A FRAMEWORK FOR ADOPTION OF ICT BY TRAFFIC POLICE FORCE IN VEHICLE INSPECTION AND MONITORING AUTOMATION: A CASE STUDY OF TANZANIA

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A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN INFORMATION COMMUNICATION AND TECHNOLOGY OF THE OPEN UNIVERSITY OF TANZANIA

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by The Open University of Tanzania, a thesis entitled **"A Framework for Adoption of ICT By Traffic Police Force in Vehicle Inspection and Monitoring Automation: A Case Study of Tanzania"** in fulfilment of the requirements for the Degree of Master of Science in Information Communication and Technology of The Open University of Tanzania

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DECLARATION

I**, Elia Ahidi Elisante Lukwaro**, do hereby declare that this thesis is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

……..

Signature

……..

Date

DEDICATION

This thesis is dedicated to my beloved parents; Mr Ahidi Elisante Lukwaro (the late) and Mrs Zenael Elisante, for their support and aspiration that one day I attain this high level of education. My father did not live to see this research completed but his inspiration still lingers on. My mother always supported my dreams and to this day, she is behind me encouraging to move forward.

May the Good Lord be with you all till we meet in that beautiful morning.

AMEN

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ABSTRACT

The number of road accidents caused by vehicles in the city of Dar es Salaam is very alarming. One of the major causes of road accidents is vehicle defects and speeding, which is largely contributed by a lack of digitally-enhanced systemic mechanisms for vehicle inspection and monitoring. To curb down vehicle crimes and accidents, automated enforcement need to complement road safety laws through adoption of ICT innovations. Accordingly, this study aims to identify critical success factors and to develop a framework for adoption of ICT in vehicle inspection and monitoring. To achieve this goal, the Ground Theory Approach (GTA) was used to carry out the study. The selection of GTA based on the nature of the phenomenon and complexity in obtaining relevant data. The exploratory and case study strategy via field interview, observation, Focus Group Discussion (FGD), and questionnaires are used for data collection. The GTA was deployed to analyze the collected data, the via open, axial and focused coding phases. The key findings of the study reveal that the critical success factors for facilitating ICT adoption for law enforcement in vehicle inspection and monitoring include ICT Policy and Strategies, Skilled Human Resources, Interoperability, Top management support, Financial support and Investments on ICT, Infrastructure development, Availability of ICT equipment (Hardware and Software), Security and Privacy measures and Staff Awareness and Training (capacity building). Based on these findings, the framework for adoption of ICT in law enforcement was developed. The study then concludes with a working model that illustrates the implementation of ICT by traffic police force in vehicle inspection and monitoring.

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LIST OF ABBREVIATIONS

ALPR	Automated License Plate Recognition
ANPR	Automatic Number Plate Recognition
AVI	Automatic Vehicle Identification
CCTV	Closed Circuit Television
DES	Director of Examination Syndicate
DNA	DeoxyriboNucleic Acidorganisms
DOI	Diffusion of Innovation
eGA	e- Government Agency
FGD	Focus Group Discussion
GPS	Global Positioning System
GSM	Global System for Mobile communications
GTA	Ground Theory Approach
HQ	Head Quarter
ICT	Information and Communication Technology
IS	Information System
IT	Information Technology
OCR	Optical Character Recognition
OUT	Open University of Tanzania
SARIS	Students Academic Records Management System
SUMATRA	Surface and Marine Transport Regulatory Authority
TAM	Technology Acceptance Model
TMS	Traffic Enforcement Management System

TPB	Theory of Planned Behaviour
TRA	Tanzania Revenue Authority
TRA	Theory of Reasoned Action
UK	United Kingdom
USA	United State of America
USSD	Unstructured Supplementary Services Data

CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Road safety is an important element for social welfare and economic development. This is because road accidents result into loss of life of men, women and children, and of resources that otherwise may have contributed to socio-economic development (Mohamed, 2015). Accordingly, Governments across the world are investing in various initiatives intended to enhance the quality and safety of roads in their countries (Rautela & Pant, 2007). It is expected that such initiatives will facilitate mobility and safe movement of goods, knowledge and people. In turn, this will provide an important catalyst to socio-economic development (Rautela & Pant, 2007).

Road safety in Tanzania is of paramount importance for economic development (Kircher & Andersson, 2012). The government has invested heavily in road infrastructure with particular attention being paid in safety and quality. Nevertheless, the safety in using roads in Tanzania and especially in Dar es Salaam is all but worrying. In the British High Commission report “Road Safety Roundtable” (2013), it is reported that road crashes are one of the top five causes of death for children and young people in Tanzania, who are commonly referred to as the key workforce for steering socio-economic development. To curb such a tremendous loss, there is a need to investigate, develop and enforce road safety measures. This research is grounded on this need and, in particular, on how Information and Communication

Technologies (ICT) innovation can be used to enhance and complement the existing road safety measures.

The adoption of ICT by governments in developed countries such as the Sweden, the Norway, the United Kingdom and Japan, has been instrumental in improving road safety (Shoukrallah, 2008). This has been achieved via inspection and monitoring processes of the vehicles, which, in turn, has contributed in reducing vehicle accidents and crimes (ibid). The adoption of ICT, especially in the public sector, does not only improve road safety but also improves efficiency, transparency and accountability in vehicle inspection and monitoring processes, which in turn reduces corruption (Mkude, 2016). The adoption of ICT is viable for the improvement of public service delivery by enhancing the internal processes and by increasing capabilities of public organizations, especially law enforcement (Alshehri & Drew, 2010).

In developing countries, ICT adoption in the public sector is only in recent years that it is actively steered by governments, unlike experiences from developed countries (Mkude, 2016). Traditionally, public organizations in developing countries deliver public services through physical interactions and paper-based approaches. Such approaches have not only proved disadvantageous in reducing cost-efficiency, effectiveness, transparency and accountability, but also, they are tedious and time consuming (U.S. Department of Justice [USDJ], 2012).

Despite the well-known benefits of ICT adoption in the public sector, governments still encounter significant challenges in incorporating ICT innovation in its processes.

The nature of the services offered by public organizations involves the process of accessing and using data from various sources. In this regard, the process of introducing ICT in the public sector needs to take into account the business processes involved. Otherwise, the envisaged benefits and outcomes may not be achieved and, consequently, incurring waste of money, resources and efforts.

From theoretical perspective, several theories attempt to describe the adoption of ICT in the public sector. Typical examples include Diffusion of Innovation (Rogers, 2003), Technology Organization Environment framework developed by Tornatzky and Fleischer in 1990 (Pudjianto & Hangjung 2009; Ebrahim et al., 2004**),** Theory of Acceptance Model (Davis, 1989) and the Theory of Resource and Capabilities of Organizations (Araya et al., 2007). Collectively, these theories identify the aspects that influence the processes of adopting and implementing ICT innovation in organizations (Oliveira & Martins, 2011).

From the empirical perspective, various studies indicate issues that hinder the adoption of ICT in the public sector including fragile environment, poor infrastructures and high illiterate rate (Imran & Gregor, 2005; Bagchi & Udo, 2007). In other studies, poor skills, poor ICT policy implementation, absence of vision and strategy, absence of government support, absence of donor support, behavioural intentions and national culture i.e. leadership style bureaucracy are also mentioned as issues hindering ICT adoption (Alam & Noor, 2009; Busagala & Ringo, 2013). Based on these implications, propositions for tackling these issues are also well documented in literature.

In the scope of this research, a number of weaknesses are identified regarding the theories and literature studies mentioned above. The identified theories do not provide sufficient guidance in adoption of ICT and technological innovations in the law enforcement entities such as traffic police force, which has different structures and characteristics compared to the other public and private organizations (Venkatesh et al., 2003). Another weakness is the failure of the mentioned studies to take consideration of the business context in which traffic police force operates and its integration with the overall environment in the public and private sectors (Lero & Kieran, 2013). Furthermore, most of the studies on ICT adoption by law enforcement entities have been developed and tested primarily in the context of developed countries. These studies may have the limitations on informing the adoption process by law enforcement entities in developing countries, where the context is different and must be taken into account (Mkude, 2016; Imran, 2005).

Furthermore, limited information is available on the adoption of ICT by law enforcement entities, especially in Tanzanian context. This situation indicates that ICT adoption by law enforcement entities is still unguided. A lack of proper framework for guiding ICT adoption by law enforcement entities may result into the failure of ICT initiatives and loss of money and resources. This lack may also result in other benefits such as simplification of public service delivery processes, transparency and timely decision-making not being realized. To bridge this gap, the research at hand aims to investigate the factors influencing the adoption of ICT by law enforcement entities in Tanzania and, thereby, to develop a framework for the adoption of ICT innovation in vehicle inspection and monitoring.

1.2 Defining the Problem Area

Tanzania, especially Dar es Salaam, continues to experience a massive increase of vehicles on its roads. The statistics indicate the growing number of 606,439 to 707,521vehicles in Dar es Salaam (Kiunsi, 2013). The Government uses the Police force and traffic unit to manage and control road worthiness and discipline of vehicles. But in Dar es Salaam only 602 traffic police are available to enforce the safety rules and to track down the vehicles that are involved in crimes (Mjema, 2016). The mostly used modality for vehicle inspection and monitoring is through checking of the discs on windows side, which is practically challenging as the trends show the increasingly vehicle crimes and accidents. For example, a comparative analysis of the major and minor road incidents of 2013 and 2014 indicates that there is an increase of incidents by equivalent of 67.3 percent in Tanzania mainland. In the period of January to December 2014, a total number of 1,125,672 major and minor incidents were reported compared with 688,202 incidents in 2013 (Tanzania Police Force and National Bureau of Statistics, 2015). The reports reveal that the accidents are not caused only by vehicle defects but also by driver negligence and road deficiencies. In Dar es Salaam, Kinondoni area is most reported with deaths caused by road accidents as presented in Table 1.1.

Table 1.1: Number of Traffic Offences Reported in Dar es Salaam in 2014

District	Minor offences	Fatal incidents	Death Caused by Accident	Number of injured persons
Kinondoni	3,086	224	242	1999
Ilala	2516	132	146	2067
Temeke	2209	111	118	1672

Source: Tanzania Police Force and National Bureau of Statistics, (2015)

In Tanzania, the disparity ratio between the traffic police on one hand and the number of vehicles and the complexity of vehicle inspection and monitoring processes on the other hand calls for interventions through ICT innovation. In their study, Denef et al. (2011) recommend the adoption of ICT in task police force activities due to the nature of the policing processes, which are complex and information-led hence requiring timely integration of multiple data sources. Moreover, ICT systems present an opportunity for task police force to increase their capabilities in enforcing the law through automated vehicle inspection and monitoring (Brinkhorst, 2004).

