

**COST-EFFICIENT ASSESSMENT OF AMBULANCE  
SERVICES FOR COMMUNITY CRITICAL CARE  
TRANSPORT NEEDS IN MACHAKOS COUNTY,  
KENYA**

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**Cost-Efficient Assessment of Ambulance Services for Community  
Critical Care Transport Needs in Machakos County, Kenya**

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of Science in Public Health in the Jomo Kenyatta University of  
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## DECLARATION

This thesis is my original work and has not been submitted for a degree in any University.

Signature: .....

Date: .....

**Francis Muchiri**

This thesis has been submitted for examination with our approval as university supervisors

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## **DEDICATION**

I would like to dedicate this thesis to my wife Asenath for the support all through, my son and daughter Elvis & Meghan, my mother for her undying help and encouragement and my brother Titus and family. Lastly to Almighty God for this far I have come is because of His Grace.

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## ACRONYMS AND ABBREVIATIONS

<b>ALS</b>	Advanced Life Support
<b>BLS</b>	Basic Life Support
<b>CI</b>	Confidence Interval
<b>CPHR</b>	Centre for Public Health Research
<b>COHES</b>	College of Health Sciences
<b>DEA</b>	Data Envelopment Analysis
<b>DMU</b>	Decision-making units
<b>EMS</b>	Emergency Medical Services
<b>EMTS</b>	Emergency Medical Technicians
<b>EMOC</b>	Emergency Obstetric Care
<b>IEC</b>	Information, Education and Communication
<b>JKUAT</b>	Jomo Kenyatta University of Science and Technology
<b>KAP</b>	Knowledge Attitude and Practice
<b>KEMRI</b>	Kenya Medical Research Institute
<b>KNBS</b>	Kenya National Bureau of Statistics
<b>KRC</b>	Kenya Red Cross
<b>MDT</b>	Mobile data terminals
<b>NAS</b>	National Ambulance Services
<b>NHS</b>	National Health services
<b>RFICD</b>	Rockefeller Foundation's Information City Dialogues
<b>USA</b>	United States of America
<b>USD</b>	United States Dollar
<b>WHO</b>	World Health Organization

## DEFINATION OF TERMS

<b>Ambulance</b>	<p>A specially equipped motor vehicle, airplane, ship or train for taking/carrying sick or injured people to and from the hospital, especially in the emergencies.</p> <p>It can also be defined as a vehicle for transportation of sick or injured people to, from or between places of treatment for an illness or injury and in some instances will also provide out of hospital medical care to the patient.</p>
<b>Cost</b>	<p>An amount that has to be paid or spent to buy or obtain something</p>
<b>Efficient</b>	<p>Ability to produce a desired effect, product, with a minimum of effort, expense, or waste.</p>
<b>Technical efficiency</b>	<p>The effectiveness with which a given set of inputs is used to produce an output.</p>
<b>Emergency medical services</b>	<p>A type of emergency service dedicated to providing out-of-hospital acute medical care, transport to definitive care, and other medical transport to patients with illnesses and injuries which prevent the patient from transporting themselves.</p>
<b>Critical Care Transport</b>	<p>The provision of medical care by a critical care transport team to a patient requiring critical care transport by a critical care transport agency such that the failure to initiate on an urgent basis or maintain during transport acute medical</p>

interventions, pharmacological interventions, or technologies would likely result in sudden, clinically significant or life threatening deterioration in the patient's condition.

## ABSTRACT

Throughout the world, performances of ambulance services are measured using indicators such as technical efficiency, response time, on-scene time and clients' satisfaction. The aim of this study was to establish whether ambulance service offered by Machakos County were cost-efficient. The study also determined knowledge, attitude and practice of community towards the ambulance services; costs associated with ambulance services as well as identifying the demand and supply transport barriers. A mixed study design was conducted. Multistage sampling was carried out to recruit household's respondents. The technical efficiency scores were computed using Data Envelopment Analysis (DEA) Programme, version 2.1 (DEAP 2.1). The results was based on two inputs (cost incurred on vehicles and medical consumables) and one output (number of kilometers covered monthly by an ambulance). The household survey results demonstrated that residents were aware of free ambulance services, 30-39 years 31.5% (95% CI=26.95-36.05) was the dominant population of which majority had 1- 3 children 66.3% (CI=61.67-70.93). It was reported by majority that the ambulance services were accessible, available and efficient to those who sought them. Between the periods starting March 2014 to May 2015, a total of 12,674 clients were transported by ambulances from the locations to various tires of hospitals, Majority 24.7% (95% CI=23.95-25.45) were in need of emergency obstetric care (EMOC). Annual operational cost was Kshs. 70,328,627; staff salaries 49% (95% CI=48.99-49.01), overheads costs 33.5% and 1.3% for space. The key demand factors were; social cultural, health seeking behaviors and political patronage while supply barriers were; transport costs, operational costs and in-efficient signage. Machakos County Government was operating at an average technical efficiency of 90.6% (95% CI=82.70-98.30). Machakos County ambulance services were operating efficiently (technically), however effort were needed to procure four wheel drive vehicles and advanced life service ambulance.



## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background information

Throughout the world, performances of ambulance services are measured using indicators such as technical efficiency, response time, on-scene time and clients' satisfaction (MacFarlane & Benn, 2009). Delivery of efficient emergency medical services (EMS) is critical in reducing mortality and disability rates, some studies have found important relationship between response time and mortality rate (Sánchez *et al.*, 2010).

Response time performance has been used as an indicator of ambulance service quality for many years. Standards for performance have been in place in England since 1974. These standards specified that 50% of all calls should be responded to within 8 minutes and 95% within 14 minutes in urban services and 19 minutes in rural services (NHS, 2014). In United States the Emergency Medical Services states that; 95% of requests should be served within 10 min in urban areas, whereas, in rural areas, they should be served within 30 min (Ball & Lin, 1994). According to statesman (2013) the move towards standardization is now reaching countries without a history of prescriptive codes, such as India, which approved its first national standard for ambulance construction in 2013.

There are currently no official "response time" standards in the South African system. However, response times of fifteen minutes for high-acuity calls in urban areas are considered acceptable, and in rural areas, response times of up to forty minutes for similar calls are not uncommon (EMS, 2014). In Kenya there is no documented information about ambulance response time standard.

According to Rockefeller Foundation's Information City Dialogues (RFICD, 2013) the Government of Kenya has no coordinated emergency response plan, even though road accidents kill nearly 3,500 Kenyans a year. There are few trained paramedics and fully equipped ambulances, and authorities at all levels do not have emergency

response plans. In a school bus crash that killed at least twenty students and teachers in western Kenya, government air evacuation did not arrive for twelve hours (Ahluwalia, 2003).

In a publication by *Benson Nyagesiba*, 23 October 2013 in a local newspaper *the star* reported what the Kenya Red Cross Society had expressed about the ill-preparedness to manage serious accidents and disasters in the counties. The report went on and said that 90 per cent of ambulances issued to government hospitals are put to the wrong use rather than attend to emergencies.

Transport and road infrastructure play key roles in the overall delivery and access to health services, and by extension, contribute to the effectiveness of the health referral process (Barnes *et al.*, 1998). Many households do not have reliable, suitable, and affordable transport services that are essential for access to care during the critical periods such as when life-threatening conditions occur either at home or outside environment. Barnes *et al.* (1998) argues that emergency access to care is also critical especially in common conditions such as during childbirth-related complications are unpredictable and the majority of births in developing countries continue to take place at home. Various financial, social and institutional factors of supply and demand impose severe constraints on the effectiveness of transport means. Moreover, families in low resource settings often cannot afford the ambulance costs to health facilities (Barnes *et al.*, 1998; Kobusingye *et al.*, 2005). Other factors that potentially contribute to the delay in access of emergency care include the family's decision to seek care, the availability of suitable transport, and the perceived availability and quality of health services.

## **1.2 Statement of the problem**

Emergency care usually begins in the community, when someone identifies a perceived emergency condition and attempts activation of the local EMS system. This ideally triggers a cascade of events resulting in a timely response of expertise, resources, and service directed to patient stabilization and/or safe emergency patient transportation to the nearest appropriate facility (Kobusingye *et al.*, 2006; Mould-Millman *et al.*, 2014; Sasser *et al.*, 2005). The current norm in many low- and

middle-income countries is, however ironic, to use a private vehicle or a taxi to transport the injured or ill person to the hospital, even when EMS has an active presence in these communities (Tiska *et al.*, 2004). Inadequate ambulances have also being a major challenge in the developing countries whereby you find a single ambulance needed to cover a large geographical area. This becomes impossible because the infrastructure of these nations is poor leading to rapid wearing of the ambulance translating to poor performance (Mould-Millman *et al.*, 2014).

The common most referenced barrier to healthcare in Kenya is the high cost of treatment (Morgan *et al.*, 2017). This is still the case when focusing on transportation of a patient whereby most Kenyan can't afford to pay for ambulance services particularly when private medical institutions are involved. Majority of sub-Saharan Africa and Asian countries have been unable to sustain the fleet of ambulances and other vehicles which had been envisaged as part of a publicly-funded health services. As a result, ambulances are used only to transfer patients between health facilities and not from the scenes of injury / accidents or from their homes (Kobusingye *et al.*, 2005). Moreover, privately operated ambulances are rarely available in many rural areas, and where available, it is often not affordable. As a result, patients are most likely to reach nearest medical facilities by walking. Others opt to use private means (taxi, private cars or public bus vehicles - *matatus*). The equipments found in the ambulances are not suitable to handle patients who need specialized care.

Response time for ambulances in Kenya is not standardized with each operator having their own response time. The twin problem of non-availability of ambulances for community-based emergency transport as well as public health facilities unable to sustain publicly-funded ambulance vehicles are a major public health concern.

