightening and cooking. The shortage of kerosene in turn leads to externalities as, the poor are forced to turn to biomass a significant source of indoor air pollution and health damage from cooking. 5.3 Fuel Pricing Mechanism in India India has traditionally operated under an administered pricing mechanism (APM) for petroleum products.

This system was based on the retention price concept under which the refineries, oil marketing companies and pipelines were compensated for operating cost and assured return of 12 % post tax on net worth. Under this concept, fixed level of profitability for oil companies was ensured subject to their achieving specified capacity utilization. Upstream companies namely ONGC, OIL and GAIL were also till recently under Retention Price concept and were assured fixed return. The administered pricing policy of petroleum product ensured that products like kerosene, used by the vulnerable sections of the society or product used by the transport sector and the agriculturist may be sold at prices that are insulated from volatility in the international oil market. The Govt. of India, Ministry of Petroleum and Natural Gas in 1995 appointed a

Strategic Planning Group for making recommendations to meet the policy objectives and initiatives required for restructuring the oil industry. Based on recommendations of the Group, the Government of India had in November 1997 notified the detail phased out programme of dismantling the APM. The notification provides that the prices of petroleum products, except for PDS kerosene and domestic LPG will be market determined with effect from 1st April 2002. Dismantling of APM is triggering competition among oil refineries, while also providing product with reasonable cost and upgraded quality.

Adulteration of transport fuel, which is currently a very flourishing business in our country, can lead to economic losses, increased emissions and deterioration of performance and parts of engines using the adulterated fuels. Some of the effects of adulteration are outlined below: ϖ Mal-functioning of the engine, failure of components, safety problems etc.

The problem gets further magnified for high performance modern engines. ϖ Increased tailpipe emissions of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), particulate matter (PM) and can also cause increased emissions of air toxin substances. ϖ Adulteration of fuel can cause health problems directly in the form of 6 increased tailpipe emissions of harmful & sometimes carcinogenic pollutants. While indirectly in the form of diversion of PDS kerosene to the diesel sector for adulteration, thus prompting the use of biomass as domestic fuel which in turn leads to health problems of various types due to indoor air pollution. It may be noted that all forms of adulteration are not harmful to public health. Some adulterants increase emission of harmful pollutants significantly, whereas others have little or no effect on air quality. ϖ Significant loss of tax revenue: - Various estimates have been made of the extent of financial loss to the national exchequer as well as the oil companies as a result of diversion of PDS kerosene, use of off-spec, low value, hydrocarbons mixed with petrol and diesel, evasion of sales tax etc. Although these estimates vary over a wide range, it is safe to assume that the nation is losing at least Rs. 10,000 crores annually as a result of adulteration of fuel.

Adulteration & Emissions Fuel adulteration causes marked effect on the tailpipe emissions of vehicles, as adulterants alter the chemistry of the base fuel rendering its quality inferior to the required commensurate fuel quality for the vehicles. This in turn affects the combustion dynamics inside the combustion chamber of vehicles increasing the emissions of harmful pollutants significantly. In some cases effects of adulteration are indirect- for example, large scale diversion of rationed kerosene subsidized for household use to the diesel sector for mixing with diesel not only hamper engine performance of diesel vehicles, but also deprives the poor of kerosene which can otherwise be used for cooking and as a consequence of lack of availability of subsidized kerosene force the poor to continue to use biomass which expose them to high levels of indoor pollution. In general fuel adulteration can increase the tailpipe emissions of hydrocarbons (HC), carbon monoxide (CO), Oxides of nitrogen (NO_x) and particulate matter (PM). Adulteration of fuels can also cause emissions of air toxins like benzene and polyaromatic hydrocarbons (PAHs) both well-known carcinogens.

Impacts due to Gasoline Adulteration Adulterating gasoline with kerosene causes increase in emissions, as kerosene is more difficult to burn than gasoline and this results in higher levels of HC, CO and PM. High sulphur contents of the kerosene can deactivate the catalyst and lower conversion of engine out pollutants. Kerosene addition may also cause fall in octane quality, which can lead to engine knocking. When gasoline is adulterated with diesel fuels, the same effects occurs but usually at lower levels of added diesel fuel. Both diesel and kerosene added to gasoline will increase engine deposit formation. Gasoline may also be adulterated with gasoline boiling range solvent like toluene, xylene and other aromatics. With the „judicious" adulteration, the gasoline would not exhibit drivability problems in motor vehicles. Larger amounts of toluene and /or mixed with xylene cause some increase in HC, CO, NOx emissions, and significant increase in the level of air toxins –especially 7 benzene – in the tailpipe exhaust. The adulterated gasoline itself could have increased potential human toxicity if frequent skin contact is allowed. Extremely high levels of toluene (45 % or higher) could cause premature failure of neoprene, styrene butadiene rubber and butyl rubber components in the fuel system. This has caused vehicle fires in some cases, especially in older vehicles. Adulteration of gasoline by waste industrial solvents is especially problematic as the adulterants are so varied in composition. They will cause increased emissions, may even cause vehicle breakdown. Even low levels of these adulterants can be injurious and costly to vehicle operation. For gasoline, any adulterant that changes its volatility can effect drivability. High volatility (resulting from addition of light hydrocarbons) in hot weathers can cause vapour lock and stalling. Low volatility in cold weather can cause starting problems and poor warm-up. 6.3 Impacts due to Diesel Adulteration The blending of kerosene with automotive diesel is generally practiced by oil industry worldwide as a means of adjusting the low temperature operability of the fuel. This practice is not harmful or detrimental to tailpipe emissions, provided the resulting fuel continues to meet engine manufacturer‟s specifications (especially for viscosity and cetane number). However, highlevel adulteration of low sulphur diesel fuel with higher –level sulphur kerosene can cause the fuel to exceed the sulphur maximum. The addition of heavier fuel oils to diesel is usually easy to detect because the resultant fuel will be darker than normal. Depending on the nature of these heavier fuel oils and the possible presence of additional PAHs, there could be some increase in both exhaust PM and PAH emissions.

Air pollution caused by automotive fuel emissions, especially NOx, PM, CO and unburned hydrocarbons (HC), has been a noteworthy matter.

Extended research on the effects of fuel properties on the emissions and engine performance has been performed worldwide . In India, ambient air pollution is one of the major factors of hazards to human health . The ambient air pollutants (AAP) such as SO2, NOx, particulate matter (PM), volatile organic compounds (VOC's) and polycyclic aromatic hydrocarbon (PAHs) are emitted from the automobile exhausts and industrial activity . Exposure of AAP is an important cause of morbidity and mortality in India . Adulteration of gasoline and diesel is as rampant in South Asia as it is elsewhere in the world. In South Asia, gasoline carries a much higher tax than diesel, which in turn is taxed more than kerosene. Adulteration increases emissions of harmful pollutants from vehicles and worsening urban air pollution that could cause adverse impact on health. An overview of the scope of the problem and some technical data on the gasoline and diesel adulteration was reported. Fuel adulteration can increase the emission of hydrocarbons and PM10. Air toxin emissions, such as benzene, depend mostly on fuel composition and catalyst performance. Polyaromatic hydrocarbons (PAHs) in the exhaust are primarily due to the presence of PAH in the fuel itself and partly due to PAH formation by fuel combustion in the engine. The result showed that addition of kerosene in gasoline results in higher level of emission of hydrocarbons, CO and PM, even in catalyst equipped cars. The emissions of air pollutants was reported due to adulteration of fuels that depend on maintenance of engine, fuel quality, air-fuel ratio, engine speed and load, operating temp. and whether the vehicles are equipped with a catalytic converter . They have used five different compositions of petrol in kerosene and tested for emission and air pollution from petrol engine.

It was observed that as the percentage of kerosene in petrol increased the concentration of SPM and CO also increased. Several reports indicate that adulteration of fuel with solvent, increase ambient air pollutants like HC, CO, NOx, SPM10. The literature verifies that PM emissions generally increase or decrease in relation to the sulphur concentration. The sulphur content and the density of the white spirit as measured were relatively lower than the automotive diesel. Sulphur in the fuel results in sulphates that are absorbed on soot particles and increase the PM emitted from Diesel engines. In addition, the use of fuels with higher density results in higher emissions of PM and smoke. The primary cause of adulteration is the greed fuelled by differential tax system. For example, in south Asia, gasoline is taxed most heavily, followed by diesel, kerosene, industrial solvents and recycled lubricants, in that order. Mixing kerosene with diesel does not lead to an increase in tailpipe emission, but contributes to air pollution indirectly in South Asia. The diversion of kerosene for adulteration drastically brings down its availability, to the poor households, who turn to bio-mass for the purpose of cooking. This leads to an increase in the indoor air pollution and consequent ill effects on health. For the prevention of adulteration, monitoring of fuel quality at the distribution point, therefore, is highly essential. In the Indian context, the gasoline is adulterated by mixing diesel and diesel is adulterated by mixing kerosene. This is because these types of adulterations when limited to small volume % are difficult to detect by the automobile user.