In Tanzania, like in most developing countries, there is still a need of empirical studies that will identify the critical success factors for adoption of ICT by law enforcement in vehicle inspection and monitoring whilst taking into account the local context. The significance of contextual research studies is emphasised in several international and local studies (see for example Mkude, 2016; World Health Organization [WHO], 2004; UN Global E-Government Surveys, 2001-2016).

1.3 Statement of the Problem

The increasingly vehicle accidents in Dar es Salaam is highly contributed by insufficient and inadequate mechanisms and reliable systems for facilitating traffic inspection interventions (Auditor General, 2012). The number of road accidents caused by vehicles in Dar es Salaam is very alarming (Tanzania Human Rights, 2015). As argued earlier in section 1.1, such accidents impact negatively the social welfare and socio-economic developments.

The statistics show that about 80 percent of the road accidents are attributed to human factors, while the rest are due to poor road infrastructure and vehicle defects (Auditor General, 2012). In addition to this high level of road accidents, vehicle breakdown and crimes further stress the need for ICT intervention to enhance the effectiveness and efficiency of law enforcement through vehicle inspection and monitoring.

In 2015 the Traffic Enforcement Management System (TMS) was introduced for tracking and penalising reckless drivers. The TMS inspects the validity of road license, routes and stops for town buses (daladala) through its interconnection with Tanzania Revenue Authorities (TRA) and the Surface Marine Transport Regulatory (SUMATRA). The adoption of the TMS by police task force is still minimal, hence the envisaged benefits of the system are hardly realised.

Adoption of ICT by law enforcement entities is not a straightforward task and it needs to be adequately informed. As per Denef et al. (2011) the issue regarding the acceptance of ICT in police force is complex. The authors state that this complexity is due to the structure of police forces environment, where adoption of ICT involves strategic, organizational, social-cultural and technological aspects. Furthermore, the authors caution on high security requirements that ought to be considered. On another note, the authors illustrate that such adoption of ICT needs also to consider ubiquitous needs of police force operations and the various forms of vehicles involved – two-wheel motorcycle (bodaboda), three wheel motorcycles (bajaji) and normal cars (buses, trucks, etc.). More crucially, the operations of police task force

require the integration of multiple data from different sources in short time frame; consequently, the sensitivity of shared information across these sources needs the adequate design and use of ICT (ibid).

There is limited knowledge and research done regarding the adoption of ICT in vehicle inspection and monitoring by law enforcers in developing countries including Tanzania. Lack of information on ICT adoption, coupled with inadequate number of traffic police officers call for an intervention to gain benefits accrued from investments in ICT. Accordingly, this raises the need for revisiting and modernising the existing measures for vehicle inspection and monitoring deployed in Tanzania in order to reduce the high level of road accidents and, thereby, to contribute in socio-economic and societal developments.

1.4 Objectives of the Research

The general objective of this study is to develop a framework for adoption of ICT by traffic police force in vehicle inspection and monitoring in Tanzania.

Specific objectives of this research are:

(i) To identify aspects necessary for ICT adoption in law enforcement through vehicle inspection and monitoring.

(ii) To examine the factors that facilitate adoption of ICT by law enforcement entities for inspection and monitoring.

(iii) To develop a framework that will guide the adoption of ICT by law enforcement entities for vehicle inspection and monitoring processes

(iv) To design a working model for vehicle inspection and monitoring per developed framework in research objective (iii).

1.5 Research Questions

(i) What aspects are considered necessary for the adoption of ICT in law enforcement through vehicle inspection and monitoring?

(ii) What factors facilitate the adoption of ICT by law enforcement entities in inspection and monitoring?

(iii) What framework is suitable for guiding adoption of ICT by law enforcement entities in vehicle inspection and monitoring?

(iv) How can the vehicle inspection and monitoring processes of police task force be automated, based on the framework proposed in research question (iii)?

1.6 Significance of the Study

The research seeks to fill the gap existing between the existing vehicle inspection and monitoring processes of traffic police force and ICT innovation in Tanzania. The police task force and other law enforcement entities will find the research findings vital in development of intervention measures to address the road safety challenges in Tanzania, and thereby, contributing to social welfare and economic development.

The findings of this study will identify the critical success factors and recommend ways for enhancing the adoption of ICT in vehicle inspection and monitoring processes. Such information will provide traffic police force with knowledge on the issues that positively contribute to deploying ICT in vehicle inspection and monitoring processes. The study intends to provide policy makers with knowledge that will assist them in setting ICT policies and strategic action plan for ICT adoption by the police task force in their various law enforcement activities.

The framework will provide police task force guidance on the factors that ought to be present for successful adoption and implementation of ICT interventions. Additionally, the working model will serve as an abstraction through which ICT systems for automation of vehicle inspection and monitoring processes can be developed.

Furthermore, the study will benefit future researchers in Tanzania and in other developing countries to draw on the findings regarding the use of information and communication technology in vehicle inspection and monitoring.

1.7 The thesis Outline

The thesis consists of six chapters with various activities. First chapter presents background of study, problem domain, objective and significance of study. Chapter two review literature regarding the adoption of ICT in public sector, ICT in law enforcement entities, various technologies used in vehicle inspection and monitoring and hence introduced the gap need to be filled. Chapter three discusses the methodology and the reasons of its choice. Chapter four presents the discussion on the findings, while chapter five proposes the solution by developing the framework for the adoption of ICT in law enforcement agency. Chapter six finalizes the result by outline the conclusion.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter examines scientific studies regarding the problem introduced in Chapter 1. The review conducted to inform the author with in-depth understanding of the existing knowledge and the research gap on the subject of adoption of ICT in law enforcement for vehicle inspection and monitoring. The chapter starts by defining the key concepts of the terms used in the study at hand, followed by review of the theories for ICT adoption. The subsequent section discusses the issues on ICT adoption in the public sector. This section is followed by a discussion on adoption of ICT in law enforcement and the application of ICT in the concept of road safety. Then a review of ICT application in road safety in Tanzania is accounted. Finally, based on these discussions, the knowledge gap is outlined.

2.2 Conceptual Definitions

This section provides the definitions and understanding of the key concepts that are used in the research.

2.2.1 Adoption of ICT

Adoption of Information and Communication Technology (ICT) is defined as the acceptance and the use of ICT innovation in accomplishing specialized tasks (Yonazi, 2010). The adoption of ICT by an organization depends on the nature and specialized usage of the technologies and the business value that an organization seeks to achieve.

2.2.2 Vehicle Inspection and Monitoring

Vehicle inspection in Tanzania is mandated to the Traffic Police Force. The term inspection is defined as the way of certifying that the vehicle conforms to the safety regulations and rules (Keall et al., 2012).

There are two main types of inspection conducted by the Traffic police force in Tanzania; Road side inspection and Mandatory inspection. The inspection can include the following parameters: legal speed, driver behavior, legitimate of insurance sticker, legitimate of road licence, legitimate of the ownership, vehicle worthiness, etc.

Monitoring is the process of checking or observing inspection activities in order to be satisfy with or set standards. For example, the commander of traffic force (at the Head Office of Traffic Police Force) is responsible for monitoring and evaluating all inspection activities, and the Minister of Works use stakeholders i.e. traffic police to set the speed limit (NRSP, 2009).

2.2.3 Framework for Adoption of ICT

The framework for ICT adoption comprises policies, guidelines and procedures, which are implemented either manually or, where possible, automated through technology (NSW Government, 2014). Accordingly, the framework for law enforcement entities will need to include both contextual and technological aspects that guide the smooth adoption of the ICT innovation. Aditya. (2011) states that, a framework makes easier to work in complex technologies, and bond together a bunch of discrete components into something useful.

2.2.4 Working Model for ICT Adoption

Working model referred to as a scientific activity, aimed to make a certain part of the world easier understand, describe, quantify, visualize, or simulate by referencing the existing practice and knowledge (Vasant, 2016). Modelling is achieved by identifying relevant aspects of situation in real world and model its events to the conceptual world (ibid). The modelling can be used to identifying and automating the processes of vehicle inspection and automation.

2.3 Adoption of Information Technologies

The growing need of technology and increasing failure of IT/IS adoption in organizations have inspired scientists to conduct studies regarding technology adoption and implementation (Basole, 2006; Chuttur, 2009). These studies have led to the development of theories and models that provides insights into the adoption of ICT. A number of these theories and models have been used to describe user acceptance and usage behavior of ICT in various ways (Gyaase, 2013). The subsequent sections discuss some of the mostly used theories and models in ICT adoption.

2.3.1 Technology Acceptance Model (TAM)

The technology acceptance model (Davis, 1989) predicts and describes ICT usage behaviour that causes individuals to accept or discard the use of ICT (Korpelainen, 2011). It describes the influence of external factors on internal beliefs, attitudes and intentions of individuals to adopt ICT. Davis (1989), describes two particular beliefs: the perceive usefulness and perceive ease of use. Perceive usefulness refers to individual believing using a specific application system would enhance his or her job

performance within an organization context. Perceive ease of use refers to the degree whereby a person believes that using a particular application system would be free of effort (Davis, 1989). TAM, therefore, is useful to illustrate the relationships of the system (ICT) design features and other exogenous factors that influence the user acceptance and use behaviour.

2.3.2 Theory of Planned Behaviour (TPB)

The theory of planned behaviour (Ajzen, 1985) provides the concept of personal behavioural attitude and different beliefs that eventually lead to behavioural intentions to adopt ICT. Attitude towards a behaviour, subjective norms, and perceived behavioural control influences an individual's intention to perform a given behaviour (Shareef et al., 2013). The TPB extends Theory of Reasoned Action (TRA) by adding the construct of perceived behavioural control. Hence, the TPB is useful in predicting the individual behavioural intentions in acceptance and usage of ICT.

2.3.4 Diffusion of Innovation (DOI)

Diffusion on innovation describes a set of constructs that could be used to study technology acceptance (Venkateshet al., 2003). Diffusion and adoption are concepts discussed together; however, in application are quite different. Diffusion is described as a process by which a technology spreads across a population of organizations (Pudjianto &Hangjung, 2009). Innovation is as an idea, practice or object that is perceived as new by an individual or a department in certain organization (Rogers, 2003). Phonkaew. (2001), argue that innovation takes place in two processes: "innovation adoption takes place in initiation stage and innovation implementation

take place in implementation stage". The advantage of utilizing innovation diffusion theory is that it provides a strong theoretical base for evaluating IS for assessing the possibilities of the diffusion of the technological innovation and its incorporation within an organization (Pudjianto & Hangjung, 2009). DOI presents four factors that influence the adoption of an innovation by organization: innovation, communication channels, time and the social system (Sahil, 2006). Social system is identified as the nature of the group to which it is introduced (ibid). However, according Phonkaew. (2001), "innovation takes place only with actual use", the intention to implement new system to the current system does not count as innovation.