### **1.3 Justification**

Ineffective transport system can result from limited services and slow travel times by various paramedics (the first responders) operating on roads under various surface conditions. Where neither public nor suitable private services are available, some communities have adopted transport measures to improve physical access and reduce delays in reaching point of care. However, there are challenges of institutional

capacity, equity and affordability to sustain such initiatives. In some countries, privately operated transport is used with the cost being reimbursed by the health sector to address equity issues (Kobusingye *et al.*, 2005). Where a motor vehicle service is not available, alternative lower cost forms of transport, such as bicycle or motorcycle ambulances, have been used with some success. Community and county government interventions to make ambulance affordable have mostly focused on financial arrangements to facilitate payment for transport services. These arrangements usually complement the more expensive private arrangements and thereby increase access to health facilities. A study by Pathmanathan (2003) shows that ambulatory medical services provided by the private sector are financed by user fees. There is little awareness of ambulance services in Kenya, which call for the government to be aggressive in enlightening the citizens on the importance of having emergency hotline numbers. These are the help lines which can be called by anybody in an event of emergency for ambulance services. This will prevent use of other means of transport to clients who might need specialized care during transportation leading to deterioration of their conditions. The type of the vehicle also matters, for instance a two wheel drive vehicle will not access poorly maintained rough roads that are a common problem in Kenya.

This study therefore aims at documenting the experiences of operating (technical efficiency) of publicly financed and operated ambulances as part of a community initiative under the primary health care strategy adopted by County Government of Machakos.

#### **1.4 Research Questions**

1. What is the level of knowledge, attitude and perception of the community on the Machakos County financed ambulance services?
2. What are the financial costs associated with ambulance services operated by Machakos County Government?
3. Which are the barriers associated with the demand and supply of ambulance services in Machakos County?

4. What is the cost-efficient index of ambulance service management for public healthcare providers?

## **1.5 Objectives**

### **1.5.1 Broad objective**

To determine the cost-efficient ambulance services appropriate for community critical care transport needs in Machakos County.

### **1.5.2 Specific Objectives**

1. To determine the level of knowledge, attitude and perception of the community on the Machakos County financed ambulance services.
2. To determine financial costs associated with ambulance services operated by Machakos County Government.
3. To identify the barriers associated with the demand and supply of ambulance services in Machakos County.
4. To determine the cost-efficient index of ambulance service management for public healthcare providers.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

For users of the health service, an ambulance call is often the first point of contact, and the mere knowledge that the service is available is a source of reassurance to many. By and large this confidence is not misplaced, ambulances have saved a lot of lives. But that does not mean no changes are necessary, to improve the ambulance services in Kenya especially for patient who need critical care. This should be geared to improving efficiency and performance of ambulance services in a manner which can be sustainable.

Most people see an ambulance and think that they are all the same. However, there are a few ambulances known as critical care transport ambulances that may appear the same on the outside, but are very special on the inside. Critical care ambulances are staffed with at least one paramedic and one critical care nurse. The nurse adds the ability to deal with medications and technology that are not part of paramedic training, such as ventilators, IV pumps, and specialized lines like arterial lines or pulmonary artery catheters. Critical care transport ambulances cannot pick and choose their patients or the patients' conditions. The critical care ambulances are stocked with medications and equipment to care for every type of patient they may need to transport. They carry most medications that emergency room or intensive care unit have, from adrenaline to propofol, and can administer the same medications one can receive at the hospital (Pathmanathan *et al.*, 2004).

The purpose of the ambulance services is to ensure that people lives are saved and protected, no matter their location and time of day when an emergency occurs (NHS, 2014). Other functions of ambulances includes;

- Ambulance services take patients between hospitals; for example, for specialist investigation or treatment.
- Readiness for responding to major incidents and disasters

- Run pre-booked transport for non-emergencies such as outpatient visits, planned admissions, or discharges.

### **2.1.2 History of ambulance**

Ambulance can be traced to the ancient time where they used carts for transporting patient with incurable diseases by use of force. In 1487, the first reportable use of Ambulances for emergency is documented by the Spanish while civilian variants were put into operation during the 1830s. Since then, there have been technological change to the modern self-powered ambulances (Kuehl & Alexander, 2002).

A major advance was made in 1832 with the introduction of a transport carriage for patients with cholera in London for civilians. The Times newspaper said that "The curative process commences the instant the patient is put in to the carriage; time is saved which can be given to the care of the patient; the patient may be driven to the hospital so speedily that the hospitals may be less numerous and located at greater distances from each other (Katherine & Barkley, 1990).

Modern ambulances are custom built, with specialist medical equipment built into the ambulances, the improvements in the industry in vehicle design have had an impact, including improvements in audible and visual warning equipment to help protect crews in vulnerable situations. According to Ross and Bonnyman (2007), there have been improvements to help safeguard the health and welfare of ambulance crews, such as the addition of patient tail lifts, ramps and winches to cut down on the amount of manual handling a crew must perform.

Ambulance design is still evolving, largely due to the growing skills and role of Paramedics and other ambulance crew, which require specialist equipment. Other factors driving improvement include the need to help protect ambulance crews from common accidents, such as traffic collisions and rarer, but potentially catastrophic incidents such as terrorist activities.

## **2.2 Classification of ambulance**

Ambulances can be classified different types depending on whether or not they transport patients, and under what conditions. These are the classes ;( Budge et al., 2010)

**Emergency ambulance** – This type of ambulance provide care to patients with an acute illness or injury. These can be road-going vans, boats, helicopters and fixed-wing aircraft.

**Patient transport ambulance** – A vehicle, which has the job of transporting patients to, from or between places of medical treatment for non-urgent purposes.

**Response unit (fly car)** – A vehicle which is used to reach an acutely ill patient quickly, and provide on scene care, but lacks the capacity to transport the patient from the scene. Response units may be backed up by an emergency ambulance which can transport the patient, or may deal with the problem on scene, with no requirement for a transport ambulance.

**Charity ambulance** – A special type of patient transport ambulance is provided by a charity for the purpose of taking sick children or adults on trips or vacations away from hospitals, hospices or care homes where they are in long term care.

**Bariatric ambulance** – An ambulance for obese patients.

## **2.3 Service provider**

These are ambulance service providers in most countries. These service providers require qualified personnel although some differences can be observed.

**Government Ambulance Service** – This are local or government funded ambulances operating separately from the fire and police service, found in big cities, whereas in countries such as Great Britain almost all emergency ambulances are part of a nationwide system under the National Hospital Service “National Audit office”(NAS, 2011).



**Fire or Police Linked Service** – In countries like the United States they are funded by local or national government whereas in others like France ambulances can be operated by the local fire or police service. This is particularly common in rural areas, where maintaining a separate service is not necessarily cost effective (NAS, 2014).

**Volunteer Ambulance Service** – Charities or non-profit companies operate ambulances, both in an emergency and patient transport function. This may be along similar lines to volunteer fire companies, providing the main service for an area, and either community or privately owned. The Red Cross provides this service across the world on a volunteer basis (British Red Cross, 2014) and in others as a Private Ambulance Service, as do other smaller organizations such as St John Ambulance. These volunteer ambulances may be seen providing support to the full-time ambulance crews during times of emergency.

**Private Ambulance Service** – These are commercial companies with paid employees, but often on contract to the local or national government. Private companies may provide only the patient transport elements of ambulance care, but in some places, they are contracted to provide emergency care, or to form a 'second tier' response (Budge et al., 2010)

**Combined Emergency Service** – these are full emergency service agencies, which may be found in places such as airports or large colleges and universities. Their key feature is that all personnel are trained not only in ambulance (EMT) care, but as a firefighter and a peace officer (police function). They may be found in smaller towns and cities, where size or budget does not warrant separate services. This multi-functionality allows to make the most of limited resource or budget, but having a single team respond to any emergency.

**Hospital Based Service** – Hospitals may provide their own ambulance service as a service to the community, or where ambulance care is unreliable or chargeable. Their use would be dependent on using the services of the providing hospital.

**Charity Ambulance** – This special type of ambulance is provided by a charity for the purpose of taking sick children or adults on trips or vacations away from hospitals, hospices or care homes where they are in long term care.

**Company Ambulance** – Where large companies and factories have ambulance services provided by employers as a means of protecting their interests and the welfare of their staff.

#### **2.4 Air medical services**

Air Medical Services is a comprehensive term covering the use of air transportation, airplane or helicopter, to move patients to and from healthcare facilities and accident scenes. An air ambulance is a specially outfitted aircraft that transports injured or sick people in a medical emergency or over distances or terrain impractical for a conventional ground ambulance. These and related operations are called *aeromedical*. In some circumstances, the same aircraft may be used to search for missing or wanted people.

According to Lam, 1990 the use of air to transport patient's dates to World War 1, but its role was expanded dramatically during the Korean and Vietnam conflicts. The first hospital-based air medical service began in Denver at St. Anthony hospital in 1972. Helicopters are used to transport patients between hospitals and from trauma scenes; fixed-wing aircraft are used for long-distance transports.

Effective use of helicopter services for trauma depends on the ground responder's ability to determine whether the patient's condition warrants air medical transport. The advantages of medical transport by helicopter may include providing a higher level of care at the scene of trauma and improving access to trauma centers (Branas et al., 2005). Helicopter-based emergency medical service (EMS) also provides critical care capabilities during inter-facility transport from community hospitals to trauma centers (Burney et al., 1995).

Some have questioned the safety of air medical services (Meier & Saul, 2005; Levin & Davis, 2005). While the number of crashes may be increasing, the number of

programs and use of services has also increased (Isakov, 2006). Factors associated with fatal crashes of medical transport helicopters include flying at night and during bad weather, and post-crash fires (Isakov, 2006).

## **2.5 Safety**

Like any other vehicles, ambulances are required to operate in all weather conditions, including those during which civilian drivers often elect to stay off the road. Also, the ambulance crew's responsibilities to their patient often preclude their use of safety devices such as seat belts. Research has shown that ambulances are more likely to be involved in motor vehicle collisions resulting in injury or death than either fire trucks or police cars. Becker et al. (2003) suggest that unrestrained occupants, particularly those riding in the patient-care compartment, are particularly vulnerable. When compared to civilian vehicles of similar size, one study found that on a per-accident basis, ambulance collisions tend to involve more people, and result in more injuries (Ray & Kupas, 2005). An 11-year retrospective study concluded in 2001 found that although most fatal ambulance crashes occurred during emergency runs, they typically occurred on improved, straight, dry roads, during clear weather (Kahn, Pirrallo & Kuhn, 2001). Furthermore, according to Baker Tilly (2014) paramedics are also at risk in ambulances while helping patients, as 27 paramedics have died during ambulance trips in the US since 1991 as of March 5, 2006. In Kenya no documents showing the required safety standards for ambulances.

