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# Standardized ICT Equipment in Emergency Vehicles in Lagos Nigeria

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# Standardized ICT Equipment in Emergency Vehicles in Lagos Nigeria

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**Laurea University of Applied Sciences** **Abstract**
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Degree Programme Business Information Technology

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The rapid growth of population in Lagos, increasing urbanization and industrialization has led to increase in road traffic, industrial accidents and medical emergencies. Lagos state government wants to initiate an ICS (Incident Command System) project which will ensure efficient and well-coordinated rescue operations in the region.

The primary objective of the Government project is to provide a solution to the loss of lives and properties due to the late response of the emergency services which include police, ambulance and firefighter. This can be achieved by minimizing the time between an emergency call and the arrival of rescue services on the scene and to create good and functioning communications between all rescue services in Lagos state Nigeria.

The purpose of this research work is to study the standard of ICT system use in emergency vehicles in Europe. The aim is to provide useful information and recommendations to the ongoing project based on the findings.

This thesis has been done as part of the incident command system project in Lagos, and it focus more on recommending better communication within the onsite personnel and emergency operation center. It clearly explained the practical steps to establish good coordination and communication among the rescue service provider. It also recommends the ICT equipment that has to be installed in emergency service vehicle for better communication and operation.

Keywords: police, ambulance, fire fighter, rescue services, communications, Lagos, road traffic, industrial accidents, medical emergencies, Incident Command System, Emergency operation centre, coordination, ICT equipment.

**Laurea-ammattikorkeakoulu** **Tiivistelmä**
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Lagosin nopea väestön kasvu, kasvava kaupungistuminen ja teollistuminen ovat vaikuttaneet tieliikenne, teollisuus- ja sairas onnettomuuksien kasvuun. Lagosin osavaltion hallinto suunnittelee aloittavansa ICS ( onnettomuus käsky systeemi) projektin joka takaisi tehokkaan ja hyvin järjestellyn pelastus operaation osavaltion alueella.

Projektin ensisijainen tavoite on tarjota ratkaisu hätä-ajoneuvojen kuten poliisin, ambulanssin ja paloauton myöhäiseen reaktioon ja näin ollen vähentää ihmishenkien ja omaisuuden menetystä. Tähän pyritään minimoimalla aika, joka kuluu hätäpuhelun ja hätä-ajoneuvon paikalle saapumisen välissä. Projektin tavoitteena on myös luoda hyvä ja toimiva kommunikaatio yhteys kaikkien hätä-ajoneuvojen välille.

Tämän tutkimuksen tarkoitus on löytää tietoa siitä, miten informaatio kommunikaatio teknologia (ICT) systeemi toimii hätä-ajoneuvoissa Euroopassa. Tutkimuksen tavoite on tarjota hyödyllistä informaatiota ja suosituksia Lagosin meneillään olevaan projektiin.

Tämä opinnäytetyö on tehty osana Lagosin projektia ja se keskittyy löytämään paremman ratkaisun hyvään kommunikaatioon työntekijöiden välille. Opinnäytetyö tuo esille käytännön esimerkkejä hyvästä kordinaatiosta ja kommunikaatiosta eri hätäpalveluiden välille. Opinnäytetyössä tuodaan esille myös suositus eri informaatio kommunikaatio teknologia (ICT) laitteiden käytöstä hätäajoneuvossa.

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# 1 Introduction

Having contacted The Infostrides, the company where I did my internship, I got permission to write my thesis on part of an on-going project. My part of the project is to recommend how to standardize the ICT equipment in emergency vehicles. The company is one of the three participants in this project. The project is one of the many projects currently being undertaken by the Lagos State Government.
Lagos state is the most populous city in Nigeria with the population of 17.5 million as at 2006 according to the Lagos State Government (based on the parallel count conducted by the state during the National Census) (Nigeria Information Guide. 2004).

The rapid growth of population in Lagos, increasing urbanization and industrialization as led to increase in road traffic, industrial accidents and medical emergencies. Therefore, Lagos state government established pre-hospital care which is called Lagos State Ambulance Service (LASAMBUS) in March 2001 to further strengthen and improve the pre-existing Lagos State Emergency Medical Service (LASEMS).

Despite the effort of the Lagos State Ministry of Health to improve and reduce the time of responding to an emergency situation, there are still some major obstacles. There is no central emergency line that connects all the various emergency services. Each emergency service has its unique dial code. Therefore, the residents are often confused by the differences between the emergency number of ambulance service from police or fire brigade.
This slow response time coupled with the confusion that most victims faced when deciding the number to call, are the main difficulties that the State Government is interested in solving through the implementation of this project.

According to the National Disaster Management Framework written by the National Emergency Management Agency in 2010, disaster management in Nigeria can be defined as a department that coordinate and integrate all necessary activities to maintain and improve the capability to prepare for natural or human-induced disasters. Dr. Michael E. Ugbeye (2010) stated that “In Nigeria with a population of over 140 million people, the annual incidence of trauma deaths has been put at 1,320 per 100,000 people. With most deaths occurred within the first hour of injury, often before victim arrives at the hospital”. (Dr. Michael E. Ugbeye 2010) Since the response time and the communication amongst all the emergency departments i.e. paramedics, police and fire – fighter is crucial to victims' survival, the need for an improved and easily accessible ICT system is required. The main purpose of this project is to recommend the European standard ICT system to the Lagos state emergency service centre and vehicles. This will enable specially designated emergency vehicles such as ambulances, fire-trucks or police cars to respond faster to an emergency situation.

## 1.1 Geography

Lagos state is located in the south-western part of Nigeria and is the smallest State in Nigeria; it occupies an area of 3,345 square kilometers, which 22% of it consists of lagoons and creeks, with 20 local Governments and 37 local council development areas. Lagos shares boundaries with Ogun state and Republic of Benin. Southern part of the state stretches for 180 kilometers along the coast of the Atlantic Ocean. Lagos is the nation's economic and industrial capital, because the country commercial activities are carried out in the Lagos state and there are over 2,000 industries and two of the nation's largest seaports -crucial and Tin-Can Ports are located in Lagos State (Nigeria Information Guide, n.d).


Figure 1: Lagos state map showing all the local government area

## 1.2 Population

Lagos state is the most populous city in Nigeria according to the Lagos state government (based on the parallel count conducted by the state during the National Census). Lagos has the population of 17.5 million as at 2006 which makes it second fastest-growing city in Africa

## 1.3 Emergency Services in Lagos

There are three main emergency services in Lagos state; police, fire and ambulance. These three emergency rescue services need to be present at the incident scene due to their overlapping tasks.