This was followed by the opening of the first refinery two years later to process the crude into kerosene (Potter, 1987). The original requirement was to produce kerosene as a cheaper and better source of light than whale oil. The first refinery, opened in 1861, produced kerosene by simple atmospheric distillation. Its by-products included tar and naphtha (Potter, 1987). It was soon discovered that high-quality lubricating oils could be produced by distilling petroleum under vacuum. However, for the next 30 years kerosene was the product consumers wanted. Two significant events changed this situation which was the invention of the electric light which decreased the demand for kerosene and the invention and development of the internal combustion engine which created a demand for diesel fuel and gasoline (Kovarik *et al.,* 2005). Since 19th century, when automotives were invented, diesel and gasoline have been used as the primary source of energy for the vehicles though many alternate fuels like compressed natural gas, Liquefied Petroleum Gas, methanol, ethanol, dimethylether and biodiesel fuel are emerging in the market (Dutta, 2003). Petroleum refining has evolved continuously in response to changing consumer demand for better and different products. Automobile engines demand for larger amounts of petroleum led to the discovery of better processes in the late 1930's and early 1940's in order to produce higher-octane gasoline with better antiknock characteristics that were required by higher-compression gasoline engines (Kovarik *et al.,* 2005). Following the Second World War, various reforming processes improved gasoline 12

A variety of products from the refineries are being used by a few people in the society for selfish interests hence tampering with the quality of the fuels. Cases of places where this practice has been carried out are Kenya where Kenya broadcasting cooperation (KBC Business, 2006) published a document on adulteration of fuel highlighting on the increase of cases of adulteration of petroleum products since the liberalization of the petroleum sub-sector in 1994. The Government of Kenya, according to this document was concerned that adulteration of either gasoline or diesel by kerosene was wreaking automobile engines apart from denying it the much needed revenue. In Tanzania adulteration of fuels has been reported to be increasing to alarming proportions. The problem is mostly due to mixing of petrol or diesel with kerosene (Charles, 2007).

In New Zealand, unscrupulous firms exceeded "acceptable" limits when they added too much of the off specification toluene to gasoline as a cheap source of octane and caused many car fires (Chang, 2001). The centre for science and environment (CSE, 2002) reported that in south Asia adulteration of automotive gasoline and diesel fuels was wide spread. A report prepared by CSE on gasoline and adulteration in Delhi has provided a good overview of the scope of the problem and some technical and economic data on the subject.

1.1.2Kenya Perspective

The government's decision to increase kerosene prices by Sh18 per litre in an attempt to curb fuel adulteration and raise more revenues may have hit a snag, according the latest data. Kerosene, blamed as the key adulterant used by a cartel operating in several parts of the country, recorded close to a 40 per cent drop in sales in the month of September when the levy was loaded on pump prices.Diesel sales plunged 24 per cent, selling 58 million litres less.The Sunday Nation exclusively obtained the sales data, which was later corroborated by figures from the Energy Regulatory Commission, showing a drop in the volume of sales for both kerosene and diesel.This has punched holes in the government narrative that over 80 per cent of kerosene brought into the country was being used to adulterate diesel.A well-placed source at the Ministry of Petroleum and Mining, who did not wish to be named due to the heat generated by the fresh figures, said ministry strategists have been forced back to the drawing board to seek an alternative proposal for dealing with adulteration and easing the cost burden on households that depend on kerosene for fuel.If diesel sales had gone up, then it would imply that with less kerosene being bought, adulteration has dropped and now the pure diesel is being sold at higher volumes. Diesel is used by very many machines and so a drop in its sale when we thought we had dealt with the adulterant is shocking," the source said.The lower sales volumes now mean the Treasury should start looking elsewhere for the anticipated Sh9.8 billion it had hoped to collect from sales of kerosene, which is now expected to suffer a further cut in sales.

Detection of adulteration in the petroleum fuels (gasoline and diesel) is challenging because the adulterants usually include those compounds which are already present in these fuels. Measurements of various physico-chemical properties are employed in addition to chromatography and spectroscopy for determining the compositional variations of these fuels. It is required to ensure their compliance with the regulatory specifications. The inclusion of statistical design and data treatments certainly provide enough sensitivity to discriminate adulterated and unadulterated samples in the case of gasoline. On the contrary, discrimination of diesel from its adulterants is difficult which demands rigorous analytical strategies and unequivocal data interpretation. Through this review, we have attempted to organize the literature information on this subject with an emphasis to identify and optimize methods suitable for monitoring adulteration. Detailed discussions on the role of physico-chemical, chromatographic and spectroscopic methods in gasoline and diesel characterization have been presented.

The move to raise tax on kerosene was premised on the idea that apart from discouraging adulteration, the government would be able to collect more money from the sale of both diesel and kerosene, while low-income households would enjoy a government subsidy on cylinder prices to adopt clean energy as Kenya phases out the use of kerosene for cooking.The Sh3 billion plan has since been abandoned, as a crafty cartel is said to have hijacked the low-cost cylinders and sold them to illegal refillers.The government later blamed manufacturers for supplying substandard cylinders under the National Oil Corporation Scheme even as a consumer lobby group took it to court.ERC Director-General Pavel Oimeke, who had earlier maintained that only five million of the 33 million litres of kerosene that is reportedly consumed monthly is used for lighting and cooking while the balance is used in adulterating diesel, disputed the impression created by the new statistics, claiming diesel sales had increased instead."Kerosene has dropped and this has been [taken] up by [an] equivalent increase in diesel and petrol," Mr Oimeke wrote in a short text message. He later sent a parallel set of data, which still confirmed that kerosene sales had dropped without a corresponding increase in diesel sales volumes.His data that details what each dealer sold shows that kerosene sales dropped by some 8.8 million litres, while diesel recorded a 58 million drop between August and September.

The Treasury had hoped to collect billions from the increased prices over and above the Value Added Tax on petroleum products, which started in September. The trend may now force it to change tack.Data collected from pipeline throughput volumes show that September sales for kerosene dropped by 2.8 million litres from the 27.1 million litres sold in August before the Sh18 per litre kerosene adulteration tax was introduced.Diesel, which would naturally rise in sales after the fall in kerosene volumes, dropped by 36 per cent in September from the 221 million litres sold in August.The government had hoped to collect more revenues from boosted sales in diesel, which was losing sales volumes from the illegal business where traders mix kerosene and diesel to reap huge margins.The practice, which was rampant in Nairobi's industrial area, where several fuel depots are located, has been a potential fire disaster apart from damaging engines and risking Kenya's fuel export market share.

In Kenya expensive petroleum products are adulterated deliberately by adding a component of cheaper low quality product with similar physical and chemical properties. Adulteration of gasoline is in Kenya is done by the introduction of kerosene into gasoline or diesel illegally with the result that the product does not conform to the requirements and specifications of the product. This in turn will result in low quality petrol and diesel products leading to losses in revenue collection. Adulteration of automotive gas oil and petrol is widespread in Kenya. It takes toll both in air pollution and losses in tax revenue from petroleum products. High prices of petroleum products is cited as one of the causes of adulteration. Adulteration deprives the consumer's quality fuels leading to engine failure. Many methods have been used to test adulteration; this study sets out to assess the adulteration of automotive gas oil and gasoline in Kenya using gas chromatography technique.

Diesel is combusted in a compressionignition engine where the fuel is atomized and sprayed into the hot compressed air. It has a boiling range of 180-370 °C and contains 10-19 carbon atoms in the form of paraffins, naphthenes, and aromatics in different proportions . There are several processes (distillation, catalytic cracking, hydro-cracking etc.) through which diesel fuel is obtained from the crude oil. There are several processes (distillation, catalytic cracking, hydro-cracking etc.) through which diesel fuel is obtained from the crude oil. The adulteration of automotive fuels is prevalent in the different parts of the developing world including India and has erupted as a result of dishonest profit-making practices, negligence on the part of regulators, limited resources for its verification and weak policies to curb it. In the case of diesel, adulteration often leads to the non-conformance of its regulatory requirements, thereby implying degradation in its quality which eventually leads to the economic losses, increased tailpipe emissions, deterioration of engine performance and wear of engine parts

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a) Gasoline

Gasoline is a mixture of hundreds of hydrocarbons many of which have different boiling points. Gasoline boils and distills over a range of temperatures, unlike a pure compound, water, for instance, that boils at a single temperature. Gasoline boils between 30°C and 202°C.

Gasoline also referred to as motor spirit premium contains many substances, such as antiknock agents, antioxidants, metal deactivators, antirust additives, anti-icing agents, upper cylinder lubricants and dyes (ASTM. 1983). The major hydrocarbon components in gasoline include alkanes, isoalkanes, cycloalkanes, alkenes and aromatics (MacFarland *et al.*, 1984). Commercial gasoline contains mainly C5 to C8 paraffin's (60 to 80%), with much smaller quantities of aromatic compounds (14 to 33%) and olefins (6.4 to 13%) (ASTM, 1983). The density of gasoline is reported to be about 0.700-0.740 Kg/l at 20°C, and its vapour pressure is estimated to be 93.3 kPa at 25°C (MacFarland *et al.*, 1984). Gasoline is highly flammable with a flash point of -45°C and minimum and maximum explosion limits in air of 1.3 and 6% by volume respectively (Cesars, 1984).

b) Kerosene

Kerosene is the name for the lighter end of a group of petroleum streams known as the middle distillates (Klimisch *et al.,* 1997). Kerosene is known as dual purpose kerosene which may be obtained either from the distillation of crude oil under atmospheric pressure known as the straight-run kerosene or from catalytic, thermal or steam cracking of heavier petroleum streams which is referred to as cracked kerosene (Klimisch *et al.,* 1997). Kerosene is further treated by a variety of processes including hydrogenation to remove or reduce the level of sulphur, nitrogen or olefin materials. The precise composition of kerosene will depend on the crude oil from which it was derived and on the refinery processes used for its production (API, 1997). Irrespective of this, kerosene consists predominantly of C9 to C16 hydrocarbons and boils in the range 145°C to 300°C (API, 1997).

The major component of the dual purpose kerosene are branched and straight chain paraffins and naphthenes and these normally account for 70% of the material. Aromatic hydrocarbon, mainly alkyl Benzenes and alkylnapthalenes do not normally exceed 25% of kerosene streams. Olefins do not normally account for more than 5% of the kerosene (API, 1997).