## **2.6 Equipment**

Modern ambulances are fitted with a range of additional equipment's to those directly used for the treatment of patients, for the purpose of facilitate patient care. This could include:

**Two-way radio:** It very important to have medium of communication during an emergency to pass information to the control Centre and to the ambulance. To achieve this a two way radio system is needed, Most recently many services worldwide have moved from traditional analog UHF/VHF sets, which can be

monitored externally, to more secure digital systems, such as those working on a GSM system (Levick & Saul, 2007).

**Mobile data terminal:** Ambulances are fitted with Mobile data terminals (MDTs), which are connected wirelessly to a central computer, usually at the control center. These terminals can function instead of or alongside the two-way radio and can be used to pass details of jobs to the crew.

**Evidence gathering CCTV:** Video cameras fitted in the ambulance used to record activity either inside or outside the vehicle. They may also be fitted with sound recording facilities. This can be used as a form of protection from violence against ambulance crews, or in some cases to prove or disprove cases where a member of crew stands accused of malpractice (Budge et al., 2010).

**Tail lift or ramp:** Tail lift or ramps are fitted in ambulances in order to facilitate loading a patient without having to undertake any lifting. It's of much importance when the patient is obese or specialty care transports that require large, bulky equipment such as a neonatal incubator or hospital beds. There may also be equipment linked to this such as winches which are designed to pull heavy patients into the vehicle (Levick & Saul, 2007).

## CHAPTER THREE

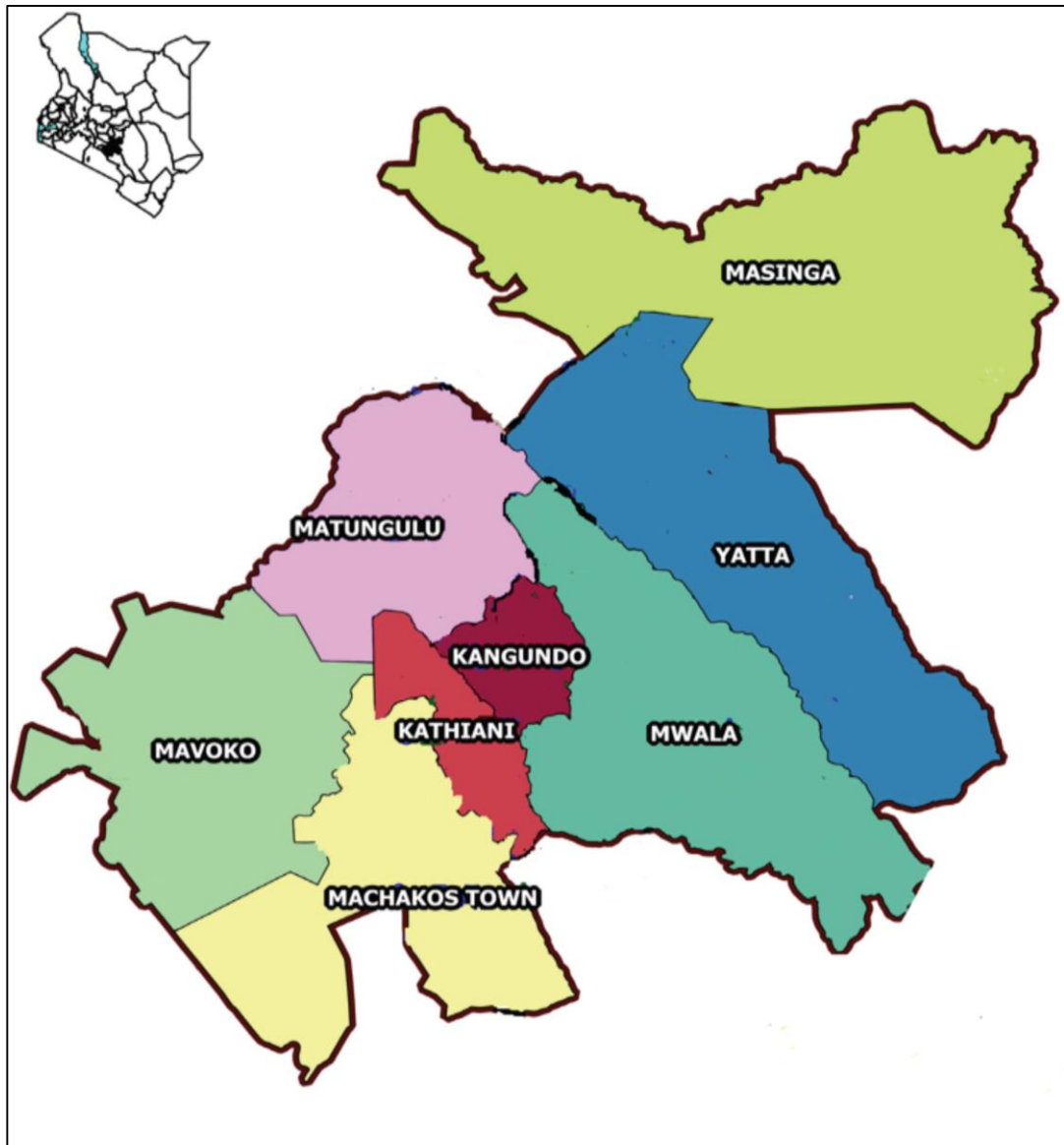
### MATERIALS AND METHODS

#### 3.1 Study site

This study was conducted in Machakos County which is one of the 47 counties in Kenya. Its head quarter is Machakos town. Machakos County stretches from latitudes 0° 45' South to 1° 31' South and longitudes 36° 45' East to 37° 45' East (Machakos Wikipedia, 2015). The county has a population of 1,098,584 people, 264,500 households and covers an area of 6,208 Sq. km (KDHS, 2009). The Population density is 177 persons per sq.km. Akamba people are the dominant habitants of the county. The county borders Nairobi and Kiambu counties to the West, Embu to the North, Kitui to the East, Makueni to the South, Kajiando to the South West, and Muranga and Kirinyaga to the North West (GOK, 2009). The County has eight (8) constituencies; Machakos Town, Mavoko, Masinga, Yatta, Kangundo, Kathiani, Matungulu, and Mwala.

Subsistence agriculture is mostly practiced with maize and drought-resistant crops such as sorghum and millet being grown due to the areas semi-arid climate. However, the County also plays host to the open air market concept with major market days where large amounts of produce are traded. Fruits, vegetables and other food stuffs like maize and beans are sold in these markets.

The local climate is semi-arid with hilly terrain with an altitude of 1000 to 2100 metres above sea level. Tourist related activities such as camping, hiking safaris, ecotourism and cultural tourism, dance and music festivals among many more are more excitingly done due to the hilly terrain. The hospitality industry in the region is decent.



**Figure 3.1: A map of Machakos administrative regions (Source: KNBS)**

### **3.2 Research design**

A mixed study design was used. This involved collection and analysis of both quantitative and qualitative data to achieve the objectives.

### **3.3 Study population**

The study population was household heads, Ambulance Fleet Manager, Procurement Officer and Human Resource Manager of Machakos County Emergency Services.

### **3.4 Inclusion and exclusion criteria**

#### **3.4.1 Inclusion criteria**

- The ambulance fleet manager
- Human Resource Manager
- Procurement officer of the Machakos County Emergency Services.
- All household heads in Machakos County with an eligible adult willing to consent to take part in the study.

#### **3.4.2 Exclusion criteria**

Households in Machakos County with members not willing to consent.

### **3.5 Sampling method**

#### **3.5.1 Ambulance operations**

The ambulance fleet Manager, Human Resource Manager and Procurement officer of the public operated ambulances was recruited for they were custodians of the required information.

#### **3.5.2 Household survey**

Multistage sampling technique was used for the household survey. Using the 8 sub counties as the sampling frame, I randomly peaked one administrative ward in each sub county and randomly peaked one village using simple random tables and sampled for 50 respondents in 50 households to achieve a sample size of 400. A sampling interval of every 27<sup>th</sup> household will be used in every selected village whereby if the 27<sup>th</sup> household has no eligible respondent the 28<sup>th</sup> household will be sampled. The interval was arrived by taking all households in the county (264,500)

divided by the 40 administrative wards then divided by an average of 5 villages in each ward (1,323) then divided by 50 to give an interval of 27.

### **3.6 Sample size determination**

The ambulance fleet Manager, Human Resource Manager and Procurement officer of the public operated ambulances was recruited for they were custodians of the required information.

Household survey: The study will use a 95% level of confidence and determine the sample size using Yamane formula (Yamane, 1967). The actual population was derived from all the households in Machakos County which was 264, 500 (KDHS, 2009).

Sample size calculation formula (Yamane,1967).

$$n=N/(1+N(e^2))$$

Where:

n = Sample size

N =the population size (no. of households in county

+e= error-95% level of confidence (0.05).

$$n=258,761/(1+258,761(.05^2))=399.4$$

$$n=400$$

### **3.7 Variables**

Independent variables

Unit cost



Overhead cost

Conditions of emergencies

Knowledge

Distance covered by ambulances in kilometers

Dependent variables

Technical efficiency (Decision Making Units)

### **3.8 Data collection**

The data was collected using a key informant interview guide, desk review and semi structured household questionnaires. A key informant interview guide was used to get information about duration of operation, number of ambulances, challenges faced, staff qualifications, improvements which they propose to upgrade the ambulance services.

Desk review was conducted to obtain data on ambulance costs, depreciation rate of ambulances, overheads, paramedics costs, replenishment of consumables costs, distance covered by ambulance per month and the various destinations of the ambulances.

Household questionnaires were used to obtain data on community knowledge, attitude and perception on the ambulance services offered by the county government.

### **3.9 Data management and analysis**

#### **3.9.1 Data type**

There were two types of data sets to be collected. The fiscal data (i.e. cost data). The second category was operational data such as; distances covered in a year, number of ambulances, number of paramedics, consumable data.