2.4 Issues on ICT Adoption in Public Sector

Public sector comprises of a huge and diverse range of departments, offices and agencies, with the wide range of services and varying ICT requirements. The adoption of ICT should focus on how to share and integrate technology across the diversity public bodies, to digitize the required public services, to improve governance, to facilitate lawful sharing of data and to improve ICT resources and ICT skill set (DPER, 2015).

Literature scan reveal that despite of increasing investments in ICT innovation, public sectors underutilize ICT in their business processes (Gyaase, 2013). The adoption of ICT in public organizations has been guided by the availability of ICT policy. Mark states that poor ICT policy and regulatory environment reduce the effectiveness of ICT for organizational and economic developments (Mark, 2010). Thus, the ICT policy is a crucial factor that harmonizes, coordinates and integrates all ICT activities; thereby, increasing adoption. For successfully adoption of ICT, an

ICT policy provides a clear vision and indicates the maps, goals, specific objectives and action plans to realize the vision. ICT Policy outlines the plan of action by drawing the activities, responsibilities and measurements for evaluation in the process of ICT adoption (EU, ITU, FDM, 2010).

In lecture workshop (Coherent ICT policies) presented at Centre of Development Informatics, University of Manchester, on March 2010, it was suggested that "in the absence of good leadership, ICT policy is unlikely to deliver, but when ICT policy is supported by strong and credible leadership that has a powerful vision on adoption of ICT, that contribution is likely to emerge". The top management are catalyst for the negative or positive changes in any organization. Rice and Leonardi (2013) indicate that a leader with innovative mind, social and institutional influence has the potential in compelling the adoption of new technology. Furthermore, in her empirical work, Mkude (2016) reports that top management and political support forms a significant prerequisite for successful adoption of ICT in the public sector.

Furthermore, the availability of ICT skills is among the factor that influencing the adoption and utilization of ICT in organizations. Literature shows that staffs with higher level of education are adaptable to technologies than those with lower level of education (Gyaase, 2013).

The assurance of the safety keeping and usage of data is critical for the adoption of ICT. Public sector entities, like law enforcement, deal with large size of sensitive data that are accessed by different sources. The security and privacy breach ruins the organization's reputation, its credibility and legal standing (Macias & Thomas,

2011); in turn, undermining public trust and consequently affecting the adoption and implementation of ICT by organizations.

Infrastructure is another element that is crucial for the adoption of ICT. Rice and Leonardi (2013) indicate that availability of digital equipment influences the way ICT can be adopted and utilised in an organization. Infrastructure includes hardware, networks, communication equipment and software. Literatures reveal that less connectivity, limited bandwidth and unreliable electricity decrease the rate of adoption (ITU, 2011; Busagara, 2013).

According to e-readiness index, in order for a country to adopt and use ICT it must be e-ready in terms of ICT infrastructure and accessibility of ICT (Dutta et al, 2015). ITU examines some of the aspects that will help to increase the availability of ICT infrastructure and services. These aspects include identifying the appropriate actors, relevant technologies, reform regulatory frameworks and promote African entrepreneurship in the field of ICT infrastructure and services (ITU, 2011).

Literature review reveals a number of problems that have been accounted for regarding ICT adoption and implementation in developing countries. Most theories have been developed and tested in various organizations, but less has been done regarding law enforcement, which is argued by Manning as caused by law enforcement entities not disclosing their activities publicly (Manning, 2003). Developing countries have constraints that undermine the application of ICT in the public sector. These includes: limited human resources, high cost of ICT equipment, insufficient bandwidth, poor ICT policies and regulatory, environment, corruption,

poor political and managerial commitment, inadequate infrastructures, poor institutional framework (Mkude, 2016; ITU, 2011; IEG, 2011; Mark, 2011).

2.5 Adoption of ICT in Law Enforcement

The information age has changed the attitude and perception of law enforcements as well as criminals. This change has led to the advent of different types of technologies used as tools to bring effectiveness in policing duties. There are several types of technologies used by law enforcements, for example Information Technologies, Analytical Technology, Sensor and Surveillance Technology and Identification Technology (COPS, 2015). The technologies are briefly explained as follows:

2.5.1 Information Technology

Information Technology is made up with applications of computers and telecommunications to capture, process, store and retrieve data. It includes the systems with features that facilitate sharing information, identification through DNA, and enhance law enforcement to interact with community (COPS, 2015).

2.5.2 Analytical Technology

The technology uses large amount of data (data mining) and modern technology to identify and analyze patterns and relationships of those data with criminal activities. The systems equipped with features to make statistical predictive which assist to intervene, investigate and perform intelligence duties (COPS, 2015; Fatih & Bekir, 2015).

2.5.3 Communication Technology

The technology enhances law enforcement to link each other and access information from diversity sources (COPS, 2015). It is crucial technology as it assists to access information from diversity sources. The ability to access and use data across different organizations and information technology systems can be enhanced where there is an interoperability of systems of data. Interoperability refers to “ability to transfer and use data and information in a uniform and efficient manner across multiple organizations and information technology systems” (Rajabifard, 2010). However, interoperability is a challenge as it depends on technology, policy and organizational spectrum. The other challenge is the need of dedicated network infrastructure due to the sensitive nature of the data so sufficient availability of broadband is needed (PERF, 2012 & COPS, 2015).

2.5.4 Sensor and Surveillance Technology

The technology is made up of the three components which include transducer, signal processor and data processor. The technology equipped with features that sense and capture the object and convert the captured image’s object to the parameter interesting by law enforcement (Fatih & Bekir, 2015; COPS, 2015).

2.5.5 Identification Technology

The technology equipped with features that use to identify the involvement of the certain entity in crime scene. The biometric technologies comprise features that measure and analyses body parts such as Iris, fingerprint, facial and DNA (COPS, 2015).

2.6 ICT and Road Safety

The technologies used in vehicles inspection and monitoring exist in various names including: Automatic License Plate Recognition (ALPR mostly in the USA), license plate readers (LPR), automatic number plate recognition (ANPR, primarily in the UK), Automatic vehicle identification(AVI) and car plate recognition(Roberts & Cassanova, 2012).

According to Roberts and Cassanova (2012), these technologies are significant in the arsenal of law enforcement and public agencies. In order to achieve the envisaged benefits of the deployment of these technologies, there is a need of proper planning, implementing, training, deployment and management of the technology and information provided. The technologies are practical and model what happens in real life environments and translate to information base system. These technologies are made up of the systems that are either permanently fixed to the light poles, traffic lights and any other safe structure located alongside the road, or mounted to a special police vehicle (known as mobile), or handled by a traffic police officer (Armstrong et al., 2010; McCormick et al., 2015).

2.6.1 Vehicle Inspection and Monitoring Systems and Technologies

The technology is equipped with the capability to detect the passing vehicle and automatically reads plate number of the vehicle. The vehicles are processed as a conceptual resource in information systems by the use of special intelligent tools. These tools capture plate number in a real environment and convert it, into a conceptual resource, the vehicle inspection and monitoring system comprises hardware and software components (Tatale & Khare, 2011).

2.6.2 Hardware and Software Technologies for Vehicle Inspection and Monitoring

The hardware parts consist of camera, camera triggers, image processor, communication and storage devices. The software comprises the Optical Character Recognition (OCR), for processing the captured plate number. The functions of the OCR are to automatically capture an image of the vehicle's license plate and to convert that image into alphanumeric characters using optical character recognition (USDJ, 2012). Then, the converted image is compared with the plate number acquired from the police databases and the OCR sends back the results for action (USDJ, 2012).

2.6.3 The Inspected and Monitored Parameters

The safety parameters inspected include insurance, driving license, vehicle road certificate, road worthiness certificate, stolen vehicle, vehicle or driver in connection with terrorism, crimes, missing persons and speed vehicle (Roberts & Cassanova, 2012). Uninsured drivers are identified from data provided by the insurance industry, where vehicles without a valid roadworthiness certificate, without valid tax disc, with unlawful number plates are identified. The vehicle without a valid parameter is flagged and the message is automatically sent to the police patrolling or located near the road where vehicle is passing, for further actions (Driver & Vehicle Licensing Agency, 2015).

2.7 Road Safety in Tanzania: Vehicle Inspection and Monitoring

In Tanzania, there are two types of inspection, mandatory and road side vehicle inspection. Mandatory vehicle inspection is the process performed once a year

("safety week"), whereby the vehicle is taken to the traffic police vehicle inspector to check the roadworthiness of the vehicle. Road side inspection is the process that is performed manually. The road side inspection are performed on a daily basis where by the police located along the roads pull out the vehicle, and then inspects through manual typing of the vehicle registration number on smart phone (recently introduced system).

However, the mostly used modality is by reading discs displayed on vehicles screen, fleet checks, intelligence information which includes data obtained from police's own management systems (no evidence if it is computer based system), other government departments and members of the public (Auditor General, 2012). In some occasions drivers are asked to produce documents such as vehicle's card, driving license card, etc. These modes of inspection undermine the police traffic performance because there is no reliable data on the number of vehicles registered, insured and vehicle with or without other safety parameters (ibid). Currently, the inspection and monitoring duties require a lot of human resources and time to manage. This is due to the fact that ICT has not yet utilized in vehicle inspection and monitoring, and there is lack of coordination among the firms or ministries dealing with vehicles (Auditor General, 2012).

The use of ICT in vehicle inspection and monitoring especially in Tanzania is the technology gap that needs to be studied. ICT resources have been proved to contribute to competitive advantages in improving the organizational performance; the studies indicate that, this benefit can be accomplished if ICT resources,

capabilities are combined with some other organizational elements (Oliveira & Martins, 2011).

2.7.1 Status quo of Accidents in Dar es Salaam

Dar es Salaam is Tanzania's most populated city. According to the official 2012 census there are 4,364,541 people living in Dar es Salaam city **(**National Bureau of Statistics, 2013). Dar es Salaam metropolitan areas cover three municipalities of Kinondoni, Ilala and Temeke. Table 2.1 describes the number of population per district. Most area of the city is severely affected by traffic accidents, faulty traffic jam, vehicles breakdown and inadequate man power i.e. traffic police. This is due to the drastically increasing of vehicle importation and registration. The statistics shows that the rate of vehicles and population increasing in Dar es Salaam is not proportional to the number of police officers (Tanzania Police Force and National Bureau of Statistics, 2015).