Kerosene finds considerable use as jet fuel and as domestic heating fue l(Klimich eta al,1997),when used as jet fuel ,the critical qualities such as freeze point, flash point, and smoke point are monitored(OTM,2003).

Commercial jet fuel has a boiling point range of about 190◦C to 273.5◦C. Kerosene with less critical specifications is used for lighting, heating and as solvent (OTM,2003)

c) Diesel

Known as automotive gas oil, is produced from petroleum, and is usually referred to as petro diesel to distinguish it from diesel obtained from other sources such as biodiesel (Cedre, 2006). Automotive gas oil is classified under distillates and is a hydrocarbon mixture obtained from fractional distillation of crude oil between 250°C-350°C. Diesel has a density of about 0.820-0.850 kg/l (Cedre, 2006). Petroleum-derived diesel is composed of about 75% saturated hydrocarbons which are primarily paraffins and 25% aromatic hydrocarbons which includes naphthalenes and alkylbenzenes (Cooke *et al.,* 1985). The average chemical formulafor common diesel fuel is $C_{12}H_{26}$, ranging fromapproximately $C_{10}H_{22}$ to $C_{15}H_{32}$ (Cooke *et al.,* 1985). Automatic gas oil is used as transportation fuel and contains between 18 and 30 percent more energy per gallon than gasoline.

1.2Statement of the Problem

Kenya is losing huge amounts of revenue through fuel dumping in western region, an area shunned by mainstream oil marketers as it is flooded with illegal petroleum products.The petroleum products meant for export are diverted into the local market, resulting in loss of revenue for the government.Western Kenya Independent Petroleum Dealers Association (Kipeda) chairman Hezekiah Kosgei said cartels involved in the fuel dumping have erected illegal filling stations along the Eldoret-Uganda highway. “Dumping of petroleum products is going on, resulting in loss of revenue to the government yet no deterrent measures has been undertaken despite complaining to the relevant authorities,” said Mr Kosgei.Malaba and Busia border towns are gateways for petroleum products exports from the Kenya Pipeline Eldoret and Kisumu depots.In addition, through diversion of petroleum products meant for export into the local market resulted in loss of revenue to the Government

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1.3 Objectives of the Study

1.3.1 General Objective

The study aim to investigate the effect of adulteration of petrol and gas oil on revenue collection in Kenya.

1.3.2Specific Objectives

a) To determine the effect of blending of kerosene into petrolon revenue collection in Kenya.

b) To analyze the effectof Blending kerosene into diesel on revenue collection in Kenya.

c) To assess effect of Blending amounts of gasoline into automotive gasoline on revenue collection in Kenya.

1.4 Research Questions

i. What is the effect of blending of kerosene into petrol on revenue collection inin Kenya?

ii. What is the effect of Blending kerosene into dieselon revenue collection in in Kenya ?

iii. What is the effect of Blending variable amounts of gasoline into automotive gasolineon revenue collection in in Kenya **?**

1.5 Significance of the Study

1.5.1 Kenya Revenue Authority

To the Kenya Revenue Authority, the finding and outcome of this study could be used to develop policies or mechanism that seeks to improve the implementation of use of the Regional Electronic Cargo Tracking Systems. This can subsequently translates to the improvement in achieving the goal of maximum revenue collection by KRA.

1.5.2 The Government of Kenya

To the Government of Kenya, strategic Think-tanks, and Policy Developers, the finding and outcome of this study can be instrumental insight on areas that requires policy formulation to improve adoption and implementation of Electronic Cargo Tracking System in Kenya. The finding and outcome of this study can further inform decisions on if ECTS is achieving its intended goals or not and give room for corrective measure to be taken.

1.5.3 Government Agencies

Government agencies, being the decision making organ in the country can find the findings from this study useful in a number of ways. First, the study points out that the most the main reasons for diversion of goods. This is an important aspect since it helps them in making decisions to counter these activities consequently guide the policy regulation. These regulations will put the needs of the different teams, government and the residents at an advantage by shielding their interests.

The research indicated the various negative impacts of diversion of goods in the region and help in realization of strategies and appropriate actions to be taken. This information will help countries in establishing international collaboration with regulatory agencies to ensure a collective approach to curb diversion of goods.

1.5.6 The future researcher

To the future researchers, the finding and outcome of this study will significantly help as it can be used by future researchers as point of reference and citations. This study will also suggest areas of further studies that future researches can undertake to add value in body of knowledge with regard to Electronic Cargo Tracking Systems

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1.7 Scope of the Study

The researcher will carry out the study on trucks carrying petroleum on transit, petrol stations, storage yards within Nairobi and neighboring counties and data from petroleum monitoring unit at KRA offices.

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CHAPTER TWO

LITERATURE REVIEW

2.1Introduction

This chapter examines the literature review of the concepts of revenue collection; its effect of iTax systems on revenue collection; and literature that various authors and scholars have put forward in relation to revenue collection.

2.2Theoretical Framework

The theoretical framework plays an important role in guiding the entire process of the research study. Theories are constructed in order to explain, predict and master phenomena e.g. relationships, events, or the behavior.

2.2.1 Fourier Transform Infrared Spectroscopy (FTIR) Theory

a) Principle

It involves the absorption of electromagnetic radiation in the infrared region of the spectrum which results in changes in the vibrational energy of molecule. Usually molecules have vibrations in the form of stretching and bending and the absorbed energy is utilized in changing the energy levels associated with them. It is a valuable tool in identifying organic compounds which have polar chemical bonds such as OH, NH, CH, -C=C-, aromatics with good charge separation (strong dipoles) (Colthup *et al.*, 1990).

b) Instrumentation

This technique utilizes a single beam of un-dispersed light and has the following components; a double beam spectrophotometer comprising IR source, grating monochromator, thermocouple detector, cells made of either sodium chloride or potassium bromide materials. In FT-IR, the un-dispersed light beam is passed through the sample and the absorbances at all wavelengths are received at the detector simultaneously (Ingle and Crouch, 1988). Spectra are obtained by screening wavelength from 4000cm^{-1} to 400cm^{-1}. A computerized mathematical manipulation known as "Fourier Transform" is performed on the data to obtain absorption data for each and every wavelength. In this type of calculations interference of light pattern is required for which the FTIR instrumentation contains two mirrors, one fixed and one moveable with a beam splitter in between them. Before scanning the sample a reference or a blank scanning is required (Ingle and Crouch, 16

1988). The diagram shown in figure 1 is a simplified design of Fourier Transform Infrared Spectrometer.

2.2.2 Determination of boiling point range characteristics of gasoline by distillation (ASTM D 86)

One of the most important features of gasoline is the volatility that is measured by a distillation experiment. In this method the determination of volatility of petroleum products is done using a laboratory batch distillation unit to determine quantitatively the boiling range characteristics of products such as gasoline, light and middle distillates, aviation turbine fuels, low sulfur diesel fuels, special petroleum spirits, naphtha, white spirits and kerosene. Distillation is based on the composition, vapor pressure, expected initial boiling 17 point, expected final end point, and combustion of the sample. Both automated and manual equipments may be used (ASTM D 86., 2006).

a) Significance of distillation

The distillation characteristics of hydrocarbons have an important effect on their safety and performance. The various ranges of a distillation profile have been correlated with specific aspect of gasoline performance. Front-end volatility is adjusted to provide: (a) easy cold starting, (b) easy hot starting, (c) freedom from vapour lock, and (d) low evaporation and running-loss emissions. Mid-range volatility is adjusted to provide: (a) rapid warm-up and smooth running, (b) good short-trip fuel economy, (c) good power and acceleration, and (d) protection against carburetor icing and hot stalling. Tail-end volatility is adjusted to provide: (a) good fuel economy after engine warm-up, (b) freedom from engine deposits, (c) minimal fuel dilution of crankcase oil, and (d) minimal volatile organic compound (VOC) exhaust emission (Al-Ghouti *et al*., 2008).

2.2.3 Determination of density using the hydrometer method (ASTM D 1298)

This method covers the laboratory determination of density petroleum products normally handled as liquids using a glass hydrometer. The values are measured on a hydrometer at either the reference temperature or at another convenient temperature, and readings corrected to the reference temperature by means of the petroleum measurement tables (ASTM D 1298., 2006).

a) Significance of density

Accurate determination of the density, of petroleum products is necessary for the conversion of measured volumes to volumes or masses at the standard reference 18 temperatures during storage. This method can also be used for viscous liquids by allowing sufficient time for the hydrometer to reach equilibrium, and for opaque liquids by employing a suitable meniscus correction. Density is an important quality indicator for automotive, aviation and marine fuels, where it affects storage, handling and combustion (ASTM D 1298., 2006).

2.2.4 Detection of copper corrosion by the copper strip tarnish Test (ASTM D 130)

This method covers the detection of the corrosiveness of sulphur compounds to copper of automotive gasoline, aviation gasoline and aviation turbine fuel (ASTM D 130., 2006).

a) Significance of copper strip tarnish Test

Crude petroleum contains sulfur compounds, most of which are removed during refining. However, of the sulfur compounds remaining in the petroleum product, some can have a corroding action on various metals. The effect can vary according to the chemical types of sulfur compounds present. The copper strip corrosion test is designed to assess the relative degree of corrosivity of a petroleum product (ASTM D 130., 2006).

2.4.5 Determination of lead in gasoline by Flame Atomic Absorption Spectroscopy (FAAS)

a) Principle of FAAS

FAAS is used to determine trace levels of metals in samples. In this technique, a fine spray of the analyte is passed into a suitable flame such as air-acetylene, oxygen-acetylene or nitrous oxide acetylene, which converts the element to atomic vapor. Through this vapour, a radiation is passed from hollow cathode lamp at the right wavelength to excite the atoms 19 at ground state to their first excitation electron levels. The amount of radiation absorbed can then be measured and directly related to the atom concentrations. A hollow cathode lamp is used to emit light with characteristic narrow line spectrum of the analyte element.