**Table 3.1: Category of data and source of the information**

<b>Category of Data</b>	<b>Where to get the information</b>
<u>Cost Data</u>	
<ul style="list-style-type: none"> <li>• Purchase price of a new ambulance</li> <li>• Fuel &amp; maintenance costs of ambulance</li> <li>• Paramedic costs</li> <li>• Consumables cost (bandages /oxygen)</li> <li>• Depreciation rates</li> </ul>	<ul style="list-style-type: none"> <li>• Vehicle sellers such Toyota Kenya</li> <li>• Unaudited annual financial reports</li> <li>• Unaudited annual financial reports</li> <li>• Unaudited annual financial reports</li> <li>• Unaudited annual financial reports</li> </ul>
<u>Operations Details</u>	
<ul style="list-style-type: none"> <li>• Number of staff</li> <li>• Kilometers travelled by the ambulance</li> <li>• No. of patients ferried per year</li> <li>• Knowledge, attitude and perception</li> </ul>	<ul style="list-style-type: none"> <li>• HR records</li> <li>• Log books of vehicles</li> <li>• Staff reports / patient reports</li> <li>• Community (households)</li> </ul>

### **3.9.2 Data management and analysis**

**Quantitative Data Analysis:** To determine the cost-efficient (technical efficiency) levels, Data Envelopment Analysis (DEA) version 2.2 (DEAP 2.1) software which was designed by Coelli was used, which measures the relative efficiencies of services with multiple inputs and multiple outputs. The range of services offered is called the decision-making units (DMUs). DEA assigns pre-determined weights to the inputs and outputs of a DMU which in return gives it the best possible efficiency. It thus arrives at a weighting of the relative importance of the input and output variables that

reflects the emphasis that appears to have been placed on them for that particular DMU. At the same time, though, DEA then gives all the other DMUs the same weights and compares the resulting efficiencies with that for the DMU of focus.

DEA formula used was:

$$\text{Efficiency} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}}$$

Which introducing the usual notation can be written as;

$$\text{Efficiency of unit } j = \frac{u_1 y_{1j} + u_2 y_{2j} + \dots}{v_1 x_{1j} + v_2 x_{2j} + \dots}$$

where

- $u_1$  = the weight given to output 1
- $y_{1j}$  = amount of output 1 from unit j
- $v_1$  = weight given to input 1
- $x_{1j}$  = amount of input 1 to unit j.

**Qualitative Data Analysis:** For the key informants interviews (KIIs), themes based on the various responses from the respondents were constructed. The outputs were used to explain some the demand and supply patterns from the qualitative findings.

For the household questionnaires, data was entered into excel and cleaned by checking for consistency and missing values. The data was later transferred to SPSS where all the variables were coded and checked once again for consistency. The data analysis was largely descriptive with the results displayed in frequency tables and graphs. Cross tabulations were also done to compare how key demographic variables related to knowledge, access, awareness and quality of the ambulance services. The

interpretation of the data and discussion was systematic whereby all the tables and graphs are explained to give further insights into the data.

### **3.10 Ethical considerations and approval**

Ethical consideration included, but not limited to; respect of respondent privacy and freedom, the right to self-determination, autonomy, volunteerism, confidentiality and safety. Clearance to carry out the study was sought from Kenyatta National Hospital/University of Nairobi (KNH/UoN) Ethical Review Committee. Permission to carry out the research in Machakos was sought from the County government of Machakos, Department of health.

The research was voluntary and none of the respondents was coerced to take part in it, however the researcher took time to explain to the respondents the importance of the study to them and that their participation was highly appreciated. All the data collected was for educational purposes and no information will be reproduced without the consent of the County officials and the investigator.

The respondents were assured that their participation was to be kept confidential and used solely for purpose of research and they will remain anonymous.

## CHAPTER FOUR

### RESULTS

#### **4.1 Knowledge, attitude and perception of the community on the Machakos County ambulance services**

##### **4.1.1 Demographic characteristics of the respondents**

Out of 400 respondents 243 (60.8%) were males while 157 (39.2%) were females. Majority 31.5% (95% CI= 26.95-36.05) were between ages 30-39 years with the least being above 60 years at 4.5 % (95% CI=2.47-6.53). A total of 333 respondents out of the 400 reported to be married with only 8 reporting to be widows. The respondents reported to have undergone through formal education with only 14 (3.5%) reporting not having any kind of formal education. Majority of the respondents were Christians 98.5% (95%CI=97.31-99.69) the rest being Muslims. The sizes of the families were small with majority reporting to having 1-3 children 66.3% (95% CI=6.67-70.93), 4-6 children 15.5% (95% CI=11.95-19.05) and above 6 children at 5.3% (95% CI=3.1-7.5). Majority of the respondents 384 (96%) reported that they earned above Kshs. 15,000 monthly with a minority of 15 reporting to be earning less than kshs.5,000 (as shown in Table. 4.1).

**Table 4.1: Demographic characteristics of the respondents**

<b>Demographic characteristics</b>	<b>Frequency(n=400)</b>	<b>Percentage [95% C.I.]</b>
<b>Sex of the respondents</b>		
Male	243	60.75 (55.96-64.54)
Female	157	39.2 (34.42-43.98)
<b>Age of the respondents</b>		
18-29 years	64	16 (12.41-19.59)
30-39 years	126	31.5 (26.95-36.05)
40-49 years	107	26.7 (22.36-31.04)
50-59 years	85	21.3 (17.29-25.31)
Above 60 years	18	4.5 (2.47-6.53)
<b>Marital status</b>		
Married/cohabited	333	83.3 (81.27-85.33)
Single	59	14.8 (11.32-18.28)
Window	8	2.0 (C0.63-3.37)
<b>Education level</b>		
No formal education	14	3.5 (2.0-5.3)
Primary school	40	10.0 (7.06-12.94)
Secondary level	237	59.3 (54.49-64.14)
Tertiary level	109	27.3 (22.93-31.67)
<b>Religion of the respondents</b>		
Christians	394	98.5 (97.31-99.69)
Muslims	6	1.5 (0.3-2.69)
<b>Number of children</b>		
No child	52	13.0 (9.7-16.3)
1-3	265	66.3 (61.67-70.93)
4-6	62	15.5 (11.95-19.05)
Above 6	21	5.3 (3.1-7.5)
<b>Income</b>		
<5000	15	3.8 (1.93-5.67)
5000-10000	31	7.8 (5.17-10.43)
10000-15000	70	17.5 (13.78-21.22)
>15000	284	71.0 (66.55-75.45)
<b>Occupation</b>		
Supported	70	17.5 (13.78-21.22)
Business	163	40.8 (35.98-45.62)
Farming	125	31.3 (26.76-35.84)
Formal employment	42	10.5 (7.5-13.5)

#### 4.1.2 Knowledge on ambulances services (Utility)

All the 400 respondents were aware of the ambulance services offered by Machakos County Government. The color of ambulances was ranked first as the most distinctive feature of Machakos County ambulances with size being ranked the last (as shown in Table 4.2).

**Table 4.2: Distinctive features of Machakos County ambulances**

	Responses (responses ticked all applicable points)
Branding	201
Colour	241
Size	60
Type of vehicle	93

Radio was the main source of information on products and services offered by the ambulances at 79.3% (95% CI= 75.33-83.2), television at 20.5% (95% CI=16.54-24.46) and newspapers at 0.3% (95% CI=0.24-0.84). All the respondents reported that the ambulance services offered by the county were free of charge.

#### 4.1.3 Access to the ambulances

Out of 400, 207 (51.75%) respondents reported that they had not or a member of their family being transported by the county's ambulances. Out of 207 respondents, 166 reported that the ambulances were easily accessible, 38 saying that they were not accessible and only 3 giving no opinion.

Out of the 193 respondents who had an experience with the ambulance services only 3 reported that they were not accessible with the majority reporting they were easily accessible.

Majority 305 (78.25%) of respondents said they had never encountered a community member complain on the ambulance services. The 95 respondents who reported

having encountered a complain mainly was due to poor response time 39 (41%), Inefficient communication 25(26.3%), poorly stocked ambulances 22 (23.15%), Incompetent paramedics 7 (7.3%) and the least being poor ambulance policies 2 (2.1%).

In the event of an emergency 89% (95% CI=82.6-89.4) of the respondent said that Machakos ambulances would arrive at the scene in good time with 8.3 % (95% CI=5.6-11) reporting the response time was poor and a minority of 2.8 %(95% CI=1.18-4.42) giving no opinion. The opinion of the respondent was that the ambulance services were available to everyone 335 (83.75%) with a minority of 65 (16.25%) reporting otherwise.

When asked if the ambulance service meet the demand of the community, Majority 52.8% (95% CI=47.91-57.69) said they were in agreement, 35.5%(95% CI=30.81-40.19%) strongly agreeing with only 1.3%(95% CI=0.19-2.41) giving no opinion to the question (Table. 4.3).

**Table 4.3: Attainment of community ambulance services demand**

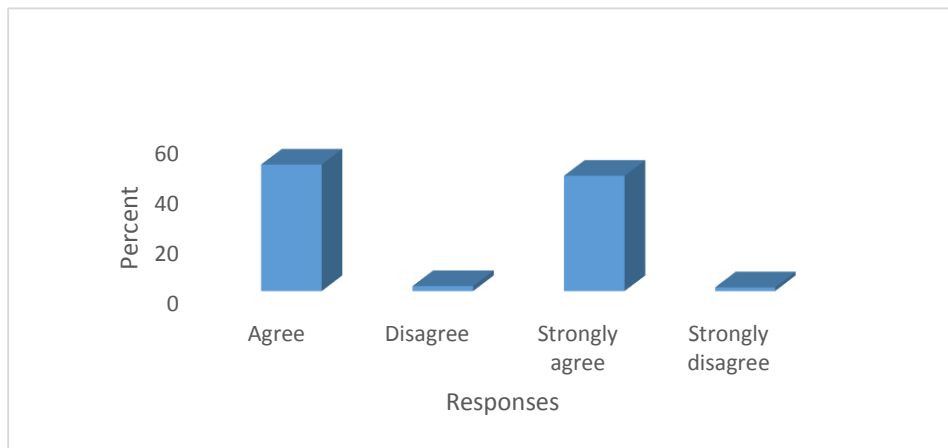
	<b>Frequency</b>	<b>Percentage [95% C.I.]</b>
Agree	211	52.8 (47.91-57.69)
Disagree	32	8.0 (5.34-10.66)
No opinion	5	1.3 (0.19-2.41)
Strongly agree	142	35.5 (30.81-40.19)
Strongly disagree	10	2.5 (0.97-4.03)