### 1.3.1 Nigerian Police

The Nigeria Police Force is under the command of the IG (Inspector-General) of Police. All commissions of the Nigeria Police Force station in a state is subject to the authority and directive of the Inspector-General of Police. The ethical responsibility of any Nigerian police officer is to act as an official representative of government, who is obliged and trusted to work within the law. The fundamental duties of Nigeria police officer is to serve and protect the community, safeguard lives and property, keep the peace and maintain law and order (Nigeria Police Force 2014). The Police Force is structured in three parts, which are: -

a. Command (Authority)
b. Administration
c. Organization

#### 1.3.1.1 Command

The command's structure (also known as the authority's structure), depends on the regimental nature of the Force and is conducted along the Force badges of ranks. All orders, directives and instructions to be performed or carried out come from the Inspector-General of Police. The command flows from the Inspector-General of Police, through a chain of Command to any Officer in the position to implement or carry out the order (Nigeria Police Force 2014).

#### 1.3.1.2 Administration

The administrative structure of Nigeria Police is divided into six departments. These are operation, logistic and supply, investigations and intelligence, training and command, management department and ICT department.

##### 1.3.1.2.1 Operation

Operation is responsible for organizing internal security measures and monitoring the implementation of the security measures in time of emergency. It also coordinate and monitor the Force communication network.

##### 1.3.1.2.2 Logistic and Supply

Logistic and supply is responsible for determining the costs and purchasing of all technical equipment such as aircraft, wireless network, medical supplies, armaments and transport that is used by police.

##### 1.3.1.2.3 Investigations and Intelligence

The responsibility of the investigations and intelligence is to investigate crimes and to keep the crime records.

#### 1.3.1.2.4 Training and Command

The work of training and command department is to supervise and coordinate the activities of the police and police staff colleges and establish effective staff development program.

#### 1.3.1.2.5 Management Department

Management department manages the information, organizes and plans research works.

#### 1.3.1.2.6 ICT Department

Technology plays important role in law enforcement to improve the efficiency and effectiveness of the police work in responding to emergency situations. It is essential for all the emergency agencies to have the capability to manage and control electronic databases and communication system. The objective of the ICT department is to equip and empower the Nigeria Police personnel with ICT equipment and skills for operation to enhance their service delivery to the public.

### 1.3.2 Fire Service

The fire service's responsibility is to ensure safety of lives and to protect property from fire damage. Firefighters have more responsibilities than just rescuing people in a burning building. They also provide emergency medical care at incident area and educate the public about fire safety. Firefighters must be able to operate all equipment they use and work with other emergency services.

### 1.3.3 Emergency Medical Service

Emergency Medical Service is emergency medical care for the sick and injured people. EMS responsibilities are much more than providing medical care to patient or transporting them to the hospital. It is a service of coordinated response and emergency medical care, involving multiple people and agencies. A comprehensive EMS is always ready for any kind of emergency (NHTSA no date). EMS is a complex system, and all the component of this system has an important role to play as part of a coordinated and continuous system of emergency medical care. An EMS is a system that comprises many components such as:

- Agencies and organizations (both private and public)
- Communications and transportation networks
- Trauma systems, hospitals, trauma centers, and specialty care centers
- Rehabilitation facilities
- Highly trained professionals
- Volunteer and career pre-hospital personnel
- Physicians, nurses, and therapists

- Administrators and government officials
- An informed public that knows what to do in a medical emergency

Emergency medical service is an integrated service that works with other emergency services such as police and fire brigades and any system that is intended to maintain and improve the community health and safety. EMS operates alongside with the health care, public health and public safety.


Figure 2: EMS operates at the intersection of public safety, public health, and health care systems

EMS system worked on combined principles of both public health and public safety. Since EMS providers work in the community, they are often the first to identify public health problems and issues. Emergency medical services, law enforcement and fire services always work together because all of them provide rescue service in any kinds of emergencies or hazards. But the central mission of emergency medical services is providing medical care (NHTSA no date). The structure of organizing emergency medical services is different depending on who is financing the services and how the communities structure their emergency medical service. In any case, the essential parts of an EMS System and their responsibilities remain the same.

# 2 Backgrounds

Lagos is the most populous city in Nigeria and also second fastest-growing city in Africa, which make it the seventh in the world as at 2006.
As a result of rapid growth in population, Increasing urbanization and industrialization in Lagos state, there is an increase in road traffic, industrial accidents and medical emergencies. Lagos state government wants to initiate an ICS (Incident Command System) project which will ensure efficient and well-coordinated rescue operations in the region.

In order to achieve a functional ICS, all personnel must be equipped with an adequate ICT (Information and Communication Technology) system. This ICT system involves the introduction of a uniform radio network and central coordination for the police, ambulance and fire brigade utilizing the modern communication technologies.

## 2.1 Research Problem

There is no unified coordination among the emergency departments which led to slow response and lack of resources needed at incident scene. Therefore, the Lagos state government embarks on a project to solve these problems that include the introduction of a uniform national radio network and central coordination for the emergency services.

## 2.2 Objectives

The purpose of this research work is to study the standard of ICT system use in emergency vehicles in Europe. The aim is to provide useful information and recommendations to the ongoing project in Lagos state based on the findings.

This research may help to facilitate quick emergency response (i.e. to minimize the time between an emergency call and the arrival of rescue services on the scene) and to create safe and functioning communications between all rescue services such as ambulances, fire brigade and police in Lagos state Nigeria.
In order to achieve a functional ICS, the logistics section must be equipped with an adequate ICT (Information and Communication Technology) system. This ICT system involves introducing a uniform radio network and central coordination for the police, ambulance and fire brigade utilizing the modern communication technologies.

# 3 Research Approach and Methods

This thesis work has been done as part of a project and case study approach has been used to review and recommend some ICT equipment for the emergency service vehicle in Lagos state Nigeria. The customer adopted action research in this project. Action research is mainly practical and applied. And it is used when there is a need to solve practical or real world problem and produce guideline for best practice. Action research goes through two stages. First is the process in which the research was carried out, and the second stage is how the knowledge generated is used. Action research can also be used as a valuable tool when company or service provider need to improve their services.


Figure 3: The cyclical process in action research

## 3.1 Qualitative Methods

Qualitative research methods are used to acquire clear and better understanding of a particular research. The purpose of using qualitative methods is to gather information as much as possible that can help in achieving good result of the research. Qualitative methods consist of thematic interviews, open interviews, focus groups, and participatory observation and their all aim to understand how the participants derive meaning from their surroundings, and how their meaning influences their behavior (Graham 2012).