Its main advantages are high specificity since the lining of hollow cathode lamp is made of the element similar to the one being determined in the sample, high sensitivity, minimum interference from other elements and very hot flame is not necessary because the atoms are used at ground state (Ewing, 1985).

2.4.6 Determination of Sulphur in gasoline by Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF)

This method covers the measurement of sulfur in hydrocarbons, such as diesel, naphtha, kerosene, residuals, lubricating base oils, hydraulic oils, jet fuels, crude oils, gasoline (all unleaded), and other distillates. The applicable concentration range is 0.0150 to 5.00 mass percentage of sulfur and a typical analysis time is 2 to 4 min per sample (ASTM D 4294., 2008).

a) Significance of the Energy Dispersive X-ray Fluorescence Spectrometry determination of sulphur

The quality of many petroleum products is related to the amount of sulfur present (ASTM D 4294., 2008). The method provides rapid and precise measurement of total sulfur in petroleum products with a minimum of sample preparation. Compared to other test methods for sulfur determination, this method has high throughput, minimal sample preparation, good precision, and is capable of determining sulfur over a wide range of concentrations (ASTM D 4294., 2008).

2.3 Conceptual Framework

A conceptual framework is a concise description of the phenomenon under study represented by graphical depiction of the major variables of the study (Mugenda, 2003). Young *et al.* (2003) defines conceptual framework as a diagrammatic representation of the relationship between the dependent and independent variables. In this study, the main variable under study is Revenue collection, which is a dependent variable. This variable will be influenced by independent variables. This study however intends to concentrate on blending of petroleum products, dumping of petroleum products and diversion of exports.

Independent variables **Dependent Variable**

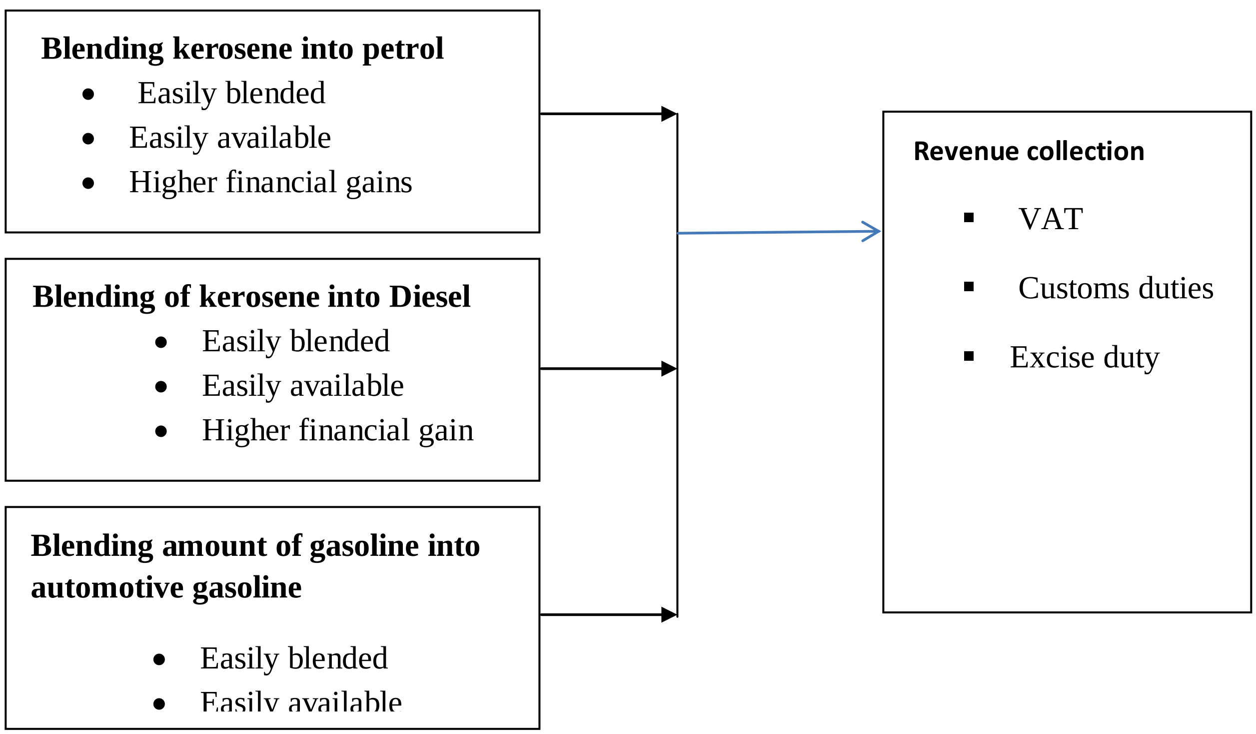

Fig. 2.1 Conceptual framework

2.4 Empirical review

As early as 14th century, some surface deposits were being distilled to obtain lubricants and medicinal products, but the real exploitation of crude oil did not begin until the 19th century

(Manning *et al.,* 1991). (Speight, 2002), reported that in 1852 Canadian physician and geologist Abraham Gessner obtained a patent for producing clean-burning, affordable lamp fuel called kerosene from crude oil. In 1855 an American chemist, Benjamin Silliman, published a report indicating the wide range of useful products that could be derived through the distillation of crude oil (Manning *et al.,* 1991). The petroleum industry began.

Since June 1999, the Kenyan Government has been adding a bio code marker to fuel

As a trace to differentiate fuel for local consumption which is taxed and fuel for export which is not locally taxed. The aim is to prevent fuel dealers from selling fuel designed for export on domestic market as a way to avoid taxes. The System is said to have reduced adulteration and illicit trade, recovering US $ 30million in taxes for the Kenyan Government and US $50million in sales for oil companies (Masani, 2009).

In September 2015 a report from star Kenya indicated that six petrol stations selling adulterated fuel were shut down by Energy Regulation Commission.This was done after the commission inspected 753 petrol stations between July and September 2015.From the exercise 19 petrol stations were found to be non-compliance out of 753 petrol stations inspected.

It was soon discovered that high-quality lubricating oils could be produced by distilling petroleum under vacuum. However, for the next 30 years kerosene was the product consumers wanted. Two significant events changed this situation which was the invention of the electric light which decreased the demand for kerosene and the invention and development of the internal combustion engine which created a demand for diesel fuel and gasoline (Kovarik *et al.,* 2005). Since 19th century, when automotives were invented, diesel and gasoline have been used as the primary source of energy for the vehicles though many alternate fuels like compressed natural gas, Liquefied Petroleum Gas, methanol, ethanol, dimethylether and biodiesel fuel are emerging in the market (Dutta, 2003). Petroleum refining has evolved continuously in response to changing consumer demand for better and different products. Automobile engines demand for larger amounts of petroleum led to the discovery of better processes in the late 1930's and early 1940's in order to produce higher-octane gasoline with better antiknock characteristics that were required by higher-compression gasoline engines (Kovarik *et al.*, 2005). Following the Second World War, various reforming processes improved gasoline.

Various literature studies reveal that petroleum is obtained from crude oil, a complex mixture containing many different hydrocarbons that vary in appearance and composition from one oil field to another (Schremp,2005)

According to the Energy Regulatory Commission (ERC) it is estimated that five million of the 33million litres of kerosene consumed monthly in is utilised for lighting and cooking while balance is used for adulterating either diesel or petrol. The choice of the adulterant is based on the financial gains,easy blending ability,availability,quality, yield and produced higher-quality products. (Kovarik *et al.*, 2005). Present-day refineries produce a variety of products including many required as feedstock for the petrochemical industry (Dutta, 2003).

A variety of products from the refineries are being used by a few people in the society for selfish interests hence tampering with the quality of the fuels. Cases of places where this practice has been carried out are Kenya where Kenya broadcasting cooperation (KBC Business, 2006) published a document on adulteration of fuel highlighting on the increase of cases of adulteration of petroleum products since the liberalization of the petroleum sub-sector in 1994. The Government of Kenya, according to this document was concerned that adulteration of either gasoline or diesel by kerosene was wreaking automobile engines apart from denying it the much needed revenue. In Tanzania adulteration of fuels has been reported to be increasing to alarming proportions. The problem is mostly due to mixing of petrol or diesel with kerosene (Charles, 2007).

In New Zealand, unscrupulous firms exceeded "acceptable" limits when they added too much of the off specification toluene to gasoline as a cheap source of octane and caused many car fires (Chang, 2001). The centre for science and environment (CSE, 2002) reported that in south Asia adulteration of automotive gasoline and diesel fuels was wide spread. A report prepared by CSE on gasoline and adulteration in Delhi has provided a good overview of the scope of the problem and some technical and economic data on the subject. In Uttar Pradesh in the city of Meerut in India, an authorized transport company was caught with adulterated stock. This transport agency had the authority to transport both petrol and diesel to retail outlets and solvents for industrial use. The agency was supposedly using its workplace for adulterating diesel with kerosene (Dutta, 2003).

Diversion of transit goods into the Kenyan market as it transits to the regions is common trade malpractice in the region.

The reason for diversion of goods is mainly to introduce disallowed or illicit products into the market. This includes drugs and substandard goods that would not have passed the requirements of Kenya Bureau of standards. However, there are traders who practice diversion of good to avoid statutory charges and taxes that increases their cost and subsequently pricing of the commodities. This leads to unfair competition in the market.