#### **4.1.4 Awareness of the ambulance services offered**

Only 6 (1.5%) respondents reported not being aware of the free ambulance service offered by Machakos County government with the majority 394 (98.5%) being aware of the free services. Out of 400,202(50.5%) respondents reported that ambulance

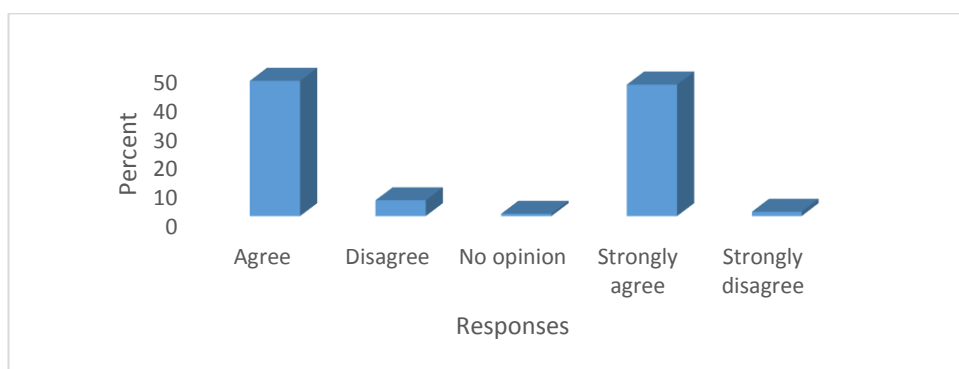


services were affordable with 184 (46%) strongly agreeing, 8 (2%) disagreeing and 6 (1.5%) strongly disagreeing (as shown in Figure. 4.1).



**Figure.4.1: Affordability of ambulance service**

Generally there was good uptake of the ambulance services in Machakos County with 187 (46.75%) agreeing and 182 (45.5%) strongly agreeing; 22(5.5%) disagreeing, 6 (1.5%) strongly disagreeing and only 3 (0.75%) giving no opinion (as shown in Figure. 4.2).



**Figure 4.2: Uptake of ambulance services offered by Machakos County**

#### 4.1.5 Quality of the Services

Majority of the respondents 190(47.5%) agreed that the quality of ambulance services offered were good with 30 disagreeing and only 3 giving no response. Majority 66.3% (95% CI=61.67-70.93) of the respondents said that the ambulance model offered by the County was efficient, 22.8% (95% CI=18.69-26.91) strongly agreeing and 1.5% (95% CI=0.31- 2.69) strongly disagreeing that the model was efficient.

When asked whether the county seeks for community opinion before implementing any new product in the emergency medical services, minority 35 (8.75%) of the respondents strongly disagreed, 75 (18.75%) gave no opinion, 85 (21.25%) disagreed and a majority of the respondents being in agreement (agree 154 and strongly agree 51).

**Table 4.4: Responses on County seeking community opinion before implementing a new product**

	<b>Frequency</b>	<b>Percentage [95% C.I.]</b>
Agree	154	38.5 (33.73-43.27)
Disagree	85	21.3 (17.29-25.31)
No opinion	75	18.8 (14.97-22.63)
Strongly agree	51	12.8 (9.53-16.07)
Strongly disagree	35	8.8 (6.02-11.58)

#### 4.1.6 Improvements on ambulance service in Machakos County

Out of 400respondents, 347 (86.75%) stated that they were satisfied with the ambulance services which were being offered. However, 53 (13.25%) were not satisfied and pointed out area which they felt needed to be improved. The breakdown of those who needed improvement is given in table 4.5.

**Table 4.5: Responses on areas which needed improvement**

<b>Areas of improvements</b>	<b>Responses</b> (respondents ticked all applicable point)
Upgrading their vehicles	15
Equipping their ambulance well	14
Improve on their communication channels	49
Standardize their response time	38
Increase the number of ambulances	53
Mass campaign to enlighten the public	37

#### **4.1.7 Distribution of cases (clients) transported by ambulances**

Between the periods starting March 2014 to May 2015, a total of 12,674 clients were transported by ambulances from locations to the various tiers of hospitals based on the severity of their condition. Majority of the transported clients 24.7% (95% CI= 23.95-25.45) were those in need for emergency obstetric care (EMOC). Other clients transported by ambulance included; clients involved in road traffic accidents accounting for 10.3% (95% CI= 9.77-10.83), respiratory disorders 9.26% (95% CI=8.76-9.76) and those suffering from gastrointestinal disorders 8.6% (95% CI=8.11-9.09).Rape victims were least transported at 0.03% (95% CI= 0-0.06).Table 3 profiles cases (clients) transported by ambulances for a period of 15 months.

**Table 4.6: Distribution of the various cases (clients) transported by ambulances over a period of 15 months**

<b>Types of Cases</b>	<b>Number of cases reported in 15 months</b>	<b>Mean of cases/ month</b>
EMOC (Deliveries and its complications)	3,153	210.20
Alcoholic coma /intoxication	169	11.27
Assault cases	238	15.87
Burns	115	7.67
Cancers	139	9.27
Cardiovascular disorders (htn, anemia)	868	57.87
CNS disorders	911	61.40
Complicated Malaria	196	12.40
Convulsive disorder	264	17.60
Diabetes and related complications	299	19.93
Musculoskeletal fracture	797	53.80
Poisoning	230	15.33
Rape	4	0.27
Road traffic accidents	1,320	88.00
Animal bites /stings	88	5.87
Gastrointestinal disorders (g/e)	1,104	73.60
Respiratory disorders	1,183	78.87
Drug and food allergies	16	1.07
ENT cases	95	6.33
Genito urinary disease	281	18.73
Others	1,294	86.27

## 4.2 Cost associated with running ambulance services in Machakos County

### 4.2.1 Annual costs for running ambulance services

The cost of running ambulances in Machakos County was as follow; Staff salaries (paramedics) was not available due to a clause in human policy guideline of none disclosure by the County Government. To estimate annual staff salaries, it was taken to account for 49%(95% CI=48.99-49.01) of total annual cost based on a similar study carried out in India by Shankar P.*et al.*2013.Equipments involved in running of ambulances accounted for 4.98%, medical consumables 4.78%, equivalent rental space in Machakos town 1.36%, Overheads cost which included insurance, ambulances servicing, fuelling, electricity and water bills 33.5% (95% CI=33.49-33.51) and IEC (Information, Education and Communication) 6.37% (95% CI =6.36-6.38) of total annual operation costs.

**Table 4.7: Types of costs associated with running ambulance services in Machakos County**

Types of Costs	Monthly Costs Kshs.(USD)	Annually Cost Amount Kshs. (USD)	% of overall cost
Capital Cost			
Purchase of ambulance	-	125,000,000 (1275510.2)*	-
Operational Costs			
Personnel	2,871 ,752 (29303.4)	34,461,027 (351643.1)	49.0%
Equipment's/ consumables	non- 291,667 (2976.2)	3,500,000 (35714.33)	5.0%
Consumables	280,000 (2857.14)	3,360,000 (34285.7)	4.8%
Space	80,000 (816.3)	960,000 (9795.9)	1.4%
Overheads**	1,963,967 (20040.5)	23,567,600 (240485.7)	33.4%
IEC	373,333 (3809.5)	4,480,000 (45714.2)	6.4%
Total Operational Costs	5,860,719 (59803.25)	70,328,627 (717639.0)	100%

Note: \* - this is a onetime payment. Hence not re-current cost.

\*\* - Overheads includes vehicle insurance, ambulances servicing, fuelling, electricity and water bills

#### 4.2.2 Unit cost estimates incurred by the County

The average unit cost per kilometer was Kshs. 30.9(USD 0.32) with a maximum of Kshs. 33.5(USD 0.34) and a minimum of Kshs. 28.7(USD 0.29) Cost per client transported by an ambulance was Kshs. 6,504(USD 66.38).

**Table 4.8: Unit cost in kilometers and patients annually**

<b>Variable</b>	<b>Unit cost in Kshs.</b>	<b>Unit cost in USD</b>
Cost per kilometer	<b>30.9</b>	<b>0.32</b>
Cost per patient transported	<b>6,504</b>	<b>66.38</b>
Net cost per kilometer	<b>30.9</b>	<b>0.32</b>
Net cost per patient transported	<b>6,504</b>	<b>66.38</b>
Maximum unit cost per kilometer	<b>33.5</b>	<b>0.34</b>
Minimum unit cost per kilometer	<b>28.7</b>	<b>0.29</b>

#### 4.3 Demand and supply transport (ambulance) barriers of public healthcare provider in Machakos County.

From key informant interview, key demand (community) factors were social cultural, health seeking behaviors and political patronage. Majority of the locals believed in the healing power of witch doctors whereby they associated illness as a bad omen which had to be undone. Most of the locals in the interior locations were not educated hence most of the time used the mother tongue which was a challenge to the paramedics. The supply (County Government) barriers were transport costs, operational costs, in-efficient signage / mapping direction to the location where the victim were to be peaked and technical output/ambulance upgrade.

**Table 4.9: Demand and supply transport (ambulance) barriers for ambulance services run by Machakos County**

<b>Demand (Community) side</b>	<b>Supply (County Government) side</b>
<p>1. Social cultural factors</p> <ul style="list-style-type: none"> <li>• Traditional beliefs like traditional medicines and witch doctors</li> <li>• Communication of directions to the place of emergency e.g. actual road distances not well articulated</li> <li>• Language - communication for the condition of the casualty to the paramedics</li> </ul>	<p>1. Transport cost</p> <ul style="list-style-type: none"> <li>• Two wheeled vehicles</li> <li>• Long distances</li> <li>• In some locations dilapidated road surfaces</li> </ul>
<p>2. Health seeking behaviors</p> <ul style="list-style-type: none"> <li>• Abuse of the system since its free</li> </ul>	<p>2. Operational costs</p> <ul style="list-style-type: none"> <li>• Fractuating fuel costs</li> <li>• Staff costs</li> </ul>
<p>3. Political patronage</p> <ul style="list-style-type: none"> <li>• Political class interferences</li> </ul>	<p>3. In-efficient signage / mapping direction to the location where the casualties are to be peaked</p>
	<p>4. Technical inputs/ vehicle upgrade</p> <ul style="list-style-type: none"> <li>• Cost of upgrading the ambulances to advanced life support (ALS)</li> </ul>
	<p>5. Motivation of staffs</p>

#### **4.4 Cost-efficient analysis for Machakos County ambulance services**

It was found that Machakos County Government was operating at an average technical efficiency of 90.6% (95% CI= 82.7-98.2). This was based on the following variable; Number of clients transported between January to May 2015; the monthly overheads cost (ambulances only); and medical consumables. All other variables were held constant in a quadratic equation.