Figure 4: how Qualitative method can be used as a data collecting tools of information

Above figure shows how qualitative method can be used as a data gathering tools of information and it aims to understand how the participants derive meaning from their surroundings, and how their meaning influences their behavior to provide solutions for the need of the customer.

## 3.2 Benchmarking

Benchmarking is a method of measuring and comparing one business processes with other comparable processes in an organization to obtain information that will help the organization to identify and implement improvement (B. Andersen & P.-G. Pettersen 1996). The author reviewed and compares the ICT system in emergency service vehicles in three countries namely Finland, Sweden and Canada. This review was done by collecting information from literature sources. The author understands that the equipment installed in the emergency vehicle is different and depends on the need of each organization, department or municipality. When planning to purchase or install emergency vehicle with equipment, there are so many things to be considered such as the weather of the area where the vehicle is going to be used, electricity and space. In this thesis work, the author describes and recommends the equipment that is commonly seen and used during emergency response.

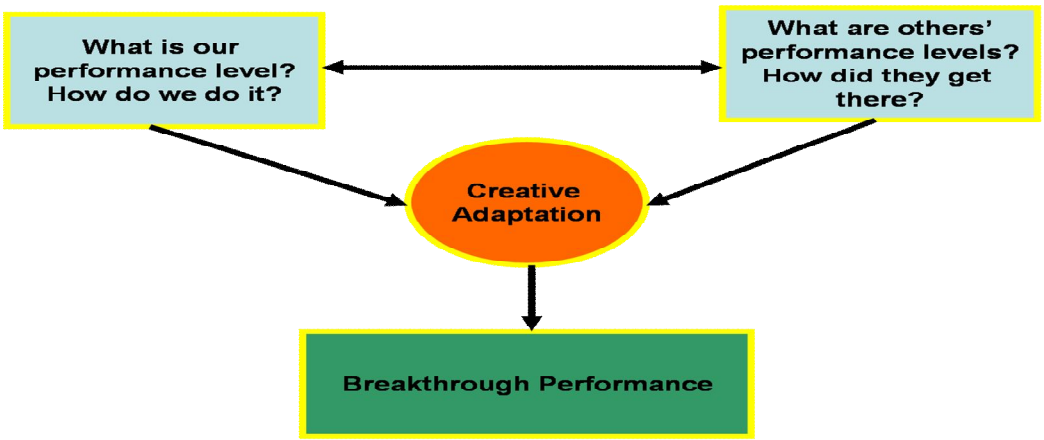


Figure 5: Benchmarking process

## 3.3 Interview

The interview is one-on-one conversation for collecting detailed information about work, environment or things. Data collection can be done through interviews. It is an open meeting that can be used to produce material that will be used for the research purposes.

There are seven ways that interview can be carried out, namely structured, semi-structured, unstructured, one to one, group and focus group interview. Interview can be conducted in many way, it may involve meeting between the researcher and the interviewee either one to one, group or focus group interview. The other way is the internet interviews which can be conducted with any interest group to be interview as long as they has access to a computer that has communication software installed such as Skype, Facebook or messenger. Other way the interview can be conducting using internet is be send Email back and forth in turn between the interviewer and the interviewee.

In this thesis work, the author interviewed four personnel from emergency service. One police officer in Finland, two ambulance nurses (one from Finland and one from Sweden) and one fireman from Canada. The interview was conducted using semi-structured open questions. The interview was done via emails. The primary aim of this interview is to evaluate the most effective ICT system while bearing in mind its cost. Also, another aim is to gather as much information as possible concerning the implementation, cost, maintenance and operations regarding the communication system used in those countries. This interview process allows the author to select the best equipment that suits the emergency vehicles in Lagos because not all the equipment that is used in the studied countries is applicable to the emergency vehicle in Lagos area.

# 4 Incident Command Systems

The Incident Command Systems (ICS) was developed to address the difficult issues that emergency and rescue services face in respond operations. These issues include the inability to determine who is in charge of the overall response effort. Incident command system was established in 1970's to manage and address the problems facing emergency service works. Some of these problems are inadequate and incompatible communications and lack of reliable incident information among emergency services (United state department of labour).

The services provided by rescue or emergency worker depend on the nature and magnitude of the incident. Fire-fighters and police are found at scenes of fire, as well as traffic accidents, although their functions are usually quite distinct (International Labour Organization 2002). In many emergency situations, all emergency rescue services are present at the incident scene due to their overlapping tasks. For example, in a life threatening situation where a victim of a car crash is stuck, it is the responsibility of the firemen to free the victim from the crash so that the paramedics may proceed to the hospital.

The law enforcement community has two vital roles in responding to disasters: to provide for the safety and security of the community and to be first responders during times of crisis (W. Craig Fugate 2013). In an emergency situation, responsibility of the police is to maintain law and order and to ensure a free flow of traffic in the incident area. The incident command system is designed to meet needs of any incident and to provide common management structure for personnel from a variety of agencies.

## 4.1 ICS Element

The main function of ICS is to establish standard planning and management system that would help the agencies responding to a disaster to work together effectively. There are many functions in the ICS system. These include common use of terminology, integrated communication and unified command structure. An ICS is divided into five sections. These are command, operations, planning, logistics and administration sections.