The port of Mombasa provides a major entry into the region through the Indian Ocean. Approximately 40% of the cargo cleared from the port of Mombasa is destined for the neighboring countries such as Uganda, Rwanda and Burundi. These goods are mainly transported by Road while other by train thereby introducing the possibility of diversion into the market. The transit goods that passes through the port of Mombasa is as shown in figure 4.1 below

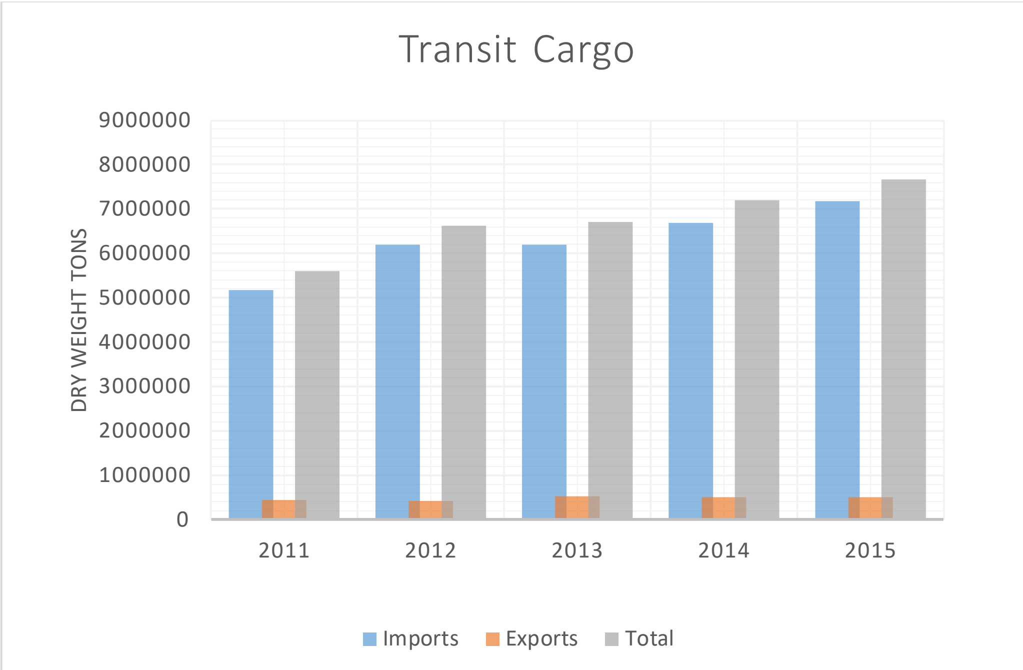

Figure 1.1: Graph of Transit goods Along The Northern Corridor

From figure 4.1, it is clear that the port of Mombasa remains as a strategic entry into the region. This is because of the increasing cargo that is transported through the port. This has also increased the efforts of the government agencies and private stakeholders to improve the services at the port and along the Northern corridor.

This however has presented the risk of diversion of goods into the local market thereby causing a number of challenges to the economy. The two main challenges are unfair completion and introduction of illicit and disallowed goods into the market. There efforts though to curb this trade menace such as the use of technology; Regional Cargo tracking system that ensures that there is real time visibility of movement of goods along the Norther corridor. This however has its challenges since only 17% of the cargo is currently monitored in real time. This leaves a huge percentage of the cargo that can easily be diverted into the local market

Kenya Pipeline Company is yet to quantify the fuel stolen after crooks linked a pipe to the 20-inch Mombasa-Nairobi Pipeline and siphoned the product at Mlolongo in Machakos County.The company said two suspects were arrested yesterday following a tip-off that water trucks were being used to ferry fuel from a plot disguised as a construction site about four kilometres off Mombasa Road.KPC acting managing director Hudson Andambi termed the incident "shocking and disturbing" and asked for a speedy investigation."With the two suspects in custody, we hope to unravel the people behind this unfortunate scheme. From what we have seen, these are people had substantial technical understanding going by the sophistication with which they taped the line,"

Mr Andambi said, adding KPC had enhanced its pipeline surveillance and intelligence gathering to deal with any such schemes.The ERC says that cash-hungry marketers have turned to petroleum adulteration, where diesel or petrol is mixed with cheaper kerosene, which attracts lower taxes, in search of bigger margins.The regulator also named dozens of dealers, mostly small dealers, diverting fuel meant for neighbouring land-locked countries for sale in the Kenyan market since the export petroleum is not taxed locally."We shall be suing ERC. This is double jeopardy; a smear campaign against Shell," Mr Igathe said when reached for comment adding that the company would stop selling retail kerosene at the pump.Four of Vivo Energy's 165 service stations were found to have mixed diesel or petrol with kerosene for sale to unsuspecting motorists.

Kenya is losing huge amounts of revenue through fuel dumping in western region, an area shunned by mainstream oil marketers as it is flooded with illegal petroleum products.The petroleum products meant for export are diverted into the local market, resulting in loss of revenue for the government.Western Kenya Independent Petroleum Dealers Association (Kipeda) chairman Hezekiah Kosgei said cartels involved in the fuel dumping have erected illegal filling stations along the Eldoret-Uganda highway. “Dumping of petroleum products is going on, resulting in loss of revenue to the government yet no deterrent measures has been undertaken despite complaining to the relevant authorities,” said Mr Kosgei.Malaba and Busia border towns are gateways for petroleum products exports from the Kenya Pipeline Eldoret and Kisumu depots.

KRA is also targeting operators who mix motor vehicle fuels with kerosene to increase the volumes of their products.Such products end up endangering the lives of many. It also shortens the life spans of motor vehicle engines and other equipment.In a notice published in the media, KRA said it would close down facilities used in illegal operations and take to court the individuals operating such facilities. KRA is working with other State agencies including the Energy Regulatory Commission (ERC) and the police to trace and shut down rogue operators. “KRA, ERC, Nema and the Police... do hereby give notice of intent to make immediate enforcement of sanctions... of persons found diverting or siphoning export petroleum products in the local market, selling motor fuels adulterated with kerosene and spilling and discharging petroleum into the environment,” said the KRA statement.“Such facilities have not been inspected or approved by any relevant government agencies and are therefore prone to endanger human life, environmental degradation, interfering with the quality of petroleum products, risk of destruction of third party property and unfair competition.”

It added that diversion of petroleum products meant for export into the local market resulted in loss of revenue to the Government.However, ERC said monitoring of the petroleum market and sanctioning players guilty of diverting export products and adulteration have seen incidences go down."This is part of a fuel-quality monitoring campaign through which we want to ensure consumers get quality products and products meant for export are not dumped in the local market," said Linus Gitonga, director of petroleum at ERC."The fact that criminals know we are monitoring has seen the number of dumping and adulteration incidences go down," he said.

"We have in the past shut down service stations found with adulterated or export products and that has deterred others that would want to attempt."Other than adulteration of fuel, uncouth players also operate illegal gas refilling plants that also put households in danger. Illegal cooking gas plants are also a pain to legitimate companies. They in addition to losing market share to the illegal players have also seen a rise in theft of gas cylinders. This is as the illegal businesses look for equipment to package their products.Inefficiencies in the fuel supply chain caused by an archaic infrastructure have

2.4.1 Gasoline

Gasoline is a mixture of hundreds of hydrocarbons many of which have different boiling points. Gasoline boils and distills over a range of temperatures, unlike a pure compound, water, for instance, that boils at a single temperature. Gasoline boils between 30°C and 202°C.
Gasoline also referred to as motor spirit premium contains many substances, such as antiknock agents, antioxidants, metal deactivators, antirust additives, anti-icing agents, upper cylinder lubricants and dyes (ASTM. 1983). The major hydrocarbon components in gasoline include

alkanes, isoalkanes, cycloalkanes, alkenes and aromatics (MacFarland *et al.*, 1984). Commercial gasoline contains mainly C5 to C8 paraffin's (60 to 80%), with much smaller quantities of aromatic compounds (14 to 33%) and olefins (6.4 to 13%) (ASTM, 1983). The density of gasoline is reported to be about 0.700-0.740 Kg/l at 20°C, and its vapour pressure is estimated to be 93.3 kPa at 25°C (MacFarland *et al.*, 1984). Gasoline is highly flammable with a flash point of -45°C and minimum and maximum explosion limits in air of 1.3 and 6% by volume respectively (Cesars, 1984).

2.4.2 Kerosene

Kerosene is the name for the lighter end of a group of petroleum streams known as the middle distillates (Klimisch *et al.*, 1997).

Kerosene is known as dual purpose kerosene which may be obtained either from the distillation of crude oil under atmospheric pressure known as the straight-run kerosene or from catalytic, thermal or steam cracking of heavier petroleum streams which is referred to as cracked kerosene (Klimisch *et al.*, 1997). Kerosene is further treated by a variety of processes including hydrogenation to remove or reduce the level of sulphur, nitrogen or olefin materials. The precise composition of kerosene will depend on the crude oil from which it was derived and on the refinery processes used for its production (API, 1997). Irrespective of this, kerosene consists predominantly of C9 to C16 hydrocarbons and boils in the range 145°C to 300°C (API, 1997).
The major component of the dual purpose kerosene are branched and straight chain paraffins and naphthenes and these normally account for 70% of the material. Aromatic hydrocarbon, mainly alkyl Benzenes and alkylnapthalenes do not normally exceed 25% of kerosene streams. Olefins do not normally account for more than 5% of the kerosene (API, 1997).

Kerosene finds considerable use as jet fuel and as domestic heating fue l(Klimich eta al,1997),when used as jet fuel ,the critical qualities such as freeze point, flash point, and smoke point are monitored(OTM,2003).