## CHAPTER FIVE

### DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Discussion

An effective Emergency Medical Services (EMS) is the main goal of all Ministries of health around the world. However, many developing countries have a long way to go before developing an integrated, efficient, and functional pre-hospital care. Machakos County being in Kenya a developing country shares the same challenges but has been on a strategic plan trying to improve its ambulance services to be the best in the region. Generally ambulances were easily accessible to those who sought them with only (3, n=193) claiming they were not accessible, these results were in agreement with (Morgan *et al.*, 2017) findings in a similar study in Kenya which found ambulance services to be easily accessible. In the event of an emergency 89% (95% CI= 82.6-89.4) of the respondent said that Machakos ambulances would arrive at the scene in good time with 8.3% (95% CI; 5.6-11) reporting the response time was poor this doesn't concur with (Mould *et al.*, 2015) study in Ghana findings which found poor ambulance response time due to poor infrastructure and communication. Majority 66.3% (95% CI=61.67-70.93) of the respondents said that the ambulance model offered by the county was efficient this was in agreement with the results obtained from the Data Envelopment Analysis which found a technical efficiency of 90.6%. Clients in need of emergency obstetric care (EMOC) accounted for 24.7% (95% CI= 23.95-25.45) of all conditions transported, this was consistent with the national focus MOH, 2014 which indicated a high maternal mortality ratio of 488: 100,000. Victims of road traffic accidents was second at 10.3% (95% CI=9.77-10.83).

Annual cost of running the ambulances was Kshs. 70,328,627 (USD. 717,639.). The results found that staff salaries took the major share of the operating costs at 49% (95% CI=48.99-49.01), which was consistent with a study done in India by Shankar P. *et al.* 2013 which found staffs salaries to range between 35- 49% of the total expenditure. Overheads cost accounted for 33% (95% CI=32.99-33.01) of total annual costs. The county had its ambulances services offices situated at the public



office, hence to obtain the cost of space (rent) similar space in the same area were evaluated and was found to be at 1.4% of the total annual cost.

To identify demand and supply barriers of publically financed ambulance services a key informant interview was carried-out with the fleet manger being the respondent. The community represented the demand side since they were at the receiving end from the County. It was found that social cultural factor was one of the major barrier to the uptake of the ambulance services like beliefs of witch doctor being healers, communication of the directions to the paramedics as well as language barrier due to illiteracy level especially in the rural areas. The second barrier was poor health seeking behaviors whereby some members of the community were making fake calls owing to the fact that calling was free (abuse of the free call service). Political patronage was also found to be a barrier in the uptake of the ambulance services whereby political classes drifted the credibility of the free ambulance services. In addition, adapting ambulance services to social and cultural norms especially the desire for accompanying family members to a referral facility have shown to improve the frequency and use of the services as it leads to trust (Krasovec, 2004). The county government (supply) barriers was transport cost; cost of upgrading the two wheeled ambulanced to four wheeled ambulances; long distances covered by the ambulances to get clients; and the dilapidated roads in some of locations. Operational costs barriers like fluctuating fuelling costs as well as staff salaries who have to rise to different job groups. This findings concur with GOK policy for disaster management, 2009 who found that greatest weakness in running government ambulances was inadequate operational funds. In-efficient signage / mapping direction to the location where clients were to be peaked and technical inputs/ vehicle upgrade, cost of upgrading the ambulances to advanced life support (ALS) were other barriers found in Machakos County. Studies in many countries have found that reducing or eliminating transport costs borne by the communities or family members is necessary to ensure access to much needed services. This study showed that transporting a patient cost the county government an average of Kshs. 6,504. This amount indirectly covers the cost of fuel, motor vehicle insurance, onboard medical consumables, a proportion of wear and tear, as well as paramedic salary. This would have been the price each patient would have paid if the vehicles were operating

under a call-and-pay scenario. In the absence of pre-paid insurance schemes, this amount was considerably high for the average rural household earning about a dollar per day. Studies carried out in Burkina Faso and northeast Brazil show that transport costs accounted for 28 percent and 25 percent, respectively, of the total patient costs of using hospital services (Ensor & Cooper, 2004). A study in Bangladesh suggested that transport was the second most expensive item for patients after medicines (Ensor & Cooper, 2004). In rural Sudan, a study showed that about half of the families cited transport costs as the reason for not taking their children with referral need to a hospital (Mohammed et al., 2003).

The average technical efficiency of the Machakos County ambulance services was found to be 90.6% (95% CI=82.7-98.2). This was based on the following variables; Number of clients transported between January to May 2015; the monthly overheads cost (ambulances only) and medical consumables. This technical efficiency found in Machakos County was higher at 90.6% (95% CI=82.7-98.2) compared to (Shankar et al., 2013) study in India which was at 76.8%. However, this model assumes that each ambulance was operating at 90% efficacy. The figure could have been lower if each ambulance was analyzed individually and determine each vehicle contribution to the DEA quadratic model.

## **5.2 Conclusions**

1. The results from the household survey demonstrated that residents were aware of the free ambulance services being offered by the county government, ambulance services were also accessible, available and efficient to those who sought them.
2. The study found that the costs involved in the running of the ambulance services in Machakos County were; staff salaries, Equipments, medical consumables, equivalent rental space in Machakos town, Overheads cost and IEC (Information, Education and Communication).
3. The key demand barriers identified by the study were; social cultural factors, health seeking behaviors and political patronage while the supply barriers were; transport costs and operational costs.

4. The study established that Machakos County Government ambulance services were operating efficiently with an average technical efficiency of 90.6%.

### **5.3 Recommendations**

1. From the demand and supply barriers identified I recommend the Machakos county government to embark on creating massive awareness to all the residents on behavior change and accepting the services offered. The County should also upgrade their ambulances to four wheel drive from the two drive wheeled ambulances.
2. Further studies required to verify the exact distance covered by each ambulance as well as determine the cost of life saved as a result of using this ambulance services.

## REFERENCES

- Ahluwalia, I.B., Schmid, T., Kouletio, M. & Kanenda, O. (2003). An evaluation of a community-based approach to safe motherhood in northwestern Tanzania, *International Journal of Gynecology and Obstetrics*, 82(2), 231-240.
- Baker, T. (2012). New Ambulance Design Protects Paramedics. *Traumatology*, 18(1), 58-64.
- Ball & Lin, L.F. (1993). A reliability model applied to emergency service vehicle location, *Operational Research*, 41(1), 18–36.
- Barkley, K.T. (1990). *The Ambulance*. Hicksville: Exposition Press.
- Barnes-Josiah, D., Myntti, C., & Antoine, A. (1998). The Three Delays as a Framework for examining maternal mortality in Haiti, *Social Science & Medicine*, 46(8), 981-993.
- Becker, LR, Zaloshnja, E, Levick, N, Li, G, & Miller, TR. (2003). Relative risk of injury and death in ambulances and other emergency vehicles. *Accident Anal Preview*, 35(6), 941–948.
- Bosson, N, Redlener, MA, Foltin, GL, Raven, MC, Foran, MP, & Wall, SP. (2003). Barriers to utilization of pre-hospital emergency medical services among residents in Libreville, Gabon: a qualitative study. *Am J Emerg Med.*, 3(4), 172–177.
- Branas, C, C. MacKenzie, EJ, Williams, JC, Schwab, CW, Teter, HM, & Flanigan, MC. (2005). Access to trauma centers in the United States. *JAMA*, 293 (21), 2626–33.
- British Red Cross, (2011). British Red Cross Event First Aid service. *Nursing Standard*, 27(6), 35.

- Budge, S., Ingolfsson, A., Zerom, D., (2010). Empirical analysis of ambulance travel times: The case of calgary emergency medical services. *Management Science*, 56(4), 716–723.
- Burney, RE, Hubert, D, Passini, L, & Maio, R (1995). Variation in air medical outcomes by crew composition: a two-year follow-up. *Annual Emergency Med*, 25(2), 187–92.
- Coelli, TJ. (1996). A guide to DEAP Version 2.1: A data envelopment analysis (Computer) Programme. University of New England, Department of Econometrics. *CEPA Working Paper 8/96*.
- GOK, (2009). *National Policy for Disaster Management in Kenya*, Nairobi: Government Printer.
- Isakov AP, (2005). Souls on board: helicopter emergency medical services and safety. *Ann Emerg Med*, 47(4), 357–360.
- Kahn, CA, Pirralo, RG, & Kuhn, EM, (2001). Characteristics of fatal ambulance crashes in the United States: an 11-year retrospective analysis. *Prehospital Emergy Care*, 5(3), 261–9.
- KDHS, (2009). *Kenya Census*. Kenya demographic health survey. 2015-03-04. Nairobi: KDHS.
- Kobusingye, O., Adnan, C., Hyder, A., David J., Eduardo, B., Romero, C., Charles, M. & Manjul, J., (2005). Emergency medical systems in low-and middle-income countries: recommendations for action. *Bulletin of the World Health Organization*, 83(8), 79-87.
- Kobusingye, O.C., Hyder, A.A., Bishai, D., Joshipura, M., Hicks, E.R. & Mock, C. (2006). *Emergency medical services*. In: Jamison DT, Breman, J.G., Measham, A.R., Alleyne, G., Claeson, M., Evans, D.B. Editors. *Disease control priorities in developing countries*. (2<sup>nd</sup> ed.). Washington (DC): World Bank.