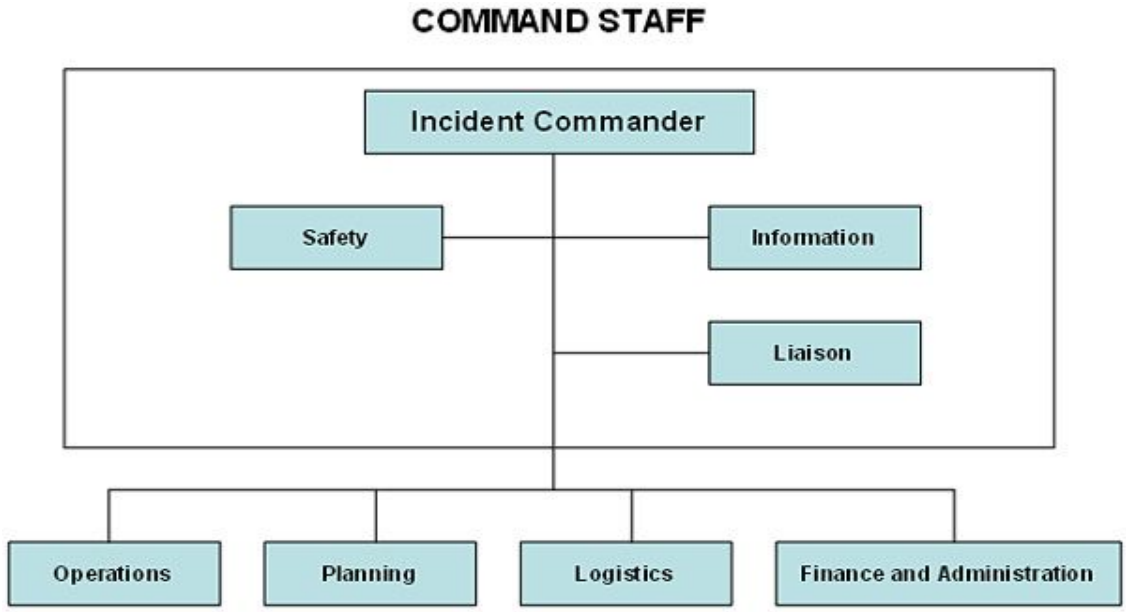


Figure 6: Incident command system structure

### 4.1.1 Command

There are two types or incident command. These are: Incident command (IC) and Unified command (UC); IC is responsible for managing the incident response activity involving single authority or emergency service provider. UC is the command that involved more than one jurisdiction, federal or state and as well as emergency organization. However, whether in the IC or UC there are one personnel that is responsible for the overall response activities (Erickson 1999, 83).

### 4.1.2 Operations

Operation is responsible for coordinating and directing tactical operations required by the response activities and it also develops tactical objectives and organization (Erickson 1999, 84).

### 4.1.3 Planning

Planning depends on the need and the situation of the incident. The IC develops an action plan that can help to anticipate problems and the situations that may occur as the incident expands and maintains resource status (Erickson 1999, 85).

### 4.1.4 Logistics

Logistics provide support to meet the incident needs; logistic section is under the logistics chief and it responsibilities to provide communications, medical support to responder, supply personnel with equipment and other needed supplies such as transportation vehicle and fuelling of the vehicle (Erickson 1999, 85)

### 4.1.5 Administration Sections

Administration section is responsible for monitoring cost that is used in the incident and procuring and administering any contracts required to implement the response activities (Erickson 1999, 85).

## 4.2 Integrated Communication

One of the characteristics of ICS is integrated communication. Integrated communication in ICS is structured in a way that it ensures communication among all the emergency agencies at the incident scene and supervisors. ICS must support efficient flow of Information through the system from the command centre down to the lowest level and also from the lowest level to the command centre (Fundamentals of Fire Fighter Skills 2009 pg108).

## 4.3 Communications among Emergency Services

Communication among emergency service is important due to their overlapping responsibilities. Poor coordination and communication can lead to slow or ineffective disaster responds that can cause losses of lives and properties. This will also damage the reputation of an organization (Haddow & Bullock 2003). Proper emergency management system must be in place. Therefore, it is the key roles and functions of the emergency operation centre and the joint information centre to free flow of coordination and communication among the emergency service and the public.

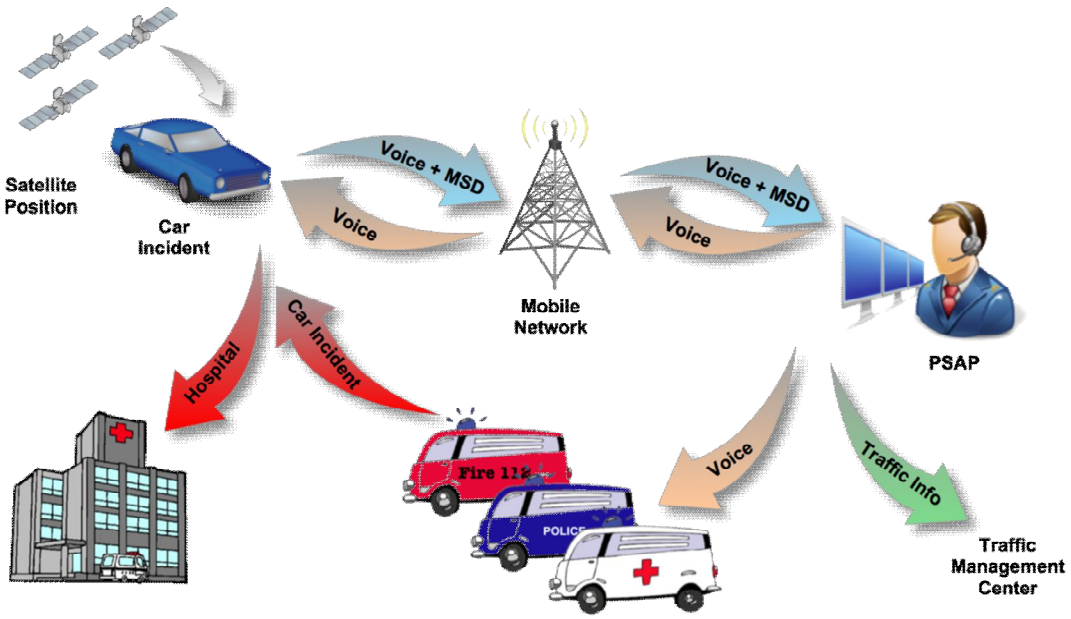


Figure 7: Show the Communication among emergency service and incident area.

## 4.4 Emergency Operation Center

Emergency operation centre (EOC) is where multi-agency response coordination happens. EOC functions include resource allocation, tracking and information collection, coordination, anal-

ysis and dissemination, and communications. EOCs can be organized in two ways. It can be permanent organizations and facilities or it can be established to meet needs for the period of the incident. It is equipped with technologies that allow communication at the incident site and also design to facilitate multiagency coordination system (MACS) functions and to support Area Command (AC), Unified Command (UC) or Incident Command (IC). EOCs can be structured in three groups which is according to discipline such as fire service, law enforcement, and medical services, by jurisdiction city, county, region or by emergency support functions (Considerations for fusion centres and emergency operations centre coordination 2010). ESF is combination of governmental and certain private sector capabilities to form an organizational structure that will help in providing support, resources, program implementation, and services that are needed to save lives, protect property and the environment, restore essential services and critical infrastructure, and help victims and communities return to normal following domestic incidents (Public health emergency 2012). It is important for all emergency services to work together and to understand each other's goals and priorities because of the overlapping responsibilities.

Figure 8: The picture show a functional Emergency operation center.

### 4.5 Joint Information Centre

Joint Information Centre is an important centralized tool for making emergency services to work together effectively during an emergency situation. It main function is to keep information flowing. Normally most of the incident involves more than one emergency service or organization in response and recovery area. JIC is developed to coordinate the publicizing of information about all disaster response and recovery programs among the services. JIC is a unified, coordinated information network system that makes sure that all the emergency service that their operations is directly related in an emergency situation are on the same page (Argonne national laboratory).