Commercial jet fuel has a boiling point range of about 190◦C to 273.5◦C. Kerosene with less critical specifications is used for lighting, heating and as solvent (OTM,2003)

2.4.3 Diesel

The blending of kerosene with automotive diesel is generally practiced by oil industry worldwide as a means of adjusting the low temperature operability of the fuel (Dutta, 2003). This practice is not harmful or detrimental to tailpipe emissions, provided the resulting fuel continues to meet engine manufacturer's specifications, especially for viscosity and cetane number (Dutta, 2003). However, high-level adulteration of low sulphur diesel fuel with high -level sulphur kerosene can cause the fuel to exceed the sulphur maximum (Masami and Robert, 2001). The addition of heavier fuel oils to diesel is usually easy to detect because the resultant fuel will be darker than normal (Masami and Robert, 2001). Depending on the nature of these heavier fuel oils and the possible presence of additional PAHs, there could be some increase in both exhaust PM and PAH emissions (Masami and Robert, 2001)Known as automotive gas oil, is produced from petroleum, and is usually referred to as petro diesel to distinguish it from diesel obtained from other sources such as biodiesel (Cedre, 2006). Automotive gas oil is classified under distillates and is a hydrocarbon mixture obtained from fractional distillation of crude oil between 250°C-350°C. Diesel has a density of about 0.820-0.850 kg/l (Cedre, 2006). Petroleum-derived diesel is composed of about 75% saturated hydrocarbons which are primarily paraffins and 25% aromatic hydrocarbons which includes naphthalenes and alkylbenzenes

(Cooke *et al.*, 1985). The average chemical formulafor common diesel fuel is $C_{12}H_{26}$, ranging fromapproximately $C_{10}H_{22}$ to $C_{15}H_{32}$ (Cooke *et al.*, 1985).

Automatic gas oil is used as transportation fuel and contains between 18 and 30 percent more energy per gallon than gasoline.

.5 Critiques of the study

As early as 14th century, some surface deposits were being distilled to obtain lubricants and medicinal products, but the real exploitation of crude oil did not begin until the 19th century (Manning *et al.*, 1991). (Speight, 2002), reported that in 1852 Canadian physician and geologist Abraham Gessner obtained a patent for producing clean-burning, affordable lamp fuel called kerosene from crude oil. In 1855 an American chemist, Benjamin Silliman, published a report indicating the wide range of useful products that could be derived through the distillation of crude oil (Manning *et al.*, 1991).

A variety of products from the refineries are being used by a few people in the society for selfish interests hence tampering with the quality of the fuels. Cases of places where this practice has been carried out are Kenya where Kenya broadcasting cooperation (KBC Business, 2006) published a document on adulteration of fuel highlighting on the increase of cases of adulteration of petroleum products since the liberalization of the petroleum sub-sector in 1994. The Government of Kenya, according to this document was concerned that adulteration of either gasoline or diesel by kerosene was wreaking automobile engines apart from denying it the much needed revenue. In Tanzania adulteration of fuels has been reported to be increasing to alarming proportions. The problem is mostly due to mixing of petrol or diesel with kerosene (Charles, 2007).

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2.6 Research gap

This research project is done purposely to assess gasoline adulteration and whether regular gasoline and petrol sold in petrol stations in Kenya mostly within Nairobi are within the Standard specification as set out by ERC.The study will consider taking samples from various petrol stations within Nairobi and the Neighbouring counties and subject the samples to laboratory analysis by GC/MS analytical method.In addition data will also be collected from PMU to assess the revenue implication of petroleum product adulteration in Kenya.

2.7 Summary

Researchers who have been analysing evidence accumulated since 1990’s have suggested that more study needs to be done both in laboratory analysis and data collection and document the findings in order to support in Enforcing laws of petroleum business in Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1Introduction

The chapter presents the research method that will be used in the research project. It includes the research design, study area, population of study or target population, sample design and procedures, data collection methods and data analysis procedures to be applied.

3.1 Research Design

The research has chosen to use descriptive survey. The study will adopt the field survey and use both qualitative and quantitative data since it is cost effective and time saving in collecting data.

3.2 Target population

The study target population was 84 officers from yards for filling petroleum tankers, petrol stations samples from different sites and data from Customs-Petroleum monitoring Unit. (PMU) from July 2016 to June 2017.

Table 3.1: Target population

	Target population
Oil marketer officers	50
Yards officers	10
Petrol stations officers	10
Petroleum monitoring unit	14
Total	**84**

3.3 Sample and Sampling Technique

In order to establish the sample size, the study adopted purposive and stratified random sampling technique. Purposive sampling is where the researcher selects what he/she is a "typical" sample based on specialist knowledge or section criteria. Also, sampling within each stratum was carried out through simple random sampling. Stratified random sampling is unbiased sampling method of grouping heterogeneous population into homogenous subsets then making a selection within the individual subset to ensure representativeness. The study employed census methods because the target population was less than 100.

3.6: Data collection methods

The study employed primary data collection. Primary data was collected through a self-administered questionnaire. The questionnaire adopted closed structured ended questions. The responses in the questionnaires helped gain an in-depth understanding. A questionnaire were gathered statistically meaningful data on the perspectives of respondents on an issue of interest based on a set of predetermined questions.

According to Kothari (2008), a questionnaire is the most appropriate instrument for this study due to its ability to collect a large amount of information in a reasonably quick span of time.

3.5 Data Collection Instrument

The study used primary data by use of questionnaires to carry out the study. Questionnaires will include structured questions that were administered to the sampled population of the study. The closed ended structured questions was used in an effort to conserve time and money as well as to facilitate analysis as they are in immediate usable form; while the unstructured questions were used as they encourage the respondent to give an in-depth and felt response without feeling held back in revealing of any information (Mugenda & Mugenda, 2003).

3.6 Data Collection Procedures

The relevant data was collected from the field with the aid of a research assistant, as the questionnaires was distributed on a drop and pick later method to allow the respondents time to sufficiently go through them and give feedback.

3.7 Pilot Study

The study was carried out a pilot test to pretest the validity and reliability of data collected using the questionnaire. A pilot group of 8 individuals from the target population was selected to test the reliability of the research instruments The major purpose for pilot testing was to test whether the questionnaires could obtain the required results. The pilot study was used to find out the clarity and objectivity of the selected questions.

3.7.1 Reliability of Research Instruments

Reliability is increased by including many similar items on a measure, by testing a diverse sample of individuals and by using uniform testing procedures. In order to test the reliability of the instruments, internal consistency techniques was carried using Cronbach's Alpha.The alpha value ranges between 0 and 1 with reliability increasing with the increase in value. According to (Mugenda, 2008), a coefficient of 0.6-0.7 is a commonly accepted rule of thumb that indicates acceptable reliability and 0.8 or higher indicated good reliability.

3.7.2 Validity of Research Instruments

According to Berg and Gall (1989), validity is the degree by which the sample of test items represents the content of test is designed to measure.

3.8 Data Analysis and Presentation

Qualitative and quantitative approaches was applied in this study as advocated for by Neuman (2000); and Babbie and Mouton (2001). These two main research approaches was examined with respect to their suitability to the current research.

3.8.1 The Qualitative Analysis

Qualitative data was collected through questionnaires and response rate calculated. The data was then then categorized into different themes according to research variable and descriptive statistics such as mean, standard deviation and frequency distribution which according to

Kothari (2012) measures the point about which items have a tendency to cluster and describe the characteristics of the data collected was computed.

3.8.2 The Quantitative Analysis

Quantitative data from the questionnaire was coded and entered into the computer for statistical analysis. The Statistical Package for Social Sciences (SPSS version 20) was used for analysis. Frequencies, mean and standard deviation was used to summarize the data.

Regression model was used to assess variables that are considered in assessing the factors that influence taxation of the informal sector.

Regression Analysis is a statistical modeling technique was used to identify meaningful, stable relationships among sets of data. The application of analytical procedures is based on the premise that, in the absence of known conditions to the contrary, relationships among information may reasonably be expected to exist. Regression measures the causal relationship between one dependent and one independent variable. Multiple regression analysis measures the effects of multiple independent variables on one dependent variable.

The study adopteda multi regression model

$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \varepsilon$

Where:

Y = Revenue collection

$\beta0$ = Constant Term

$\beta1$ = Beta coefficients

X1 = Blending of kerosene into Diesel

X2 = Blending kerosene into petrol

X3= Blending amount of gasoline into automotive gasoline

ε = Error term

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

This chapter shows response rate, the results of data reliability, and descriptive statistics of the study variables, regression analysis and an interpretation of the study findings.

4.2 Response Rate

The researcher administered a total of 84 questionnaires and 82 were completed and returned. This represents a response rate of 98 % as shown in Table 4.1. This response rate was adequate to allow the researcher to continue with the analysis. The questionnaires were composed of questions that addressed the objectives of the study.

Table 4.1 Response rate

Category	Frequency	Percentage
Completed and returned	82	98
Not returned	2	2
Total	**84**	**100**

4.3 Reliability test results

Reliability is measure of the degree to which a research instrument yields consistent result after repeated trials (Mugenda & Mugenda, 2003). The results are depicted in tale 4.2 below.

Table 4.2: Reliability tests results

Constructs	Reliability Cronbach's alpha	Comment
Blending of kerosene into petrol	0.711	Accepted
Blending of kerosene into diesel	0.811	Accepted
Blending of gasoline into automative gasoline	0.713	Accepted
Revenue collection	0.715	Accepted

The results of the reliability test produced an overall Cronbach Alpha correlation coefficient of 0.701 while specific findings indicated that, blending into petrol had a coefficient of 0.711, blending into diesel had a coefficient of 0.811, blending into gasoline into automative gasoline had a coefficient of 0.781, and Revenue collection had a coefficient of 0.715. Table 4.2 shows that all the study variables yielded Cronbach alpha coefficients values of more than 0.7, which is the recommended value.

4.4. Descriptive statistics

4.4.1 Blending of kerosene into petrol

This section sought to evaluate several statements on infrastructure to determine its effect of blending of kerosene into petrol on revenue collection. Table 4.6 shows the results obtained.