Table 2.1: The Land Area, Population, Wards, Street and Road Length in the Three Municipalities of Dar es Salaam City

Municipal	Land Area Sq (kms)	Population	Wards	Street	Road Length (kms)
Kinondoni	501	1,775,049	34	180	914.16
Ilala	208	1,220,611	26	101	804.37
Temeke	684	1,368,881	30	171	787.30

Source: Tanzania Police Force & National Bureau of Statistics (2015)

The NBC (2015) report indicates that the road accidents in Dar es Salaam are highly increasing. Therefore, there is a need of sophisticated technologies that will assist the low number of human resources (Traffic Police force) to handle and execute inspection and monitoring on 2,505.83 kms of roads in Dar es Salaam.

The rapid increase of the population which leads to fast expanding of infrastructure network such as roads, does not match with the rate of employment of the law enforcements officers especially traffic police force. Table 2.2 indicates the number of polices per district. Population, lack of modern techniques and rapid growing of the city constrained the ability of police force to respond to the wide range of criminal activities and accidents (NBS, 2015).

Table 2.2: Number of Police Compared to Number of Accidents

Municipal	Number of Police	Accidents
Kinondoni	1,516	3086
Ilala	1,360	2516
Temeke	960	2516

Source: Tanzania Police Force & National Bureau of Statistics (2015)

The road network of the Dar es Salaam city is categorized into four types as illustrated in Figure 2.1 national highways (owned by TANROADS), arterial roads, distributor roads and local roads (owned by Municipal Councils). Traffic Police Force responsible for managing the traffic, while SUMATRA regulate routes, stops and fires for commuter's buses (DCC, 2010).

Increasing accidents and crimes and increasing number of vehicles are the essential ingredients that guided to the selection of Dar es Salaam to be a case study of the research at hand.

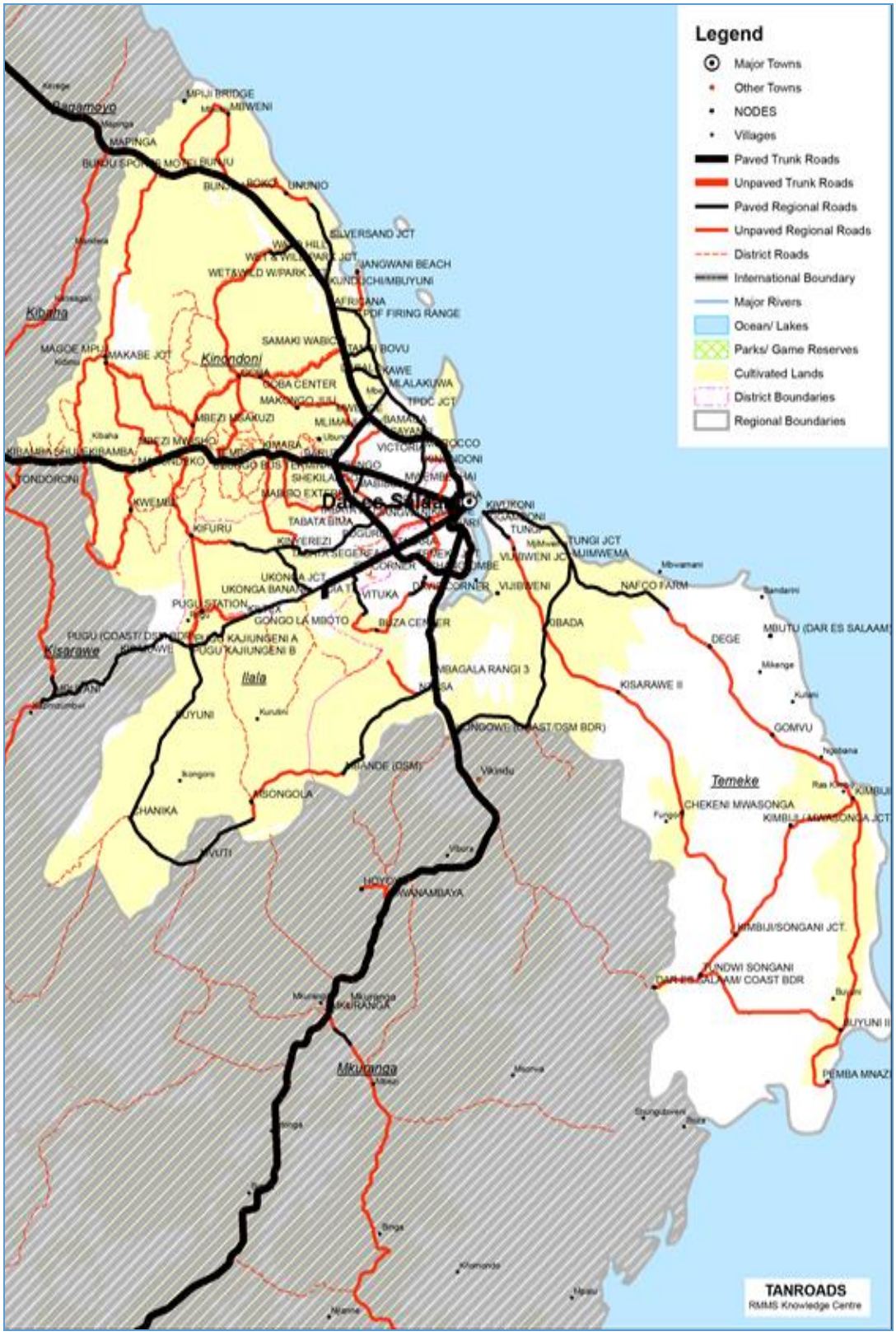


Figure 2.1: Map of Dar es Salaam Road Networks

(Source: TANROAD Google Image)

2.8 Related Work

Various studies have been conducted regarding the adoption of ICT by law enforcement. Busagala & Ringo, (2013) explains the issues that undermined the adoption of ICT by police force including lack of ICT skills (among police staffs), lack of enough funds, lack of ICT infrastructure, lack of training to police staff, low access of internet and inadequate training programs. The study recommends the introduction of an information system for e-policing whereby a citizen can report crime incidents by sending a short text message and a notification to the police officer for action (ibid.). Nyamawe & Mbosso, (2014) explain the adoption of ICT for tracking vehicles and proposed the model for tracking real time buses over speeding. The proposed model by the authors utilizes Global Positioning System (GPS), Global Positioning Satellites and Global System for handheld device communications (GSM) Technology (mounted on bus/vehicles) by updating the law enforcement (ibid).

2.9 The knowledge Gap

From the theories and models (presented in section 2.3) and the studies presented above, a number of gaps are identified. The studies show that the adoption theories and models (presented in section 2.3) explain the adoption of ICT in an organizational context. Venkatesh et al (2003) argue that the adoption technologies that have been studied do not fit for the sophisticated and complex technologies needed for the organizational context. Other limitations include the testing of most models done by using students (individual centered rather than organization) rather than working places (at organization). Moreover, most of the model tested after

participant's acceptance or rejection rather than during the active adoption decision-making process (Venkatesh et al., 2003). Furthermore, the proposed theories and models in literature have been tested into simple, individual-oriented information technologies (Venkateshet al., 2003).

Several studies have been conducted for the ICT adoption in public, but most of the mechanisms proposed are not adequate to provide the guidelines or framework for vehicle inspection and monitoring in Tanzania context. Lero (2013) states that, there is a weakness in innovation adoption research in its failure to take adequate consideration of business context and its integration with overall environment. There are problems of technological alignment of proposed solution with police force processes in vehicle inspection and monitoring.

Accordingly, this study attempts to fill the gap by identifying the critical success factors and developing the framework for the adoption of ICT in vehicle inspection and monitoring for traffic police force. Then, through the framework a model that illustrates capturing, processing, storing, extraction and dissemination of the vehicle information is designed.

2.10 Summary

This chapter has informed us with knowledge regarding the definition of adoption of ICT and adoption framework. The chapter also review the theories proposed about the adoption of ICT. The findings recognized the proposed theories; however, the applicability of these theories seems to be limited to the traffic police environments. Most research fails to take adequate consideration of business context and its integration with overall environments.

The chapter concludes with insights that there is a need of appropriate mechanism that will assist police traffic force to adopt and utilize ICT in vehicle inspection and monitoring. The study seeks to fill the knowledge gap by developing a framework that will guide successful adoption of ICT by traffic police force. Additionally, the study seeks to fill in the gap by developing a model to illustrate automation of vehicle inspection and monitoring processes performed by the traffic police force.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Chapter three presents the scientific methods and research instruments used to carry out the research and achieve the objectives of the research in logical considerations. It includes the constructs that present research approach, collection of data, and data analysis.

3.2 Research Design

The Grounded Theory Approach (GTA) was selected to guide this research. This is due to the fact that there is less information regarding the adoption of ICT by law enforcement, particularly traffic police force. Accordingly, we need the mechanism that will guide us to do our research in field of study; therefore, allowing the relevant issues to emerge (Esteves et al., 2002). The choice of GTA is due to the nature and environment of the study. The study involves the law enforcements entities; whereby, limited study has been done regarding the adoption of ICT especially in Tanzania context. Furthermore, the nature of the operations performed by law enforcements such as traffic force involve information-led activities that require integration on multiple data sources and the nature of information is sensitive (Denef et al., 2011).

These indications highlight the inadequacy of theory and research to guide this study. Accordingly, GTA fits this study as it is appropriate to the area where there is limitation of information and theory (Esteves et al., 2002).

3.3 Study Area

The area of study was a unit of law enforcement entity, the traffic police force in Dar es Salaam region. The aim of this sample selection was to get the insights into the ICT skills, ICT resources, ICT strategies, ICT policy and capabilities of the traffic police force. Additionally, the selection aimed to identify the challenges, initiatives and mechanisms used in vehicle monitoring and inspection processes. The ICT experts from the Open University of Tanzania and SUMATRA were involved as well. The former were involved due to their collaboration with traffic police force through training and capacity building, which were performed by the ICT department in the University. SUMATRA were involved because of their close cooperation with the police force in law enforcement activities such as their collaboration in implementing measures and tools for checking the validity of road licence.

3.4 Study Population

The Law enforcement organs comprise a variety of entities such as Military, Police Force, Sumatra, Police Field Force Unit, immigration, etc. The population of study addresses the sample of study drawn. Accordingly, in this study, the population of study exhibited from law enforcement entity, particularly the traffic police force in Dar es Salaam region, and ICT experts from OUT and SUMATRA. Dar es Salaam selection is due to the huge influx of vehicles, and high rate of vehicles crimes and accidents.