- Krasovec, K. (2004). Auxiliary technologies related to transport and communication for obstetric emergencies, *International Journal of Gynecology and Obstetrics*; 85(1), 14- 23.
- Kuehl, A.E. (2002). *Prehospital Systems and Medical Oversight*. (3rd ed.). Dubuque: Kendall.
- Lam, D.M. (1990). Wings of Life and Hope: A History of Aeromedical Evacuation, *Problems in Critical Care*, 4(4), 477-494.
- Levick, N & Saul, S. (2007). *Motorola and Tetra Ireland Consortium Deliver National Public Safety Network*. USA: Motorola, National Public Safety Network.
- Levin, A. & Davis, R. (2005). Surge in crashes scars air ambulance industry. USA Today. Retrieved from: <http://usatoday.printthis.clickability.com/pt/cpt?action=cpt&title=USATODAY.com+++Surge+in+crash>
- MacFarlane, C. & Benn, C.A. (2009). Evaluation of emergency medical services systems: a classification to assist in determination of indicators. *Emergency medical Journal* 30(2), 18-24.
- Meier, B. & Saul, S. (2005). Fatal crashes provoke debate on safety of sky ambulances. *New York Times*, 8(2), 70-78.
- MOH, (2014). Maternal and new born Health care in Kenya. Ministry of Health. Retrieved from: <http://www.healthpolicyproject.com/kenya>.
- Mohammed, A.L. Fadil, S. Simon, H., Bustreo, N, Shadoul, F. & Suzanne. F. (2003). Integrated management of childhood illnesses strategy: compliance with referral and follow-up recommendations in Gezira State, Sudan/Bulletin of the World Health Organization: *International Journal of Public Health*, 81(10), 708-716.

- Morgan, .C. B., Emilie, J.B., Alexander, P.S., Benjamin, W. & Lee, A.W. (2015). Perceptions of emergency care in Kenyan communities lacking access to formalised emergency medical systems: a qualitative study. *BMJ Open*, 5(2), 123-128.
- Mould, N.K., Oteng, R., A. Zakariah, Osei-Ampofo, M., Oduro, G., Barsan, W., Donkor, P. & Kowalenko, T. (2015). Assessment of emergency medical services in the Ashanti region of Ghana, *Ghana Medical Journal*, 49(3), 51-58.
- Mould-Millman, NK, Naidoo R, de Vries, S, & Stein, C, (2014). Wallis LA.AFEM Consensus Conference, 2013. AFEM Out-of-Hospital Emergency Care Workgroup Consensus Paper: advancing out of- hospital emergency care in Africa-advocacy and development. *Afr J Emerg Med*, 4(2), 90–95.
- NHS, (2011). *A vision for emergency and urgent; the role of ambulance services care*. National health service, UK. Retrieved from <http://www.nhsconfed.org>
- NHS, (2011). *Ambulance Service Information National Audit office*. UK: NHS Direct.
- Nyagesiba, B. (2013 Oct.23). *Road accidents a menace in Kenya; The star newspaper, 23 October*
- Pathmanathan, I., Liljestrand J., Martins, J.M., Rajapaksa, L.C., Lissner, C., De Saliva, A., Selvaraju, S. & Singh P.J. (2003). *Investing in maternal heath: learning from Malaysia and Srilanka*. Washington D.C: The World Bank, health, Nutrition and population department.
- Ray, A.F. & Kupas, D.F. (2005). Comparison of crashes involving ambulances with those of similar-sized vehicles. *Prehospital Emergency Care*, 9(4), 412–5.

- RFICD, (2013). Rockefeller Foundation's Informal City dialogues. Retrieved from <http://nextcity.org/informalcity/entry/help-kenyans-tweet-their-emergencies-and-ambulances-arrive-within-minutes>.
- Ross, P. & Bonnyman, H. (2007). Ambulance Lifts. Retrieved from <http://www.rossandbonnyman.co.uk/specialist-lifts.html#aa>
- Sánchez-Mangas, A., García-Ferrer, A., de Juan. & Arroyo, A.M. (2010). The probability of death in road traffic accidents. How important is a quick medical response. *Accid. Anal. Prev.* 42(4), 1048- 1056.
- Sasser, S, Kellermann, A.L. & Lormand, J.D. (2005). Prehospital trauma care systems. Geneva: World Health Organization. Retrieved from [http://www.who.int/violence\\_injury\\_prevention/publications/services/04\\_07\\_2005/en/](http://www.who.int/violence_injury_prevention/publications/services/04_07_2005/en/)
- Shankar P., Neha, M., Arun, K., Manmeet, K., Gursimer, J & Rajesh, K. (2013). Cost & efficiency evaluation of a publicly financed & publicly delivered referral transport service model in three districts of Haryana State, India. *Indian J Medical Research* 138(15), 1003-1011.
- Skinner, D. & Henry A. (2014). *The Origin of Medical Terms*. Baltimore: Williams &Wilkins.
- St John Ambulance, (2014). *St John Ambulance First Aid Cover for Events*. UK: St John Ambulance.
- Statesman (2013). Ministry gives its nod to national ambulance code, EMS systems in South Africa, Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15680521>
- Tim, E. & Stephanie, C. (2004). *Overcoming Barriers to Health Service Access and Influencing the Demand Side through Purchasing*. Geneva: World Bank.

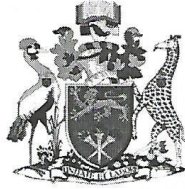


Tiska, M.A., Adu-Ampofo, M., Boakye, G, Tuuli, L. & Mock, C.N. (2004). A model of prehospital trauma training for lay persons devised in Africa. *Emergency Medical Journal*; 21(2), 237–239.

Yamane, T. (1967). *Statistics, an Introductory Analysis*. (2nd Edition), New York: Hamper and Row.

## APPENDICES

### Appendix I: Ethical Clearance Form



UNIVERSITY OF NAIROBI  
COLLEGE OF HEALTH SCIENCES  
P O BOX 19676 Code 00202  
Telegrams: varsity  
(254-020) 2726300 Ext 44355

KNH/UON-ERC  
Email: [uonknh\\_erc@uonbi.ac.ke](mailto:uonknh_erc@uonbi.ac.ke)  
Website: [www.uonbi.ac.ke](http://www.uonbi.ac.ke)



KENYATTA NATIONAL HOSPITAL  
P O BOX 20723 Code 00202  
Tel: 726300-9  
Fax: 725272  
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/332

Link: [www.uonbi.ac.ke/activities/KNHUoN](http://www.uonbi.ac.ke/activities/KNHUoN)

6<sup>th</sup> October 2014

Francis Muchiri Wambura  
TM310-1153-2013  
JKUAT

Dear Francis

**RESEARCH PROPOSAL: COST-EFFICIENT AMBULANCE SERVICE MODEL FOR COMMUNITY  
CRITICAL CARE TRANSPORT NEEDS IN NAIROBI COUNTY, KENYA (P519/08/2014)**

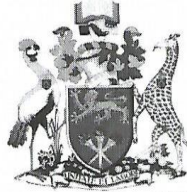
This is to inform you that the KNH/UoN-Ethics & Research Committee (KNH/UoN-ERC) has reviewed and **approved** your above proposal. The approval periods are 6<sup>th</sup> October 2014 to 5<sup>th</sup> October 2015.

This approval is subject to compliance with the following requirements:

- Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
- All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH/UoN ERC before implementation.
- Death and life threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH/UoN ERC within 72 hours of notification.
- Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
- Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal.*)
- Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
- Submission of an *executive summary* report within 90 days upon completion of the study  
This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

For more details consult the KNH/UoN ERC website [www.uonbi.ac.ke/activities/KNHUoN](http://www.uonbi.ac.ke/activities/KNHUoN).

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Ref: KNH-ERC/ MOD/115

13<sup>th</sup> March, 2015

Francis Muchiri Wambura  
 TM310-1153-2013  
 JKUAT

Dear Francis

**Re: Approval of modifications: Cost-effective ambulance service model for community critical care transport needs in Nairobi County, Kenya (P519/08/2014)**

Refer to your communication of 9<sup>th</sup> March, 2015.

The KNH/UoN-ERC has reviewed and approved modification of the following:

1. To change study site from Nairobi County to Machakos County

Yours sincerely

**PROF. M. L. CHINDIA**  
**SECRETARY, KNH/UON-ERC**



- c.c. The Principal, College of Health Sciences, UoN  
 The Deputy Director CS  
 The Chairperson, KNH/UoN-ERC  
 The Principal, College of Health Sciences, UoN

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## Appendix II: Introduction Letter



**JOMO KENYATTA UNIVERSITY  
OF  
AGRICULTURE AND TECHNOLOGY  
COLLEGE OF HEALTH SCIENCES (COHES)**

TEL: 067- 52181-4 Extn. 2226 FAX: 067-52030 Email: director@itromid.jkuat.ac.ke

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JKU/2/37/030

January 8, 2015

TO WHOM IT MAY CONCERN


Dear Sir/Madam

REF: MR. FRANCIS MUCHIRI WAMBURA

This is to confirm that Mr. Francis Muchiri Wambura – TM310-1153/2013 is our Master of Science Student who is collecting data for his MSc.

Any assistance accorded to him is highly appreciated.

Yours faithfully

  
DR. GIDEON KIKVI  
DEAN, SCHOOL OF PUBLIC HEALTH



JKUAT is ISO 9001:2008 Certified  
Setting Trends in Higher Education, Research and Innovation



### Appendix III: Cost Sheet

#### Introduction

My name is Francis Muchiri, an MPH student at Jomo Kenyatta University of Agriculture and Technology. I am the principal investigator in this study that aims at determining the cost-efficient ambulance service for community critical care transport needs in Machakos County for public operated ambulances.

Name of the institution ..... Date .....

Initials of the respondent .....Position in the organization .....

ITEM	UNIT/PERIOD	KSH.
Purchase of ambulance;		
Depreciation rate		
Maintenance cost/overheads		
Fuel cost		
Staff/personnel cost		
Medical consumables replenishment cost		
Equipment's /non consumables		
Rent		
Cost paid by patients;		
Cost per kilometer		
Cost per trip		
Other charges		
Other costs eg, trainings, brochures etc		

Signature of the respondent .....Date .....

## Appendix IV: Workload Sheet

### Introduction

My name is Francis Muchiri, an MPH student at Jomo Kenyatta University of Agriculture and Technology. I am the principal investigator in this study that aims at determining the cost-efficient ambulance service for community critical care transport needs in Machakos County for public operated ambulances.

Name of the institution .....Date .....

Initials of the respondent .....Position in the organization .....