Table 4.3 Blending of kerosene into petrol

Statement	Mean	Std. deviation
a) Blending of kerosene into petrol easily available	2.22	1.172
b) Blending of kerosene into petrol easily blended	2.35	1.251
c) Blending of kerosene has higher financial gain	2.24	1.214
d) Blending of kerosene not easily available	1.83	1.102

According to the results on table 4.6 show that, highest mean values were 2.35, 2.24 and 2.22, which correspond to the likert scale value of 2. This indicates that the respondents agree that blending of kerosene into petrol easily available, blending of kerosene into diesel easily not available, blending of kerosene into petrol easily blended and blending of kerosene has higher financial. 'The lowest mean value was 1.83, which indicates that the respondents strongly agreed that blending of kerosene not easily available. The study findings are supported by a number of studies which includes Otsuki et al, (2003).

4.4.1 Blending of kerosene into diesel

This section sought to evaluate several statements on blending of kerosene into diesel to determine its effect on revenue collections.

Table 4.4 Blending of kerosene into diesel

	Mean	Std. deviation
Blending of kerosene into diesel easily available	3.20	1.344
Blending of kerosene into diesel easily blended	2.61	1.468
Blending of kerosene into diesel not easily available	2.39	1.085
Blending of kerosene into diesel has higher financial gain	2.11	1.080

According to the results on table 4.7 the highest mean values were 3.28 and 3.20 which corresponds to the scale value of 3. The results indicate that the respondents were indifferent on blending of kerosene into diesel easily available. The results also established that the respondents agreed that blending of kerosene into diesel easily blended, blending of kerosene into diesel not easily available. The results also established that respondents strongly agreed that blending of kerosene into diesel has higher financial gain. The study findings are supported by a number of studies which includesKrugman (1979).

4.7 Blending of gasoline into automative gasoline

Blending of gasoline into automotive gasoline seeks to assess the blending of gasoline into automotive gasoline on revenue collection.

Table 4.5 Blending of gasoline into automotive gasoline

	Mean	Std. deviation
Blending of gasoline into automotive gasoline easily blended	2.39	1.085
Blending of gasoline into automotive gasoline easily available .	2.11	1.0801
Blending of gasoline into automotive gasoline not easily available	3.20	1.344
Blending of gasoline into automotive gasoline has higher financial gain	2.61	1.468

According to the result in table 4.5 the highest mean values were 3.20 and 2.61.Meaning respondents were indifferent in blending of gasoline into automotive gasoline easily available, blending of gasoline into automotive gasoline easily blended, blending of gasoline into automotive gasoline has higher financial gain . The study findings are supported by a number of studies which includes Wilmsmeier et al. (2006).

4.5 Correlation Analysis

4.5.1 Correlation results on independent variables

Correlation shows the relationship existing between variables in the study. The study's dependent variable is Customs revenue collection and the independent variables consist of blending of kerosene into petrol, blending of kerosene into diesel and blending of gasoline into automotive gasoline.

The results depicted in table 4.6 below

Table 4.9: Correlation between independent variable and dependent variable

Variables		**Revenue collection**	**Blending of kerosene into petrol**	**Blending of kerosene into diesel**	**Blending of gasoline into automotive gasoline**
Revenue collection	Pearson Correlation	**1**			
	Sig. (2-tailed)				
Blending of kerosene into petrol	Pearson Correlation	0.456	1		
	Sig. (2-tailed)	0.002			
Blending of kerosene into diesel	Pearson Correlation	0.431	.3421	1	
	Sig. (2-tailed)	0.001	.0014		
Blending of gasoline into automotive gasoline	Pearson Correlation	0.458	.1240	.0621	1
	Sig. (2-tailed)	0.003	.0120	.0043	

In an attempt to show the relationship between the study variables and their findings the study used the Karl Pearson's coefficient of correlation (r).

According to the findings as indicated in table 4.9, it was clear that there was a positive correlation between revenue collection and blending of kerosene into petrol as depicted by a correlation value of 0.456. This implies that blending of kerosene into petrol was linearly related to revenue collection. The study also depicted that there is a positive correlation between blending of kerosene into diesel and revenue collection with a correlation value of 0.431. Another positive correlation was between blending of gasoline into automotive gasoline and revenue collection with a correlation value of 0.458. This shows that there was a positive correlation between blending of kerosene into petrol, blending of kerosene into diesel and blending of gasoline into automotive gasoline and revenue collection . The findings of this study agreed with the study conducted by Nordas et al, (2000)

4.6 Regression Analysis

A multiple regression analysis was conducted to investigate the joint causal relationship between the independent variables and dependent variable customs revenue collection. This is represented by the overall model Y =$\beta_0 + \beta_1 \mathbf{x_1}^{z} + \beta_2 x_{2z} + \beta_3 x_{3z} + \beta_2 x_{2z} \varepsilon \ldots$

The coefficient of multiple determinants denoted by R Squares is a measure of proportion of the variation of the regress and explained and by the corresponding explanatory variables.

The values of R squared lies between zero and unity, $0 \leq R^2 \geq 1$. A value of unity implies that 100% of the variation of Y has been explained by the explanatory variables.

Table 4.19: Model Summary for independent and dependent variables

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.707[a]	.505	.453	.71722	2.001

a. Predictors: (Constant), Blending of kerosene into petrol, blending of kerosene into diesel, blending the amount of gasoline into automotive gasoline
b. Dependent Variable: Revenue collection

From the model summary The R square value in Table 4.19 is 0.502 which clearly suggests that there is a strong relationship between blending of kerosene into petrol, blending of kerosene into diesel and blending the amount of gasoline into automotive gasoline and revenue collection as indicated in table above. This indicates that blending of kerosene into petrol, blending of kerosene into diesel and blending the amount, blending the amount of gasoline into automotive gasoline share a variation of 50.5% of revenue collection in Kenya .

The overall goodness of fit was obtained through regressing the goodness of fit for all the independent variables. The results of the multiple regression indicate R^2= .505 and adjusted R=.453 as shown in Table 4.19. This is an indication that there is a strong relationship between independent variables and customs revenue collection.

Table 4.19: ANOVA for independent and dependent variables

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	28.376	1	5.466	11.338	.000[b]
	Residual	28.262	155	.513		
	Total	45.629	155			

a. Dependent Variable: revenue collection
b. Predictors: (Constant), **Blending of kerosene into petrol, blending of kerosene into diesel and amount of gasoline into gasoline automotive**

The overall model significance was presented using the ANOVA test table. The results in Table 4.19 shows that the overall model was a good fit since (F-value=11.338 and p-value=0.000<0.05) for all independent variables meaning that null hypothesis is rejected and concludes that there is a relationship between different independent and dependent variables. The findings there imply that all independent variables were statistically significant in explaining revenue collection in Kenya. ANOVA was used to test whether the regression analysis model used is fit or the relationship of the variable just occurred by chance.

Significance of F ratio is used to determine whether model used was fit or not. If the F ratio is significant the model used is considered fit and vice versa. A P - value of less than 0.05 indicates that the F statistics is high and that the null hypothesis of independent needs to be rejected since it's not true. In this case the F ratio (F=11.338, P=.000[b]) was found to be significant hence the model used for analysis was fit

Table 4.20: Coefficients of Overall Regression Model

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.195	.096	-	2.054	.044
	Blending of kerosene into petrol	.312	.096	.234	2.266	.016
	Blending of kerosene into diesel	.241	.098	.355	3.560	.043
	Blending amount of gasoline into automotive gasoline	.296	.096	.314	3.061	.022

a. Dependent Variable: Revenue collection

$Y=\beta_0+\beta_1x_1+\beta_2x_2+\beta_3x_{3+\beta_4x_4}+\varepsilon$……….

$Y = 0.195 + 0.312X_1 + 0.241X_2 + 0.296X_3 + 0.315$ were significant with p- values of 0.044, 0.0.16, 0.043 + 0.014, respectively.

The regression equation above has established that taking all factors into account (blending of kerosene into petrol, blending of kerosene into diesel and blending amount of gasoline into automotive gasoline) the findings reveals that assuming other variables are at zero a unit change (increase) in blending kerosene into petrol will lead to a 0.312 increases revenue collection; a unit increase in blending kerosene into diesel will lead to a 0.241 increases revenue collection; a unit increase in blending amount of gasoline into automotive gasoline will lead to a 0.296 increases revenue collection This infers that blending kerosene into petrol affects revenue collection to a great extent followed by then blending kerosene into diesel.

The regression coefficient results indicate a positive significant effect between blending kerosene into petrol, blending kerosene into diesel and blending amount of gasoline into automotive gasoline and revenue collection.

4.7 Discussion of key Findings

The key findings of the study are discussed in this section as per study objectives.

4.7.1 Blending kerosene into petrol and revenue collection

Blending kerosene into petrol was assessed using five measures and the overall mean score or responses regarding blending kerosene into petrol were 2.2 on a 5-point scale which indicates that majority of the respondents agreed that blending kerosene into petrol on revenue collection in Kenya.

The average overall standard deviation of 0.7 infers that 68% of the response was spread within one standard deviation of the overall mean. Further collinearity analysis was done and the results showed that blending kerosene into petrol had positive and significantly related to revenue collection (r = 0.456, p-value=0.00<0.05).

4.7.2 Blending kerosene into diesel and revenue collection

Blending kerosene into diesel was assessed using five measures and the overall mean score or responses regarding blending kerosene into diesel were 1.6 on a 5-point scale which indicates that majority of the respondents agreed that blending kerosene into diesel affects the revenue collection in Kenya. The average overall standard deviation of 0.0.66 infers that 68% of the response was spread within one standard deviation of the overall mean. Further collinearity analysis was done and the results revealed thatblending kerosene into diesel had a positive and significantly related to revenue collection (r = 0.431, p-value=0.00<0.05).