3.5 Case Study

The field works were both exploratory and case study strategies. It was exploratory due to the fact that it is well suited with Grounded Theory Approach and still less is

known regarding ICT adoption by law enforcement in Tanzania context. The significant actors in vehicle inspection and monitoring and road safety were visited and requested to present their experiences, views and observations regarding the adoption of ICT in law enforcement entities.

The case study strategy was deployed in order to provide insights into the real situation and to explore in depth the activities, processes and personnel involved in issues regarding ICT adoption. Furthermore, the case study strategy is useful when a researcher seeks to describe phenomena, to build or test a theory, and to conduct a cross-case analysis (Benbasat, et al., 1987).

3.6 Case Study Selection

The public organizations that had adopted ICT were approached to validate our findings – OUT, SUMATRA and Police Traffic Headquarters. This selection validates one of the ground theory building blocks, i.e. the theoretical sampling which saves the purpose of checking emerging theory against reality by sampling incidents that may challenge or elaborate its developing claims. The criteria of selection include successfully adoption of ICT, capability in ICT expertise, collaboration with traffic police in consultation, training and research in ICT field and the role play in road safety management and environment.

3.6.1 The Surface and Marine Transport Regulatory Authority (SUMATRA)

SUMATRA is a government multi-sector regulatory agency that regulates and facilitates safe environment for transport services. The company has 4 ICT experts, with both academic and professional qualifications. SUMATRA works closely with

the traffic police force in a number of activities. For instance, in collaboration with consultants, SUMATRA introduced an application to enable traffic police force to check the validity of road licence of drivers using smart phones. In using the application, a traffic police types a registration number of the vehicle on smart phone (android operating system) and processes the number to check if the owner had paid road licence or not.

3.6.2 Open University of Tanzania

The Open University of Tanzania is one of the public universities that utilize ICT in various tasks related to learning, teaching and functions of the University. The institution has made a huge investment on ICT staff with a number of experienced staff growing to 44 (academics and non-academics).

Adoption of ICT has enhanced the University to accomplish its core activities in efficient ways, via in-house ICT staff. Several systems have been either developed or customised, these systems include;

(i) Learning Management System - students access study material and associated interactions via smart mobile phones and computers,

(ii) File tracking system – handling and tracking the movements of file,

(iii) Students' Academic Records Management System - DES upload students results and students access and view their results,

(iv) Examinations Registration System - students register the examinations, they want to attempt.

The Open University of Tanzania has been collaborating with Tanzania Police Force by training 1,017 police staffs, on provision of special ICT basic training. The training conducted in Dar es Salaam, Iringa, Rukwa, Mbeya, Katavi, Kigoma, Shinyanga, Mwanza, Kagera and Singida. This indicate the rich experience and expertise of OUT on ICT issues, accordingly, we were able to get the helpful information regarding the adoption of ICT by law enforcement.

3.6.3 Police Traffic HQ (ICT Department)

The Tanzanian Police Traffic Force is responsible for vehicle inspection and monitoring among its core functions. The vehicle inspection and monitoring is carried out to ensure the properly functioning of the vehicle in accordance with road safety regulations. To date, efforts have been put in place to increase the capacity of traffic force in fulfilments of their inspection and monitoring duties. Such efforts include: the establishment of ICT Department, Training police in ICT and conducting ICT seminars to police staffs. On the 16th September, 2015, the Traffic Police Force introduced a system which is responsible for processing the information of the road regulations offenders. The vehicle plate number and driving licence information are recorded and the offended drivers are given the ticket to instruct them how and where to pay the penalty and the consequences for delaying paying. The degree of ICT usage by Police Traffic Force is still low, much of the tasks of vehicle inspection and monitoring are performed manually.

3.7 Sampling Design

In order to generate sufficient data, appropriate sample size was needed (Thomson, 2011). Therefore, appropriate number of traffic police force were needed to be

interviewed to establish the patterns, concepts, categories and properties regarding the factors favouring the adoption of ICT by police force. The decision on appropriate number of traffic police force can be guided by the concept of data saturation (ibid). Following this concept, the ICT expertise and other traffic force members were interviewed until the data gathering becomes repetitive. Thomson (2011) argues that, to reach the point where interviews become repetitive i.e. no new data emerge, it may take 10, 20, 30 interviews. Ignoring theoretical saturation, the researcher risks creating theory based on inadequate development of patterns or themes, and the result might be findings based on the lack of reliability and/or validity (ibid). Interviewing traffic force at the extent suggested by Thomson (2011) can be hard due to the nature of their work. However, Strauss & Corbin (1998) recommend narrowing the focus of the research questions after three or four interviews; and hence, reducing the number of interviews.

Generally, when used using the Grounded Theory Approach, the sampling process evolves during the research process (Thomson, 2011). Nevertheless, sampling cannot be planned before embarking on the study (Bitsch, 2005). Therefore, it is proposed to use the theoretical sampling procedures which dictate the researcher to choose participants who have experience or are experiencing the phenomenon under study (ibid). Accordingly, ICT experts and traffic police on vehicle inspection and monitoring systems chosen in order to gather the empirical data. Table 3.1 below summarised the profile of ICT experts from OUT, SUMATRA and Police Traffic ICT department.

Table 3.1: Participant Profile

Participant ID	Place of Work	Gender	Competence
O01, O03, O05, O06 O02, O04 O07, O08, O09, O010, O011, O014.	OUT (ICT Department) OUT (ICT Department) OUT (Educational Technologists)	M F M	System Analysts, Computer Engineering Network Engineer
P01, P02, P03, PO4	Police Traffic ICT department	M M M M	Computer science
S01 S02 S03	SUMATRA SUMATRA SUMATRA	M M M	Director of ICT Computer Science and Health Informatics Computer Science and Network expertise

3.8 Data Collections Methods

The research seeks to collect the information regarding adoption of ICT by law enforcement entities in Tanzania context. Therefore, the source of information was from ICT expertise from OUT, SUMATRA and Traffic police force. The selection of only ICT expertise, is due to the fact that, we wanted to conduct the qualitative in-depth interview with knowledgeable and understandable individuals (key informants) who can inform us with insight nature of problem and recommendation for solutions

The information requirements included existing initiatives, challenges, opportunities, experiences and issues regarding adoption of ICT. Accordingly, for systematic data collection from these three sources, tools that were used include interviews, focus group discussion, observation and documentary analysis are summarised in Table 3.2.

Table 3.2: Research Questions, Information Required, Data Sources and Collection Tools

RQ	Research Question	Information required	Data Source	Tools/Instrument
1.	What are the aspects necessary for the adoption of ICT in vehicle inspection and monitoring?	Findings favouring the adoption of technology in vehicle inspection	Academic journals, Government publications, OUT, SUMATRA	Literature review/ document analysis, Interview, FGD, Questionnaires,
2.	What are the factors that might influence the adoption of ICT by law enforcement entities for vehicle inspection and monitoring?	Adoption theories and framework, ICT policy in vehicle inspection, police preference, ICT infrastructure, organisation structure and integrations	Traffic police force personnel, ICT expertise (SUMATRA, OUT), academic journals	Interview, Questionnaires, observation, FGD and academic journals
3.	What framework can be used to guide the adoption and usage of ICT in vehicle inspection in the Tanzanian context?	Police preferences, Theories and framework fits Tanzania context	Input from question 1 and 2	Literature review, Interview, Observation, Research findings
4.	How can the framework (in research question iii) be implemented to achieve the general objective of the study?	Implemented level – from developed from work figure 5.1 above	Input from question 3. Pseudocode and algorithm per implemented level figure 5.1	Programming languages technologies.

3.8.1 Interview

The open-ended type of interview questions allows respondents to provide rich and detailed elaborations (appendix 02) (Mbogo et al., 2012). The interview started by the researcher introducing himself and explaining the aim of conducting the interview. Both English and Swahili languages were used as the media of communication depending on the comfortability of a respondent. During the

interview with respondents, in some occasion the researcher recorded the conversations, though in most cases, the interviewees were not ready to be recorded, instead the researcher took notes. The duration of each interview was approximately between 25 to 35 minutes. However most of the respondents were not comfortable to be recorded only few of them agreed to be recorded. During interview the following procedures were taken to avoid biasness (Irani et al., 2005):

(i) The interviewer acted as non-allied intermediate through which questions and answers are transmitted.

(ii) The interviewer did not adjust the wording of the question to fit the respondent or record only selected portions of the respondent answer

(iii) The interviewer did not give overt signal such as smiling, nodding approvingly when respondent answers or fails to answer a question

(iv) For any probes, care was taken not to introduce any ideas that may form part of the respondent's subsequent answer.

3.8.2 Observation

The researcher conducted the non-participant observation to balance the experience and views collected during the interviews. The researcher attended the field where vehicle inspection are carried out and observed without active participation in the processes. This assisted to understand the phenomena from a different perspective. This validates the Mbogo et al., (2012) findings that observation can be one of the handful techniques if it deploys to check the availability of the phenomena under study.

3.8.3 Focus Group Discussion

2 Focus Group Discussions were conducted. FGDs focus on research question 1 and 2 which sought to inform us with non-technological, technological aspects and factors necessary for the adoption of ICT for the vehicles inspection and monitoring. The Focus Group Discussion Guide in appendix 04 presents the rules and guidance including respecting each view aired by individual and disallowed few individuals to dominate the discussion. The duration of FGD was approximately 2 hours.

Focus group discussions included the OUT-ICT experts and traffic police force from ICT department using the discussion guide in appendix 04. The focus group discussion started by open ended questions followed by structuring of the subsequent discussion based on the experience, feelings, practices and responses to potential aspects that influence the adoption of ICT.

3.8.4 Questionnaire

As shown in appendix 03, the questionnaire was deployed to capture the primary data. The mixed types of questionnaires, which include both closed and open ended type of questions, were used. The duration of the questionnaires was approximately 10 minutes.

A total of 40 questionnaires administer to the group of ICT's expertise and technicians (selected according to their expertise), 4 questionnaires not returned, 36 questionnaires were filled and returned while 9 questionnaires were partial filled (hence discarded) see appendix 03.

In summary, the interviews, focus group discussions and questionnaires were research instruments used to collect data regarding the factors influencing the adoption of ICT. Table 3.3 summarises the type of research instrument and number of respondents per case. The total of 18 ICT experts and other significant actors i.e. technicians were interviewed at Open University of Tanzania, SUMATRA and Police Traffic HQ (ICT Department).