### 4.6 Information Technology

The most essential part of ICS is the communication tool. Sharing of information and communication among the emergency service during and after an incident is very important. Therefore, all the emergency services should review their current processes of their communication to identify how there can be improvement in communication between them and get across all necessary departmental levels. Interoperability is essential when planning the equipment they will be using, communication Infrastructure, systems, facility and physical Infrastructure. There must be a secure and reliable communications platform for all the emergency service within the physical infrastructure and the vehicle they are using.

There have been global improvement in communication and the use of internet is obviously going faster and faster every day. Therefore, internet is one of the commutating tools that have to be provided for all the emergency services. Countries, state or city design a website and integrate it to their emergency communication plan to provide immediate access to information to for all member of emergency service (Haddow & Bullock 2003).

# 5 Rescue Service Vehicles

An emergency vehicle is all vehicles that designated and authorized to respond to an emergency. Emergency vehicle can be designed in a different way depending on where and what it will be used for. It is equipped with ICT (information communication technology) equipment and non-IT equipment that will make their work easier and function well. Emergency services use their vehicle as their personal office just like their normal offices. Emergency vehicle equipped with a radio, mobile phone, and computer and forms necessary for completing reports. When planning or designing an emergency vehicle, interoperability of technical systems have to be put into consideration so as to increase the effectiveness of the operation. The ICT system installed in emergency vehicles must be incident support and facilitate easier reporting, free flow of communications and ability to access relevant data information.


Figure 9: The picture shows different emergence vehicles include police car, ambulance, fire fighter truck and towing truck.

## 5.1 ICT Equipment in Emergency Vehicles

ICT equipment is installed in an emergency vehicle to make emergency personnel work easier, and safer. Example of such ICT equipment are computers, video cameras, license plate readers, two-way radios, stolen-vehicle and manually operated light and siren controllers. Information and communication technology has a big role to play in emergency vehicle, and there are some factors to considered when selection this equipment. There is no maximum number of equipment that can installed in emergency vehicle, but power supply (electricity) and space have to consider. The equipment that is installed to these vehicles must be suitable for variable and high demanding conditions. The equipment also needs to have robust secure. The following are the common and most useful equipment in the emergency vehicles (Interview).

### 5.1.1 TETRA Radio

TETRA radio is a private mobile radio communications system that provides fast call set-up time for emergency services or any other organization. TETRA radio has excellent group communication and individual communication support. Direct mode operation between individual radios, packet data and circuit data transfer services, the system also supports call hold, call barring, call diversion, and ambience listening (Ian Poole n.d).

Figure 10: Simple mobile TETRA radio

#### 5.1.1.1 Individual call

TETRA radio can be used to make call within the TETRA network or outside the TETRA network such as fixed or cellular network (GSM). Calls can be made with TETRA radio in two ways which are full-duplex and half-duplex (Heikkonen, Saaristo & Pesonen 2004, 18). Individual call within a TETRA network can be done in two ways, one involves dialling the entire number of the recipient before pressing the connect button and the recipient receives incoming call notification and answered it by pressing the connect button too. The other calling option is to make a direct call by dialling the number of the recipient and press the PTT key. The recipient did not need to press any button before the caller can start talking.

Full-duplex call is when both parties can talk and hear at the same time with no need of pressing the push to talk button (PTT). When making a call to a recipient outside the TETRA network, full-duplex is usually used. And a direct call is always a half-duplex call. Half-duplex call allows one person to talk at a time by using the PTT key to request turn to speak.

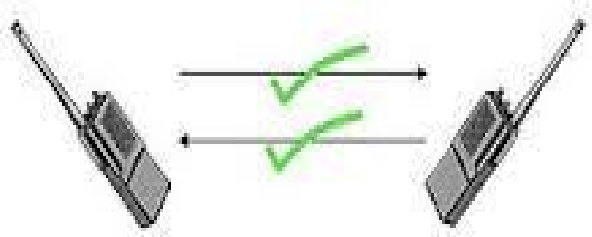

Figure 11: Shows the communication in full-duplex

#### 5.1.1.2 Group call

Group call is a call that involves more than two participants. Group call communication between one speaker and several participants is made by pressing the PTT key on the TETRA radio. And this call is always half-duplex in nature.

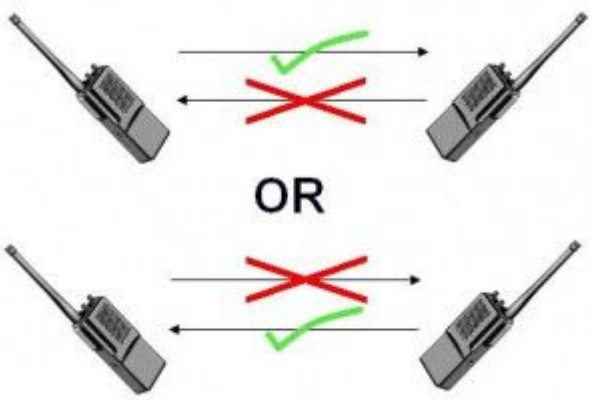


Figure 12: Shows half-duplex communication nature.

### 5.1.2 Laptops in the Emergency Vehicles

Laptop is mobile devices that are not frequently used as mobile phones in any ordinary car, but are commonly used in emergency vehicles such as police cars, ambulances, and fire trucks. To make recording, accessing a database and finding locations easier while out on a call, an emergency worker can complete an electronic report without getting to their office. This can be completed by checking fields on the touch display and this help emergency personnel to write out most of the data and then send the report to the emergency service's information system automatically, without subsequent rewriting of data and save more time (interview).

Figure 13: Show the possible position in emergency vehicle

### 5.1.3 Global Positioning System Tracker

The Global Positioning System (abbreviated as GPS) is an integral part of modern information and communication technology. According to Techterms.com, GPS stands for Global Positioning System, which is a satellite navigation system that can be used to determine ground position and velocity.

As affirmed by all the personnel who participated in the research interviews, a standardized GPS system is one of the main modern technologies that has greatly enhanced and speeded up the response time of emergency personnel to distress calls. Beforehand, there had been several cases where the emergency teams which are dispatched to the crash site has spent many minutes or hours trying to locate the crash site due to the non-availability of a GPS system. Since the major challenging factor in Lagos state emergency services is slow response time to emergency or accidents sites, a standardized GPS system will help eliminates most of the unnecessary additional time which is wasted on locating of the emergency sites.