4.7.3 Blending amount of gasoline into automotive gasoline

Blending amount of gasoline into automotive a gasoline was assessed using four measures and the overall mean score or responses regarding blending amount of gasoline into automotive gasoline were 2.5 on a 5-point scale which indicates that majority of the respondents agreed that blending amount of gasoline into automotive gasoline affects the revenue collection in Kenya. The average overall standard deviation of 0.74 infers that 68% of the response was spread within one standard deviation of the overall mean. Further collinearity analysis was done and the results showed that blending amount of gasoline into automotive gasoline had a positive and significantly related to revenue collection compliance (r = 0.458, p-value=0.00<0.05).

CHAPTER FIVE

SUMMARY,CONCLUSIONSAND RECOMMENDATIONS

5.0 Introduction

Chapterfiveoutlinesthesummary ofthisresearch,conclusionsandrecommendations basedonresearchfindingsandsuggestionofareaswhichmay require furtherconsideration as far asfutureresearch is concerned.

5.1 Summary of the findings

The findings of the study have been summarized below as per the study objectives. The findings were supported by the frequencies of the responses

5.1.1 Blending kerosene into petrol

The first objective of the study was to evaluate the effect of blending kerosene into petrol on revenue collection in Kenya. Methods used to arrive at the findings included descriptive statistics, analysis of variance and regression analysis. The study found out that blending kerosene into petrol had a significant positive influence on revenue collection. The overall mean score of responses regarding blending kerosene into petrol indicated that majority of the respondents agreed that blending kerosene into petrol affects the revenue collection in Kenya.

The reliability analysis results showed that all the coefficients of the constructs were positive and significant.

5.1.2 Blending kerosene into diesel

The second objective of the study sought to find out` the effect of blending kerosene into diesel on revenue collection in Kenya.

Descriptive statistics, regression analysis and analysis of variance were conducted. The study found out that blending kerosene into diesel had a significant positive influence on revenue collection. The overall mean score of response regarding blending kerosene into diesel and revenue collection indicated that majority of the respondents agreed that blending kerosene into diesel affects the revenue collection in Kenya. Correlation results indicated that there was a positive and significant relationship between simplification of rules and customs revenue collection. It was therefore concluded that blending kerosene into diesel has significant positive effect on revenue collection.

5.1.3 Blending amount of gasoline into automotive gasoline

The third objective of the study sought to investigate the effect of blending amount of gasoline into automotive on revenue collection compliance in Kenya. Descriptive statistics, regression analysis and analysis of variance were conducted. The study found out that blending amount of gasoline into automotive gasoline had a significant positive influence on revenue collection.

The overall mean score of response regarding blending amount of gasoline into automotive gasoline and revenue collection indicated that majority of the respondents agreed that blending amount of gasoline into automotive gasoline affects the revenue collection in Kenya. Correlation results indicated that there was a positive and significant relationship between blending amount of gasoline into automotive gasoline and customs revenue collection. It was therefore concluded that cross agency dialogue has significant positive effect on revenue collection.

5.2 Conclusions

Data collected and analyzed through both descriptive and inferential statistics established that all independent variables had significant effects on revenue collection.

5.2.1 Blending kerosene into petrol

The study found out that blending kerosene into petrol had a significant positive influence on revenue collection. The overall mean score of responses regarding infrastructure development indicated that majority of the respondents agreed that blending kerosene into petrol affects the v revenue collection in Kenya. The reliability analysis results showed that all the coefficients of the constructs were positive and significant.

5.2.2 Blending kerosene into diesel

The study found out that blending kerosene into diesel had a significant positive influence on revenue collection. The overall mean score of response regarding blending kerosene into diesel and revenue collection indicated that majority of the respondents agreed that blending kerosene into diesel affects the revenue collection in Kenya. Correlation results indicated that there was a positive and significant relationship between blending kerosene into diesel and revenue collection. It was therefore concluded that blending kerosene into diesel has significant positive effect on revenue collection.

5.2.3 Blending amount of gasoline into gasoline automotive

The study found out that blending amount of gasoline into gasoline automotive had a significant positive influence on revenue collection. The overall mean score of response regarding blending amount of gasoline into gasoline automotive indicated that majority of the respondents agreed that blending amount of gasoline into gasoline automotive affects the revenue collection in Kenya.

Correlation results indicated that there was a positive and significant relationship between blending amount of gasoline into gasoline automotive and revenue collection. It was therefore concluded that tax rate has significant positive effect on revenue collection.

5.3 Recommendations.

5.3.1 Managerial recommendations

Thestudy foundthatBlending kerosene into petrol, blending kerosene into diesel and blending amount of gasoline into gasoline automotive were significantlyinfluences revenue collection.Basedonstudyfinding,thisstudyrecommendsthere is need for Kenya Revenue Authority to put mechanisms in order to prevent adulteration of petrol, diesel and gasoline to enhance revenue collection, .

5.4 Suggestions for Further Research

Thestudyrecommends anadditionalstudy ontheotherfactors thataffect petroleum products on revenue collection,

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APPENDICES

APPENDIX 1

INTRODUCTION LETTER

Fred Isaboke Ondieki
P.O Box 59473-00200
Nairobi, Kenya
26th April, 2019.

Dear Respondent,

RE: **DATA COLLECTION**

I am a student at KESRA currently undertaking a research study to fulfill the requirements of the Award of Post Graduate Diploma in Tax Administration on the factors affecting petroleum products on revenue collection in Kenya**.** You have been selected to participate in this study and I would highly appreciate if you assisted me by responding to all questions in the attached questionnaire as completely, correctly and honestly as possible. Your response will be treated with utmost confidentiality and will be used only for research purposes of this study only.

Kindly note that the study will be conducted as academic research and the information you provide will be treated as confidential. Your participation in the exercise is voluntary and so you are free to choose to or not to participate.

Thank you in advance for your co-operation.
Yours Faithfully,

Fred Isaboke Ondieki

APPENDIX 11

QUESTIONNAIRE

SECTION A: GENERAL INFORMATION

This section asks general questions about the respondent. Please use a Tick (✓) or (✗) in spaces provided or appropriately fill in the spaces as per questions provided

1) Please indicate your age bracket: 18-25 years (…) 26- 35 years (…) Over 35 years (…)
2) Gender Male (……) Female (…….)
3) What is your level of study? Certificate (…) Diploma (…) Undergraduate (…) Masters (…)
4) How many years of service do you have in the industry? Below 1 year (…) 1-10 years (…) 11-20 years (……) 21-30 years (……) Above 30 years (…..)
5) How many years have you worked at the ITAX Center, Nairobi?

   Below 1 year (……) 1-5 years (……) 5-10 years (……) above 10 (……)

SECTION B: FACTORS AFFECTING REVENUE COLLECTION ON PETROLEUM PRODUCTS IN NAIROBI COUNTY.

This section asks general questions on blending of petroleum products and its effect on revenue. Please use a Tick (✓) or (x) in spaces provided or appropriately fill in the spaces as per the questions provided.

1. Strongly Agree 2. Agree 3. Not sure 4. Disagree 5.Strongly Disagree

PART 111: BLENDING KEROSENE INTO PETROL

1. Evaluatethe followingstatements and tickwhere appropriate under thechoices below

Where: 1 – Strongly Agree, 2– Agree, 3 – Neutral, 4-Disagreeor5 –StronglyDisagre

Statements	**1**	**2**	**3**	**4**	**5**
Kerosene is easily blended into petrol					
Kerosene is easily available for blending					
Blending of kerosene into petrol has higher financial gain.					

PART B: PART 11: BLENDING KEROSEN E INTO DIESEL

2. Evaluatethe followingstatements and tickwhere appropriate under thechoices below

Where: 1 – Strongly Agree, 2– Agree, 3 – Neutral, 4-Disagreeor5 –StronglyDisagr

Statements	**1**	**2**	**3**	**4**	**5**
Kerosene is easily blended into diesel					
Kerosene is easily available for blending into diesel					
Blending of kerosene into diesel has higher financial gain					

PART 1: BLENDING AMOUNT OF GASOLINE INTO GASOLINE AUTOMOTIVE

3. Evaluatethe followingstatements and tickwhere appropriate under thechoices below

Where: 1 – Strongly Agree, 2– Agree, 3 – Neutral, 4-Disagreeor5 –StronglyDisagree

Statements	**1**	**2**	**3**	**4**	**5**

Gasoline is easily blended into automotive gasoline					
Gasoline is easily available for blending into automotive automotive gasoline					
Blending of gasoline into automotive gasoline has higher financial gain					

THANK YOU FOR YOUR PARTICIPATION

APPENDIX 111: BUDGET

DESCRIPTION	COST PER ITEM	TOTAL AMOUNT (Kshs)
Stationery Photocopying papers Pens, pencils, rubbers Ink cartridge (Printer) Files (12 rim binders)	 10 reams @600/=	**20,000.00**
Personnel Questionnaires administrators Stastician		**20,000.00**
Transport and subsistence Vehicles Subsistence allowance		**10,000.00**
Communication Telephone Internet		**20,000.00**
Other Services Library services Purchase of periodicals and books		**20,000.00**
<u>Total expected cost</u>		**<u>90,000.00</u>**

APPENDIX 1V: WORK PLAN

ACTIVITY (2018)	DECEMBER(2018)	FEBRUARY(2019)	APRIL (2019)
Draft proposal			
Proposal presentation			
Designing the research instrument			
Proposal defense			
Field work & data Collection			
Data Entry / Analysis			
Report Writing			
Presentation of 1st draft			
Presentation of 2nd draft			
Submission of final report			