Table 3.3: Data Collection Instruments and Type of Respondents Per Case

Instrument	OUT	Sumatra	Police ICT Dept.	Total
Interviews	11	3	4	18
Observation reports	3	-	2	5
Focus Group Discussion	6	-	3	9
Questionnaires	31	3	6	40

3.8.5 Document Analysis

A range of academic writings were studied and analysed to verify the emerging themes. This installs us with assurance on the issues emerged regarding the ICT adoption in public sector specific police traffic force in Tanzania, especially the city of Dar es Salaam. The documents studied include desk reports from the traffic police force HQ, SUMATRA and OUT. Official documents available online were also studied for relevant information regarding ICT adoption in law enforcement.

3.9 Data Analysis Methods

Ground theory approached has emerged as one of the most common methodological framework that is incorporated with all building blocks that can be utilised in data analysis process (Thomson, 2011). Accordingly, the process of data analysis

accomplished via the incorporated framework processes which comprises phases such as open coding, axial coding, selective coding and developing a theory (Williams, 2007). The interviewees' feedbacks were transcribed and transcripts were coded. Prior to coding, the transcriptions were sent to the interviewees for accuracy checking in order to ensure accuracy and reliability of the findings as suggested in (Riege, 2003). Coding process includes open, axial and focus coding, which are explained as follows (Charmaz, 2008):

(i) During open coding stage the initial concepts relevant to the phenomena were identified (through bolded texts). The constant comparative analysis technique used to determine the consistency in coding the concepts; then, the memos were developed to explain the process (see appendix 05).

(ii) Then during axial coding stage, the concepts were categorised and make the connection between categories and rearrange in new way.

(iii) The third phase is selective coding/focused coding, examined focused code to evaluate which one best explain or interpret the empirical phenomenon. The related categories were refined and the relationships were validated in order to understand the interaction exists between categories.

3.10 Validity and Reliability of Data

To enhance the validity of this study we used the strategies highlighted on Table 3.4: triangulation, member checking and spending enough time on field. Multiple data sources were used to develop the factors that influence the ICT adoption. To ensure the reliability we recorded interview carried out by some respondents and the transcriptions were sent to the interviewees for accuracy. Table 3.4 depict the

particular strategy, descriptions and action that will be taken to guarantee the validity and reliability of data.

The measure that will be taken to insure the validity and reliability have been addressed above. Creswell (2007) recommended that at least two of the all eight strategies should be engaged in a study, to guarantee the validity and reliability.

Table 3.4: Data Validity and Reliability

STRATEGY	ACTION TO BE TAKEN
Triangulation	Various data collected methods used these include; primary and secondary data source, workshop, interview and focus group discussion. Other method includes observation and document analysis, all these used to bring up the validate of data
Use member Checking	The ICT expertise, and other significant actors deployed to ensure validity of data collect instruments and then later reviewed the accuracy and credibility of findings
Spend time in field	The exploratory and case study strategies together with Grounded Theory approached will provide the chance of spending more time on ground this will enhance with in-depth understand of the phenomenon hence enhance credibility and narrative account
Use an external auditor	The final finding will send to external supervisor to review the entire report
Transcription checking	The interviewees checked the transcribed interviews to ensure accuracy

3.11 Summary

GTA used to guide this study its choice is due to the complexity of obtaining data and scarcity of information. This motivates us to apply exploratory and case study strategies because is not only fit with GTA but also still less is known regarding the

ICT adoption by law enforcement in Tanzania. The population of study was the law enforcement entity particularly traffic police force in Dar es Salaam region. Sampling in GTA suggest up to 30 interviews to reach repetitive data which is hard in law enforcement, so we narrowed the focus interview questions after three/four question which complied by Strauss and Corbin principle. The data analysed and coded by using GTA framework and obtained the factors influencing the ICT adoption by police force. The researcher used various techniques to measure the validity and reliability of data collection methods and findings. This achieved by deployed various strategies, which are; cross verification of findings, use ICT expertise to check the validity, spend time on field to observe the phenomena investigated and Transcription checking.

CHAPTER FOUR

RESULTS/FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents the analysis and discussion of the study findings based on objectives of the research, mainly the first two objectives that aimed at obtaining the critical success factors that influence the adoption of ICT by traffic police force.

4.2 Results Overview

The first section of the enquiry seeks to capture the respondent's experience and job title (aimed to collect the relevant data from the right person). Respondents possess a range of background experience in ICT, majority are very experienced ICT users. The second section aimed to inform us with the aspects and knowledge of the factors influencing ICT adoption.

There were about 83 initial concepts transcribed from the data collected. As depict in appendix 04, the initial concepts filtered by means of constant comparative approach, which is accomplished by the process of identifying the similarities and differences between the concepts and grouping and labelling them into categories. The identified categories are summarised by memo, which was used as a starting point for the formulation of the final manuscripts. The categories were the substantive findings of the critical successful factors influencing the adoption of ICT by law enforcement.

In brief, the research study identified the critical success factors including the policy and strategies of the organization concerning ICT adoption, well established network infrastructure, alignment of the daily routines with the use of ICT, financial

capability, interoperability of the systems, skills, top management (leaders) support, privacy concerns and security of Information System, power supply and stakeholder support. The subsequent section elaborates the findings further.

4.3 Findings Analysis

This section describes the coding process which includes the identification of initial concepts and categories developed from the collected data. The collected data are analysed and coded to indicate their relationships with the factors influenced the ICT adoption by the law enforcement. The primary data derived from case studies were represented by three characters. The first letter represents the first letter of the public organization where the data collected. The second letter is the number of the respondent personnel for that organization while the third letter is representing the first letter of the key issue that respondent is presenting. For example, ‘’S01A’’ represents the first staff to be interviewed in SUMATRA, raised the key issue ‘’Awareness’’ regarding the factors influence the adoption of ICT, while ‘’O12I’’ represent the twelve staff to be interviewed at Open University, raised the issue regarding Infrastructure.

4.4 Factors Influencing ICT adoption by Law Enforcement

The analysis and interpretation of collected data revealed the aspects and critical factors which influence the adoption of ICT by law enforcement, particularly in the vehicle inspection and monitoring. The identified factors relate with the themes summarised in Table 4.1 and elaborated in subsequent sub-sections:

Table 4.1: Themes Identified from Collected Data

Theme (Factor influencing ICT adoption)	Letter assigned for coding purpose
ICT Policy and Strategies	P
Skilled Human Resources	T
Interoperability	X
Top management support	M
Investments on ICT and financial Support	F
Infrastructures	I
ICT equipment's (Hardware and Software)	Q
Security and Privacy	S
Staff Awareness	A
Training	E

4.4.1 ICT Policies and Strategies

Analysis shows that the absence of appropriate ICT policies and strategies cause the low level of ICT adoption. It was realised that while ICT policies and strategies are vital for adoption, less effort has been done to develop policies that are sufficient reflected and integrate strategies for the adoption and use of ICT. When asked factors that leads to the successfully adoption of ICT in their organization, the respondents claimed that:

> *''The successful adoption of ICT is due to the policy that compliance with our rules and regulations.''*

ICT Policies and Strategies are essential for ICT adoption as they are taking into account organizational and operational issues, and incorporate quantitative targets, timeframe, monitoring and evaluation mechanism for the potential deploying and adoption of ICT.

Appendix 5 depicts the initial concepts analysis for descriptive purpose. Once the initial concepts developed, the related concepts are grouped, and labelled (to formulate categories). Then, the labelled categories were interconnected to obtain the substantial findings. Table 4.2 depicts the coding process that used to analysed data, the table indicate how the researcher analysed data from the interviewees and then reach to the one focused point that best interpret the phenomenon investigate.

Table 4.2: Coding Process for Issue Subtracted from Respondents

Interview code	Open code	Axial Coding	Focus Coding
O01P, O02P	Supportive Policy for ICT adoption	Set ICT Policy	ICT Policy and Strategies
O08P, O09P,	ICT policy compliance with routines		
P03P, S01P	ICT vehicle inspection policy		
O06P, O05P, O07P	Develop ICT strategic plans	Need ICT strategic plan	
P01P, P02P, S02P, S03P	Design and Implement Strategies		

4.4.2 Interoperability

Interoperability of the systems is among the factors that increases the rate of ICT adoption by law enforcement, see Table 4.3. Systems interoperability is the term that describes the ability of two or more systems to exchange and use the exchanged information. ICT experts argue that, the environment within which vehicle inspection and monitoring operated is complex as it needed data from different sources. Furthermore, they state that, the system should not only be compatible with existing needs, but also need the capability to work in harmonious or agreeable with other genuine system. To emphasise the importance of interoperability, one respondent stated that:

"There are many insurance agencies that issued vehicles insurance, the technologies use in their back-office applications, interface and databases are quite different, there is a need of setting the technical standards that will influence the interoperability of these diverse systems".

Currently, Traffic Police can check the validity of Road Licence by typing and process the vehicle registration number via smart phone provided in corporation with Sumatra. The challenges existing are on the side of vehicle worthiness and vehicle insurance. One respondent stated that:

''to date no any *effort that has been done to make sure that traffic police can access the insurance details while on patrol".*

There is a need of interoperability standards whereby the information from insurance agencies can be converted in format needed by traffic police force on patrol. Accordingly, interoperability will enhance the compatibility of existing needs i.e. access and retrieve of data needed from particular source, hence increase adoption of ICT. The Table 4.3 summarised the data analysis process and substantial finding emerged.

Table 4.3: Coding process for Interoperability factor

Interview code	Open code	Axial Coding	Focus Coding
O01X	Setting the technical standards that allow exchange of data	Need set standards	**Interoperability**
S01X	Need to set the standards for back end applications		
S03X	Heterogeneous systems limit level of integration		
P01X	Lack of Interoperability of System to enhance access of data	Enhance access of data	
O04X	Traffic police can't access the insurance details while on patrol''		
P02X	Automatically accessing the data from the source where data is located		

After analysing data as shown above, two issues emerged, which including the lack of standard to the back-end applications and accessing of data in various source. These issues led to the focus code of interoperability.

4.4.3 Top Management Support in ICT adoption

The researcher wanted to identified the position of senior office or top management in ICT adoption, and realise that top management are engine power in strategize the initiative of ICT adoption. Senior officer's awareness of the potential benefits accrued by ICT in vehicle inspection will increase adoption. One respondent state that;

> *" there is a need of commitment to accepting the modern technology by the top officials, however this will only be succeeding through well informed by the advantages accrue by ICT"*

This validates most of the research findings; which indicate that top management had a vital role in ICT adoption decision making (Gono, Harindranath, Özcan, 2013). Gono, 2013 states that ''once the decision is made to acquire the needed ICT the top management team are fully supportive of the initiatives''. One of the factors that influencing ICT adoption is top management takes a strategic and effective role to deploy ICT in vehicle inspection and monitoring this install the motivation of adoption. As analysed in Table 4.4, it was demonstrated that senior office is one of the main factors in ICT adoption.