Also, it is worth noting that the GPS system can also be used as a tracking system. GPS tracking system operates on the Global Navigation Satellite System (GNSS) network. This navigation network works base on the range of satellites that use wave signals and these signals will be transmitted to GPS devices that provide information about the vehicle such as location, vehicle speed, time and direction (Patrick Bertagna, 2010). This GPS tracking system may be used by emergency personnel at the command unit (where dispatch team are selected according to their available tools and proximity or nearness to emergency sites) to efficiently choose the best team in terms of closeness to the emergency area.

### 5.1.4 Emergency Vehicle Pre-emption (EVP)

EVP system is designed to give emergency response vehicles the ability to control the traffic light. This enables emergency vehicles to change the red light to green light when they are approaching where there is a signalized intersection while providing a red light to conflicting approaches (Traffic Signal Pre-emption for Emergency Vehicles, 2006). Using EVP in emergency vehicles make response time faster and improve safety. The operational features and in-

teroperability requirements of this technology have to understand and consider before it is implemented.

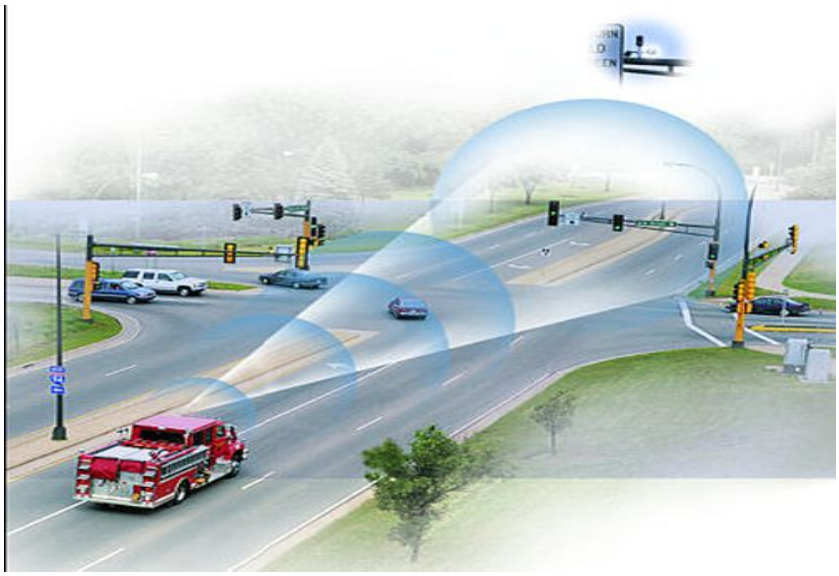

Figure 14: Picture showing how the Emergency vehicle preemption detector transfer signal.

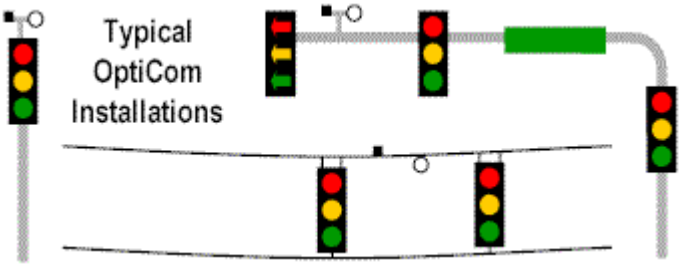


Figure 15: This figure shows the positions where the Emergency vehicle preemption detector equipment is installed on traffic control poles.

There are four types of EVP technologies infrared-based, sound-based, radio-based detector systems and light- based.

#### 5.1.4.1 Light- Based \ Infrared-Based System

Light and infrared systems are operated in the same way. They both utilize the emitters which is usually placed on the roof of emergency vehicle and operated in conjunction with the emergency lights. The emitter on the emergency vehicle authorizes direct one-way communication with the detector through an optically coded high intensity blinking light (Traffic Signal Pre-emption for Emergency Vehicles, 2006).

#### 5.1.4.2 Sound-Based System

In sound based type emergency vehicle's siren activates the EVP system. It uses the siren as the emitter. The wave formed by the siren is transferred to the detection and processing equipment. The moment the waveform is verified green light will be obtain at the signal (Traffic Signal Pre-emption for Emergency Vehicles, 2006).

#### 5.1.4.3 Radio-Based Emitter/Detector Systems

Radio-based systems employ a receiver with an Omni directional antenna (an antenna that radiates equally in all directions) to detect a narrow band radio transmission from an emergency vehicle.

### 5.1.5 Pager

A pager is a small radio that only listens to just one station every time. All pagers in a particular network have a built-in receiver that is tuned to the same frequency broadcast from the transmitter. All this pagers listen to the signal from the transmitter constantly as long as they are on. There are five types of pager; Beeper, Voice/Tone, Numeric, Alphanumeric and Two-way, they are different according to their capabilities (howstuffworks,2014).


Figure 16: Pager radio system.

#### 5.1.5.1 Beeper Pager

Beeper is the first and simplest pagers. Beepers that only provide audio signals or light up, and some of this pager can vibrate to notify the user about an event or received message.

#### 5.1.5.2 Voice Pager

This pager can listen to a recorded voice message when the pager receive message alert that it has a page.

#### 5.1.5.3 Alphanumeric Pager

Alphanumeric pagers can send a text message along with the page alert.

#### 5.1.5.4 Two-Way Pager

Two-way pagers can be used to send or receive a message because of its ability to send as well as receive information. The two-way pager is commonly used by emergency service personnel. This pager provides quick and easy communication for on the go personal such as police, firefighter and ambulance.

# 6 Communication Channel (TETRA network)

TETRA is a digital trunk radio standard. TETRA name comes from words Terrestrial Trunked Radio. Different manufacturers adopt TETRA radio. TETRA can be used by private and government organizations such public transport, public safety and military. The European Telecommunications Standards Institute (ETSI) standardized the use of TETRA (Tetra-Consultancy no date).

The TETRA air interface makes it possible for it to interoperate with mobile subscribers from different manufacturers and also with many vendors in TETRA infrastructure or networks. (Tetra-Consultancy no date).

TETRA was developed based on (Time Division Multiple Access); TDMA is digital transmission technology that is designed to allow multiple users to use a single radio frequency channel with no interference between unique allocated time slots for each user within the channel (Spectracom 2007).

TETRA is developed as a trunk system that is economical and efficient. It supports sharing and usage of the system by several organizations. The virtual networking inside the TETRA system allows each organization to operate independently, and benefits in a large, high-functionality system with efficient resource employment (TETRA). It is also planned to provide fast call set-up time of 300 MS that is the important requirement of the public safety and emergency services. TETRA supports two types of operations semi-duplex and duplex communication for efficient group calls and individual calls.