Parameter	Units	Costs
Distance covered by an ambulance/year		
Total number of ambulances		
Number of staff		
Number of patient ferried in an year		
Destinations/ costs		
From home to hospital		
From hospital to hospital		
From hospital to mortuary		
From accident sites to hospitals		
Cost per kilometer (charges)		

Signature of the respondent ..... Date .....

## Appendix V: Key Informant Interview (KII) Guide

### Introduction

My name is Francis Muchiri, an MPH student at Jomo Kenyatta University of Agriculture and Technology. I am the principal investigator in this study that aims at determining the cost-efficient ambulance service for community critical care transport needs in Machakos County for public operated ambulances.

Name of the institution ..... Date .....

Initials of the respondent ..... Position in the organization .....

### Questions *(to be probed by the researcher)*

1. For how long has this County been running ambulance services?/ The new improved ambulance services
2. Currently how many ambulances do you run?
3. Who pays for the ambulance services?
4. What your comment on the sustainability of the ambulance services you run?
5. How often do you replace the ambulances? / What plans do you have for replacing your ambulances?
6. What types of vehicles do your institution prefer and why? (*Probe for the types of vehicles, the source and why the preference*)
7. What are the qualification requirements for your staffs?
8. What number of patients do you ferry per week/month/year?
9. What do you consider emergency in your County? (*Probe whether there are some diseases/illness regarded as emergency*)
10. What is your response time to an emergency? (*Probe if they have laid down their own standard or adopted from another source*)
11. How do you deploy your ambulances in an event of an emergency?
12. Can you give a situation analysis (experiences) of running the ambulance services? Before devolution and after devolution.
13. Which are the challenges facing the ambulance services?

14. What are your suggestions to make the ambulance readily available to the patients?
15. Do regions matters (rural/urban) if yes, what are the factors?
16. Do you keep up to date with technology? If yes, what measures have put in place? (*probe for the current technology and the equipment's fitted in the ambulances*)
17. Do you have monitoring systems in place for the ambulance (control measures)?
18. As a County would you consider hiring/leasing ambulances from a private operator?
19. As a county would you also consider buying ambulances and looking for a company to manage them for you?
20. How many ambulance did you inherit from the former regime and how many are operational? (*give a comparison of the current and previous ambulance*)
21. How efficient is the communication system for emergency situations?
22. Apart from referral and in disasters events what other roles does the ambulances do?
23. What the average cost of stocking an ambulance for a week/month/year?
24. What factors contribute to the success of this ambulance model you are running?
25. What is the maintenance cost for an ambulance per month?
26. What is the purchase price of an equipped ambulance?
27. How do you track your ambulances?
28. How are the ambulances distributed all over the County?
29. What innovative ideas do you consider to continue the success of the ambulance services?

Thank for your time and response.

**Francis Muchiri**



## Appendix VI: Household Questionnaire

**Title: Household Knowledge, attitude and perceptions towards the county funded ambulance services in Machakos County.**

Sub - County:\_\_\_\_\_ Study ID:\_\_\_\_\_ Gender:\_\_\_\_\_

Date:\_\_\_\_\_

### **A. Demographic and socio-economic details**

1. Age \_\_\_\_\_

2. What is your marital status?

- Single
- Married/cohabited
- Divorced/separated
- Widowed

3. What is your level of education?

- No formal education
- Primary school
- Secondary education
- Tertiary

4. What is your religion?

- Christian
- Muslim
- Hindu
- Other (specify)\_\_\_\_\_

5. How many children do you have?

- No child
- 1-3
- 4-6
- Above 6

6. What is your family monthly income in Kshs?

- <5000
- 5000-10000
- 10001-15000
- >15000 (specify how much) \_\_\_\_\_

7. What is your source of income?

- Farming
- Business
- Supported
- Formal employment
- Other (Specify) \_\_\_\_\_

8. What is the occupation of your spouse (if applicable)

- Farming
- Business
- Supported
- Formal employment
- Other (Specify) \_\_\_\_\_

**B: Knowledge on the Ambulances Services (Utility)**

1. Are you aware of ambulance services operated by Machakos County Government?
  - Yes
  - No
2. Which is the distinctive feature which will make you differentiate Machakos County ambulances from others? (tick as many as possible/ applicable)
  - Color
  - Branding
  - Size
  - Type of vehicle
  - Others (specify) \_\_\_\_\_
3. What is your source of information on ambulance services offered by Machakos County Government?
  - Television
  - Radio
  - Newspapers
  - Billboards
  - Posters
  - Road shows
  - Others (specify) \_\_\_\_\_
4. On average, how much does the ambulatory service cost to the client (KShs.)?
  - Free of charge
  - 1000-3000
  - <3000 (specify) \_\_\_\_\_

### **C: Access to the Ambulances**

1. Have you or a member of your family been transported by the County's ambulances?
  - Yes
  - No
2. If yes to Q1, how do you describe the accessibility of the ambulance services?
  - Easily accessible
  - Not accessible
  - No opinion
3. If no to Q1, how would you rate the accessibility of county ambulance services?
  - Easily accessible
  - Not accessible
  - No opinion
4. Have you ever encountered any member of the public complain on the ambulance services offered by the county government?
  - Yes
  - No
5. If yes to Q4, what was the complaint about? (tick as many as possible/ applicable)
  - Inefficient communication
  - Incompetent paramedics
  - Poor stocked ambulances
  - Poor response time
  - High cost of ambulance services
  - Poor ambulance policies
5. In the event of an emergency how would you rate the response time of the county's ambulances?
  - Good

- poor
- No opinion

7. In your own opinion, is the county ambulance service available to everyone?

- Yes
- No

8. The ambulance services offered by Machakos County Government meet demands of the people in the County?

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

**D: Awareness**

1. Are you aware of free ambulance services offered by Machakos County Government?

- Yes
- No

2. The ambulance services offered by Machakos County Government are affordable?

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

3. There is good uptake of ambulance services offered by Machakos County?

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

**E: Quality of the Services**

1. Ambulance services offered by the Machakos County government are of good quality

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

2. The current model of ambulance services in the county is efficient

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

3. The county seeks the opinion of the community members before implementing any new product in the emergency medical services

- Strongly agree
- Agree
- No opinion
- Disagree
- Strongly disagree

**F: Areas of Improvements**

1. Are you satisfied with the ambulance services offered by Machakos County Government?
  - Yes
  - No
  
2. If no, what do you think they should improve on?(tick as many as possible/ applicable)
  - Training their paramedics
  - Upgrading their vehicles
  - Equipping their ambulance well
  - Improve on their communication channels
  - Standardize their response time
  - Increase the number of ambulances
  - Mass campaign to enlighten the public on the importance of ambulance services
  - Others (specify).....

## **Appendix VII: Informed Consent**

### **PART A:**

**Date.....**

**Title of the study:** Cost-efficient evaluation of ambulance services for community critical care transport needs in Machakos County, Kenya.

**Investigators: PI,** Francis Muchiri Wambura, ITROMID/ JKUAT

: Prof. Simon Karanja, JKUAT

: Dr. James Kariuki, KEMRI

**Study location:** Machakos county Ambulance services and Kenya Red cross Machakos branch

### **INTRODUCTION**

My name is Francis Muchiri Wambura, a Masters student at Jomo Kenyatta University of Agriculture and Technology. I am the principal investigator in this study that aims at determining the cost-efficient ambulance service for community critical care transport needs in Machakos County for public operated ambulances. In order to be sure that you are informed about being in this research, am asking you to read (or will read to you) this consent form. The purpose of this consent form is to give you the information you will need to help you decide whether or not to participate in the study. Please read the form carefully. You may ask questions about the purpose of the research, what I would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. Before you decide if you wish to be in this study, you need to know about any good or bad things that may arise if you decide to join.



## **PURPOSE OF THE STUDY**

I am asking you to participate in this study to help us determine the most cost efficient ambulance service to be used by the county governments in Kenya. I would also like to get information on the cost of purchasing, depreciation, payment of services, leasing and maintenance of ambulance so as to find out the most technical efficient model to be adopted by the county government.

## **PROCEDURES**

If you agree to participate in this study by signing at the end of this form, you will participate in the following activities: You will be questioned about ambulance services operation in the Machakos County. You will also be asked questions to assess your knowledge on ambulance services, gaps which you have identified and the way forward to improve the existing services. This interview will take approximately 10– 15 minutes of your time. This will be a one-time assessment.

## **POTENTIAL HARM OR RISKS**

There is no harm or risks associated with participation in the study.

## **BENEFITS**

This research is purely academic and there are no direct benefits to the participants. The findings will benefit science by adding information to solve health challenges in our society.

## **COMPENSATION**

If you agree to participate, you will not be paid for any study procedures to be carried out.

## **CONFIDENTIALITY**

All information relating to your participation in this study will remain private. Your name will not be used; instead, a unique code for each informant will be used. The information will be locked up for information security.

## **ALTERNATIVE TO PARTICIPATION**

Your participation in this study is voluntary. If you do not want to participate there will be no penalty. You may stop your participation at any time without penalty or loss of benefits.

## **CONTACT PERSON'S**

In case of any queries or concerns, please contact the following: The Director; Kenyatta National Hospital/University of Nairobi Ethical review Committee (KNH/UON-ERC), Email [uonknh.erc@uonbi.ac.ke](mailto:uonknh.erc@uonbi.ac.ke) or Jomo Kenyatta university of Agriculture and technology P. O. Box 62200-00200, Nairobi; Tel No 2722541-2713349- 072220590. Or Francis Muchiri Wambura, Principal Investigator cell No: 0720273517; Email [kanaire@yahoo.com](mailto:kanaire@yahoo.com)

**PART B: PARTICIPANT CONSENT FORM**

**PARTICIPANT STATEMENT**

The study you are about to participate in is aimed at determining the cost-efficient ambulance service for community critical care transport needs in Machakos County for public funded ambulance services. Should you agree to participate in the study, you will be asked to give relevant information about ambulance service operation. Any additional information about the study will be provided to you including the final study results.

The methods and means by which the study will be conducted have been explained to me by the researcher. All questions have been answered to my full satisfaction and I fully understand my role. I also understand that withdrawal from the study at any point is voluntary and not subject to penalty. I agree to participate in this study.

Participant signature.....

Date .....

Researcher's signature.....

Date.....