Table 4.4: Coding Process for Top Management Support

Interview code	Open code	Axial Coding	Focus Coding
O01M **O02M**	Management ensure the availability of the necessary resource i.e. human, material	Initiative from management	**Top Management support**
S02M, S03M	Top officials attitude toward ICT		
S01M, S02M	Support of the government		
S01M, S02M	Evolvement of top officials to ensure what has to be done.	Commitment from management	
P01M, P02M, P03M, PO4M	Top management commitment		

4.4.4 Security and Privacy

Most of the respondent expressed their concern regarding security and privacy. The issues raised include the concerning about protecting data and ICT infrastructures against vandalism. The researcher realised that the issues about the integrity of data, privacy and sufficient use of data in designated purpose, can increase cooperation between law enforcement and other stakeholder, hence maximise the chance for these organizations (safety parameter issuers) deals with vehicle inspection and monitoring to share data. The government need to implement the law to protect the public equipment's against vandalism. The policy regarding the security and privacy needs to be implemented as well. Currently the traffic police are using smart phone to check same parameter such as driving licence and road licence, the modality use is still inefficient, so there is need of CCTV camera alongside roads for automated plate number reading. Assurance security and privacy will not only motivate the cooperation with other stakeholders but will maximise the chance of adoption. One of the respondents argued that;

> *"Police will be able to access data, originated from variety sources, will they be trusted to keep the integrity and privacy while processing the individual data?''*

Table 4.5 indicate the data analysis process that guided the researcher, to identify security and privacy issues.

Table 4.5: Coding process for Security and Privacy

Interview code	**Open code**	**Axial Coding**	**Focus Coding**
O01S, O02S	*'need to know about the **security of data** and **overall system** while accessing, sending, retrieving*	Security of data and ICT devices	**Security and Privacy**
O03S**,** O04S	*Will they be trusted to keep the **integrity and privacy while** processed the individual data?*	Data integrity and privacy	
O01S S01S S02S	*'the other thing is the **protection of devices**, as I know CCTV cameras will be install with other ICT equipment's...",*	Protect ICT Devices against vandalisms	

4.4.5 Skilled Human Resources

The respondents indicate that one of the key factors that increase the ICT adoption is the availability of ICT Technical Knowledge. Table 4.6 indicate the way transcribed concepts was analysed to reach to the main factor regarding ICT skills.

However, during interview one participant suggested that:

> *'' Staff need to be trained and encouraged on how to use technology. ''The Ministry of internal affair especially when recruiting the staffs on vehicle inspection and monitoring department, should consider either skilled or semi-skilled personnel''.*

The availability of enough ICT skilled (human resources) definitely increases the chance of ICT adoption. It was revealed that lack of ICT technical skills may be

major obstacle for ICT adoption, this is because top management can't invest much on ICT while their insufficient number of ICT skilled labour and expertise. Increase ICT building capacity workshop and employing ICT skilled staff will maximise ICT human resources hence increase adoption. The interview conducted at Police Traffic HQ it seems there are less than 5 ICT experts, however there are much effort that has been previously done in training the Police Officers in basic ICT knowledge. As suggested in interview, the ICT skills qualifications should be one of the factors used when employing the candidates in Traffic Police Force.

Table 4.6: Coding process for Availability of Skilled Human Resources

Interview code	Open code	Axial Coding	Focus Coding
O01T, O03T, S03T,	IT expertise that can fulfil technology needs	Skilled IT personnel	**Skilled Human Resources**
O08T, O04T	Staff knowledge in ICT still low	ICT knowledge	
O01T, P03T, O05T, S01T, O06T	Staffs training in ICT	Training	

4.4.6 Investments on ICT and Financial Support

The budgetary constraints affect the adoption of ICT by law enforcement. During interview, we realised that either there is no specific budget for traffic police force on ICT investment or the money approved by parliament doesn't not discharge to the police force. One of the interviewees state that:

> ‘*’the alarming increasing of injuries and death should send the message to the government to invest much on technology that will enhance traffic police force to execute their duties*’’.

Finance is critical element which supports acquiring of tangible and intangible ICT assets. Tangible ICT assets include ICT equipment's such as CCTV cameras, servers, network, computers, et cetera while intangible ICT assets includes ICT knowledge which brought shortage of skills due to the lack of training, seminars and ability to recruits expertise. As data analysed in Table 4.7, investment on ICT department and financial support will enhance Traffic Police Force in ICT department to do research, training, conducting seminars and ability to purchase ICT equipment's and software's hence increase ICT adoption.

Table 4.7: Coding Process for Investments on ICT and Financial Support

Interview code	**Open code**	**Axial Coding**	**Focus Coding**
O01F, P01F	Lack of Investments on ICT	Investing on ICT	**Investments on ICT and financial Support**
P02F, P03F	Initiatives to remove tax on ICT equipment's		
P03F, S02F	Funds to support ICT research and projects	Support ICT research and projects	

4.4.7 Infrastructures

The study indicates that, infrastructure is one of the key factors influencing the ICT adoption. The limited physical network infrastructure, constraints the adoption of ICT in vehicle inspection and monitoring. During interview, the researcher realised that much of the ICT equipment's used in inspection and monitoring are standalone equipment's. However, in recently, September 2015 traffic police introduce the ICT system whereby when the drivers break the road safety regulations, their vehicles registration number and drivers licence numbers are captured and kept as the record for future reference. Then the driver is issued with ticket to pay the penalty, if the

penalty is not paid within a given time, the records are kept whereby when scanned again the police will be able to recognize the non-penalty paid vehicle and make arrest. This is good effort however due to the less provision of telecommunication infrastructure, still most of the safety parameter such as insurance and vehicles worthiness are conducted manually. While, speed and road licence conducted both visually and by the use of special USSD code and speed radar. The use of standalone equipment's is not efficient as it is much controlled by human feelings, there is a need of automated system that will be able to capture and process all vehicles on roads. Table 4.8 highlight the data analysis process that produced the infrastructure as one factor that leads to adoption of auto inspection and monitoring process.

Table 4.8: Coding Process for Infrastructure

Interview code	Open code	Axial Coding	Focus Coding
O01I O02I	Need to invest much on infrastructure	Utilization of wireless network infrastructure	**Infrastructure**
03I 01I	*' investment on Infrastructure"*		
O03I O04	Wireless network infrastructure well developed in Tanzania can support		
O04I O05I S01I	Mobile can support as infrastructure		
P02I P03I P04I	Use TTCL National ICT Broadband backbone	Take advantage usage of National ICT backbone	
P01I P02I P03I	**Use, existing infrastructure** *e.g.* **mobile network***, TRC/TRL' '*		

The study indicates that the advent of mobile infrastructure eradicates the statement of inefficient network infrastructure, one of the ICT expert claimed that:

> ‘’*the national backbone of fibre optic has been widely installed in Dar es salaam city, so we only need to use minor usage of wireless network only to capture the vehicle and send information to the fibre network in order link with police servers and send back the details to the police on roads’’.*

Inadequacy of the utilization of wireless network infrastructure and gadget to access the network constitute to the less adoption of ICT by law enforcement of ICT adoption.

4.4.8 ICT equipment’s (Hardware and Software)

We observe that the inspection process need an intelligent equipment’s that are able to identify vehicles in real environment and provides information in real time for decision making. The study shows there is a need of mechanism to capture the vehicle identification number and access the information. Most of the equipment available are controlled by human feelings and are standalone systems, one of the interviewees state that:

> “*One of the key factors is the availability of automated system that will be able to automatically capture and process the vehicles information without being activated by human action’’.*

It was claimed that various recognition techniques have been developed and used in traffic enforcements. The system of vehicle inspection and monitoring comprises; camera to capture the vehicle and forward the data to computer, and the software which recognise the vehicle registration number and keep it in storage equipment. Table 4.9 highlight the data analysis process that present equipment as one of the factors needed for adoption of auto inspection and monitoring.

Table 4.9: Coding Process for ICT Equipment

Interview code	Open code	Axial Coding	Focus Coding
O01Q	Install a **central database or link up various information systems**	Central integrated Database System Automated Digital devices	**ICT Equipment**
O02Q	Integrated systems		
O03QO04Q	Intelligent equipment to recognizes vehicles		
O06Q O05Q O04Q	***devices that detects*** *all vehicles breaking road safety regulations''*		
O04Q, O07Q	*the automatic plate number* ***recognition system*** *need to be adopted to read the vehicle number in a real environment and transform in a mechanism where police can be use*		
O08Q	supportive equipment will increase the rate of adoption		

4.4.9 Staff Awareness

The study indicates that a limit number of law enforcement officers are aware of the potential benefits accrued by ICT. One of the respondents suggests that:

"Arrange the exposure visit in order to raise awareness".

Awareness create positive attitude on the staff's inclination to adopt ICT. See Table 4.10 for data analysis that derived awareness of ICT as one of the factors for adoption of auto inspection and monitoring technology.

Table 4. 10: Coding process for Awareness

Interview code	Open code	Axial Coding	Focus Coding
S01A, SO2A,	Staff awareness on ICT	Staff awareness Positive attitudes Study tour, raise awareness	**Awareness of ICT**
S01A, SO2A,	How to use ICT		
P01A P02A	Exposure visiting to raise awareness		
O01A, O014A	*'Most of CEO's not* aware *with the potential benefits accrued by ICT*	Management Awareness of the technology	

4.4.10 Training

Training is one of the aspect that influences the adoption of ICT. According to our observation see data analysis process on Table 4.11, It was suggested that training helps to initiate the environments for the easily adoption of ICT. One respondent stated that:

> "*Training provide the knowledge hence build the confidence of usage awareness and hence assist to bring positive attitude towards ICT".*

Table 4.11: Coding Process for Training

Interview code	Open code	Axial Coding	Focus Coding
O01T	Lack of IT human resources	IT human Resources	**Training**
O03T	**Staff knowledge in ICT** *is still low''*	Staff Knowledge in ICT	
O08T	*Staff need to be* **trained** *and encouraged on how to use technology*	Staff training	
O04T O06T	*'Police officers need to* ***be trained*** *on how to use vehicle* ***tracking***	Police officers trained	
S01T	*'Presence of IT skilled and ICT expertise in a traffic police force'*	Presence of ICT expertise	
P03T, P03T	''Conducting seminars and training on traffic unit about the use of ICT in vehicle inspection and monitoring	Conducting seminars and training	
S01T, O06T, S03T, S02T	'Provide training on Police Traffic officers on ICT		

4.4.11 Other Related Findings

Power supply is one of the key factors that have impact on the adoption of ICT. The study reveals that lack of constant supply of electricity hinders the adoption of sophisticate ICT system. However, there is good indication that the issues of power

will no more be obstacles due to the discovery of gas in the region of Mtwara and Lindi. One respondent stated that:

> "*In order to accrue the benefit of ICT you need a standby generator due to the problem of power cut".* Table 4.12 analysed the issue of power supply.