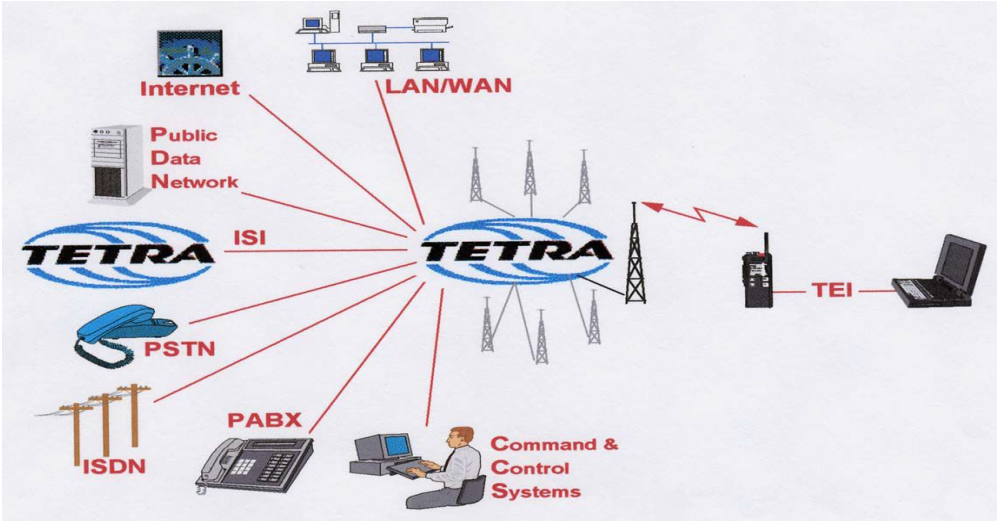


Figure 17: TETRA Network Infrastructure.

## 6.1 TETRA Network Switch

TETRA network switch holds the information in the database of any allowed mobile radios or services assigned to them. TETRA network switch has the ability to handle the talk configuration group's calls and responsible for switching the voice coming back and forth in the mobile radios. It monitors the track of the affiliation of the mobile radios to the base stations and allocates the traffic channels of the base station (Tetra-Consultancy n.d).

## 6.2 TETRA Base Station

TETRA base station is where the TETRA radio signal sends out and receives TETRA signal coming from the mobile radios. There must be a connection between TETRA network switch and TETRA base station; the connection can be done in two ways depending on the manufacturer that design the base station. Base station is connected to the TETRA system switch in a star or ring configuration. When TETRA mobile radio has to move from one base station to another, there must be provision for sufficient overlapping coverage (Tetra-Consultancy n.d).
"TETRA carrier is divided into four-time slots as specified by the ETSI. The maximum number of carriers for one base station is eight, giving a total of (4*8=32) timeslots". (Tetra-Consultancy n.d)
The first slot of TETRA carrier is used for the control channel. Information is transmitted using the control channel. Mobile stations received information from the control channel informing them to move to a traffic channel.
Traffic channel is one of time slots of the base station that make the mobile station to receive audio signal. Whenever the mobile station wants to transmit, they request to use the control channel (Tetra-Consultancy n.d).

## 6.3 Control room or Dispatchers

Control room or dispatchers are added to the TETRA system to communicate with the emergency workers that are on the field through the use TETRA portable radios. The control room is connected to the TETRA system switch via landline. Control room is the center point of communications; the main priority of the control room is voice communication depending on the implementation or operator's configuration.

## 6.4 Direct Mode Operation (DMO)

Direct mode operation is a direct communication between two or several TETRA DM terminal or mobile station without trunking. DMO made it possible for the user of TETRA radio to communicate with each other radio to radio without the need of TETRA network infrastructure. This kind of communication is necessary where there is no network coverage (Heikkonen, Saaristo & Pesonen 2004, 19).

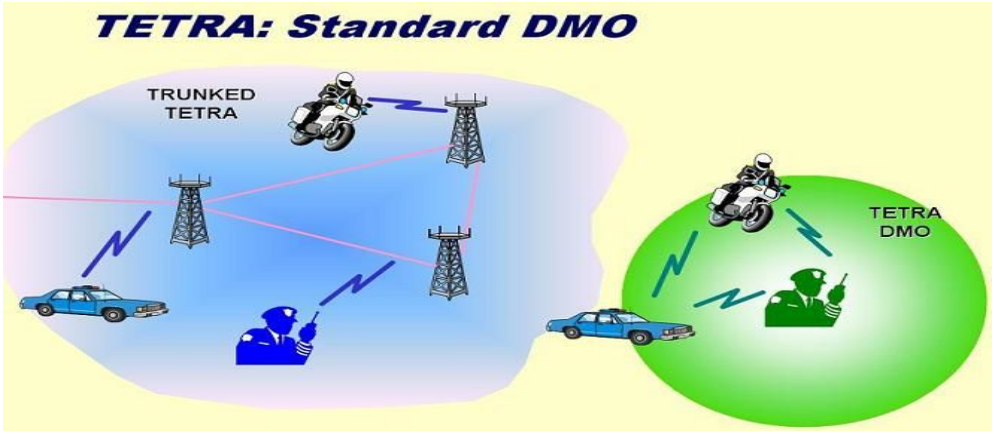


Figure 18: Direct mode operation is a direct communication between two or several TETRA DM terminal or mobile station without trucking network infrastructure.

### 6.5 General Packet Radio System

General packet radio system is popularly used in emergency service organization because it can support both phone calls and Internet data transmission. It is a non-voice wireless Internet technology. By adding GPRS technology to some global system in mobile communications, mobile phones are given the ability to handle both phone communication and Internet access at the same time (bright hub 6/1/2010).

GPRS is also working as GSM-IP that is a Global-System Mobile Communications Internet Protocol as this system always keeps the users online, allows making voice calls, and access internet any time. Even Time-Division Multiple Access (TDMA) users benefit from this system as it provides packet radio access (tutorialspoint 2004)

European Telecommunications Standard Institute (ETSI) stated the specifications for GPRS and has opened a wide range of services due to its unique characteristics in order to enhance the value of services provided to the users. Below are the characteristics:

- Mobility - General Packet Radio System can maintain constant voice and data communications while on the move.
- Immediacy – It allows the users to have connectivity when needed, regardless of location and without a lengthy login session.
- Localization - Allows users to have relevant information to their current location.

#### 6.5.1 General Packet Radio Service Architecture

GPRS architecture was designed to work, in the same way as GSM network work with an additional component that allows transmission of packet data. This data network overlaps a 2G GSM network to increase packet data transport at a faster rate from 9.6 kbps by 2G to 171 kbps. Along with the packet data transport the GSM network allows multiple users to share the same air interface resources concurrently (tutorialspoint 2004).

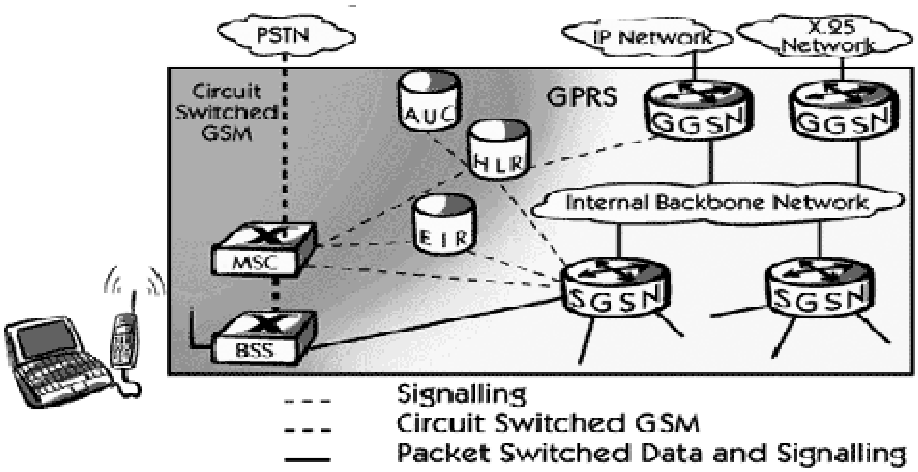


Figure 19: shows the connection within the general packet radio service architecture.

#### 6.5.1.1 GPRS Mobile Stations

The function of a Mobile Stations in the GPRS-Networks is to transmit and receive packet-oriented data. The existing GSM phones do not support the enhanced air interface and packet data. A new mobile station that uses GPRS services is design. And it is used as a backward compatible for making voice calls using normal GSM phone (tutorialspoint 2004).

#### 6.5.1.2 GPRS Base Station Subsystem

The base station subsystem (BSS) is a section in GPRS network that is responsible for handling traffic and signaling between a mobile phone and the network switching subsystem. It also carries out transmission and reception. Additionally, it translates coding speech channels and allocation radio channels to mobile phones over the air interface in radio network of GPRS. Packet Control Units (PCUs) and a software upgrade are installed in Base Station Controller (BSC) to provide data interface to the Base Station Subsystem (BSS) logically and physically for packet data traffic. Base Transceiver Station (BTS) require a software upgrade but does not require hardware enhancements (tutorialspoint 2004).

# 7 Installation

When agreement has been made on what the entire departments want to install in their emergency vehicles, the next step is the selection of the company that will carry out the installation of the equipment. The law binding the importation of this equipment, training of staffs on usage and maintenance of the equipment is the next line of discussion.
All products have to be properly and safely installed. Before starting the installation or operating the new equipment, the installer and the operator must have good understanding of automotive electronics, systems and procedures to be follow in installing the those equipment (A.J. Morganelli, n.d ) .

## 7.1 Maintenance

All the emergency service equipment cannot be installed and be left without proper maintenance. These equipment are specially designed and installed for emergency purposes and maintained in accordance with codes which include operating parameters, guidelines and requirements for regular maintenance and monthly testing also keeping the record of maintenance important (D. Marchetti, 2004).

## 7.2 Personnel Training

Personnel training are based on the operations of the equipment and goals of the working environment. Personnel training can be acquired by organizing training program for the employees. Emergency service must ensure that the competence of their employees remains up to date through training. This training consists of short-term refresher courses about how to use this equipment and various other courses about their services and work, based on the needs of the organizations.

# 8 Conclusion

It is clear that incident command system is a managing system tool that is developed to ensure effective and efficient incident management by introducing a combination of facilities, equipment, personnel, procedures, and communications operating among emergence respond organizational structure and it has been accepted worldwide. So for this reason; implementing incident command system in Lagos state will create good platform for coordination and communication among all the rescue and emergency service and will enable effective and efficient incident management and response in the state.

Secondly, transportation is another area of concentration; it is known that rescue service vehicles have a big role to play when responding to an emergency situation. Police, firefighter and ambulance, cannot do their work effectively without well-equipped emergency vehicles. It is clear that Lagos state has these vehicles in place but is it up to standard? No because those vehicles are not well equipped. However if those vehicles can be equipped with the equipment mentioned in this thesis work, a faster response time can be achieved. It will also enable emergency and rescue service personnel to work effectively in the area of documenting and reporting and create good channel for free flow of information among the rescue service onsite personnel and control centre.

## 8.1 Recommendation

The author recommends that if the Lagos state can implement Incident command system and install all the ICT equipment mentioned in this thesis in their emergency vehicles, the emergency service personnel will be able to understand their overlapping works and make their work easier. Also, it will create good and functioning way of communication among the emergency service and this will allow them to respond to the emergency situations faster than they are doing now and save more life and protect more properties.

# 9 Discussion

When I started planning on my thesis, my first plan was to do my own project but later I changed it because the project is too wide and it cannot be done before my graduating date. The rescue service system in Nigeria are not so improved so I decided to search for information how western world emergency and rescue services operate when compared to Nigeria (Logos state) and how a standard ICT system could be implemented by the rescue services in Lagos state. Lack of communication both within the rescue services and the citizen is the major problem in Lagos state. There is no uniform coordination among the rescue services and sometimes people are not aware of the differences between the emergency number of ambulance service from police or fire brigade. If they need to call to police or fire brigade, they sometimes called to ambulance service because of the different communication channel rescue services are using.

I sent five questionnaires to different emergency professionals; ambulance driver and nurse, policeman and fireman. I asked fifteen questions in total. Most of which deals with ICT equipment that were been used in their emergency vehicles. The answer to those questions generates lot of useful information that helps in so many areas in this thesis. Not all of them answered, and one fireman answered that he was not allowed to answer to my questions for security purposes. One person who has worked as an ambulance driver and fireman answered and he gave some useful information about TETRA- network and how it is being used in their work. I haven't heard about that before, and it was interesting. After that, I started looking for information about TETRA, and I found a lot of information.

I also went to different libraries to find books, but it was hard to find them in English. Even in Finnish there were not so many that I could use. I would have needed more interviews, but my schedule was tight since I have to graduate this spring. I learn a lot in this thesis work which gave me a lot of insight about emergency services, what they do, how they do it and what it takes to be emergency personnel.

## 9.1 Limitations

It was very difficult to find information about the Nigeria rescue service on the internet due to poor database, so it takes longer time to get the information that was needed. Secondly, the timeframe for conducting this research is short.

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Figures