Table 4.12: Coding Process for Power Supply

Interview code	Open code	Axial Coding	Focus Coding
P02E	*if no sustainable power you can't use ICT equipment's*	**Supply of power**	**Power Supply**
P01E P03E P04E O01E	*like other developing country we are lacking the sustainable* ***supply of power''***	**Reliable supply of Electricity**	
O02E O03E O04E O05E O06E	***Electricity is compulsory*** *to run our business*		
S01E S02E	*'Sometimes we use our own* ***generator to supply power***	**Generator to supply power,**	

When asked the extent to which ICT is used to perform vehicle inspection, and probe with question what reasons for this condition. The study discloses low usage of ICT in vehicle inspection. It was revealed that speed tracking tools are very few and mainly used to track the speed violation for the vehicle travel from one city to another, one respondent say that it is hard to find a traffic police with speed radar guns inside Dar es salaam city. Moreover, the tool doesn't inspect all parameters that need to be investigated, it scans only the speed parameter. The study shows that traffic police are using only the basic communication facilities like radio call, website, internet however the ability to integrate with institutes such as insurance, TRA and ministries is still inadequate. This research finding also confirmed Nyamawe and Mbosso (2014) claim that "one of the factors results into uneven prioritization of vehicle inspection and monitoring is lack of human resources and

speed tracking tools". Moreover, on the modality used to inspect the vehicles, the results suggest that police on ground inspects and monitors by looking at the discs displayed on vehicles and information on documents such as vehicles' card and driving licences.

In this digital age, the authentication and validity of this modality of inspection seems to be uncertainty. With fast paced technological growth, criminals can use very simple ICT equipment at home, to produce these discs. Furthermore, inspection of these parameters on road with formal system require a lot of human resources and time to manage (The Auditor General of Tanzania, 2012).

4.6 Summary

The analysis above, guide this research to three key levels of ICT adoption in an organization: Strategic adoption level, Management and Organization adoption level and Implementation adoption level. Table 4.13 illustrates these levels of adoption and the respective specific factors for adoption, which were obtained from the individual factors presented in previous sub-sections.

Table 4.13: Adoption Level

Level of Adoption	**Factors for Adoption**
Strategic	ICT Policies and Strategies
Management and organization	Top Management Support
	Staff awareness
	Training
Implementation	Infrastructure
	ICT equipment
	Interoperability

CHAPTER FIVE

FRAMEWORK FOR ICT ADOPTION

5.1 Introduction

This chapter introduces the proposed framework for ICT adoption in law enforcement entities. The framework stems from the factors influencing ICT adoption outlined in Chapter 4.

5.2 Framework for ICT Adoption

Based on the findings, the framework was designed as a guideline to adopt the ICT in vehicles inspection and monitoring by law enforcement. The schematic below (Figure 5.1) depicts a typical framework for ICT adoption by law enforcement.

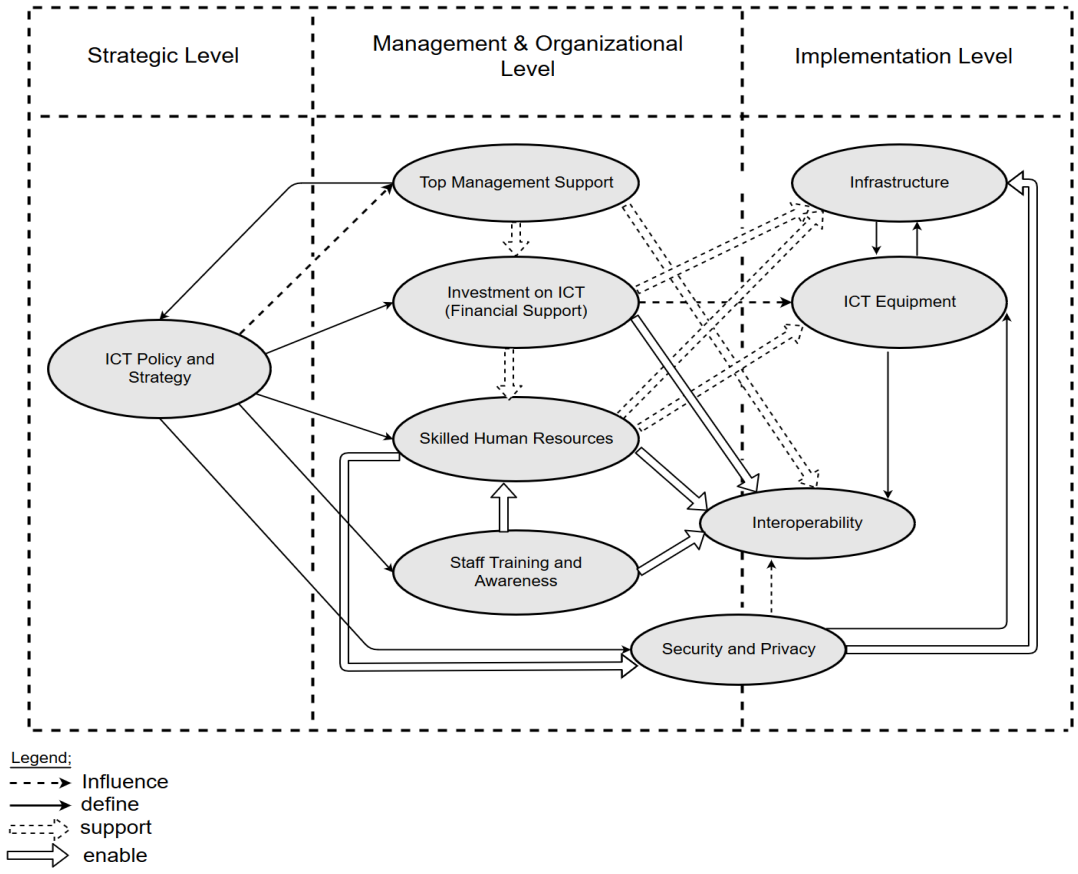


Figure 5.1: Framework for the Factors Influencing the Adoption of ICT by Law Enforcement

The framework comprises factors that are grouped into three blocks; strategic level, management and organizational level, and implementation level described below.

5.2.1 Strategic Level

As shown in Figure 5.1 the strategic level is comprises ICT Policy and Strategy factor. The level includes the formulation of the policy and the strategies to accomplish the policy. This factor intertwines with management and organizational level factors as it is influencing and defining the actions and timeframe to execute the objectives that guide the ICT adoption.

The policy and strategy constitutes the plans and actions to influence top management towards making decisions on adoption of ICT. The researcher learned that when decision is enforced by top management the chance of adoption is higher and satisfactory. With defined policy and strategy in place, top management becomes obliged to fulfill the action plans and objectives specified therein.

Figure 5.1 indicate as well the relation between ICT policy and strategy with the ICT investment and financial support, the researcher explore that the ICT policy and strategy define the allocation of financial resources to implement the strategic objectives and programs. Furthermore, the policy and strategy define training needs, and types of training hence strengthening ICT human resources. Moreover, ICT policy defines the aspects covering security and privacy issues, which are very important as police work with sensitive data. To ensure appropriate measures for security and privacy of data and business processes (among police and other

government institutions), the policy and strategy must clearly include these aspects for successful adoption of ICT by the law enforcement agencies.

5.2.2 Management and Organization Level

The factors that influencing the adoption at management and organizational level, include top management support, investments on ICT, Skilled human resources and staff training and awareness, security and privacy. Gambatese and Hallowell, (2011) found that effective Top Management support influence the ICT adoption by allocating sufficient resources such as financial support. As depicted in Figure 5.1 the top management are entitle to set or define the ICT policy and strategy.

Furthermore, Top Management support interoperability by initiating collaboration and coordination with other organizations in some aspects that needs interoperability hence influencing adoption. For instance, organizational interoperability, which involves interoperability of organizational processes in sharing and processing data and information among law enforcement agencies and other government institutions such as TRA and SUMATRA.

Investments on ICT is one of the factors that drive the adoption as it supports development of standards and architecture that enable interoperability of ICT systems, hence facilitating information sharing. Additionally, sufficient financial support is a key factor to facilitate availability of infrastructure to support implementation of ICT in the law enforcement agencies; thereof, sustaining adoption of ICT country-wide. Lastly, as indicated in Figure 5.1, financial support is also a key factor to ensure that skilled human resources are available in law enforcement

entities for development, implementation and maintenance of ICT systems and applications.

Skilled human resources use their expertise to enable information security and privacy to prevent the security breach and unlawfully accessing personal information by un-authorized personal. The Figure 5.1 indicate that skilled human resource enable interoperability, this is due to the fact that vehicle inspection and monitoring involves accessing data sources from diversity organizations, so the knowledge of the interoperability across platforms is crucial.

Moreover, skilled human resources needed to support in development of ICT infrastructure of vehicle inspection and monitoring, and as well analyzed, specify the fully cost and implementation of ICT equipment's for vehicle inspection and monitoring.

5.2.3 Implementation Level

Implementation level comprises most of the technical aspects that are essential for ICT adoption. These include infrastructure, ICT Equipment, Interoperability and Security and Privacy. However, as indicated in Figure 5.1, interoperability and security and privacy spans across this level and management and organizational level.

5.2.3.1 Infrastructure Network

Infrastructure components provide the secure external gateway that enhances the communication between traffic police or digital device (CCTV camera), resources

back at the office (i.e. police database, traffic personnel in control room) and other agencies that are involved in vehicle inspection and monitoring. To facilitate this, the existing national broadband (hard-wired) and wireless infrastructures can be used instead of install a leased lines or dedicated communication facilities, which are very expensive. For proper installation of infrastructure network, sufficient financial resources must be available (as indicated in Figure 5.1). Furthermore, there is a need of sufficient skilled human resources for installation and implementation of the infrastructure.

5.2.3.2 ICT Equipment

These are operational equipment that includes information/image captures devices (CCTV's Camera) and data storage devices (Server, Database). The license plate recognition is the tool that scans the plate number information by using the sensor technology. The scanned information is compared against an existing database of vehicles that are interest to law enforcement, for example those vehicles without insurance, road license, stolen vehicles, violation of road safety rules, vehicle worthiness and other parameter important for road safety. The database system should be including Back up or Disaster Recovery System as it stores the sensitive data.

5.2.3.3 Interoperability

The process of inspection and monitoring involves data from different source, so the system interoperability is crucial as it provides the principles of use and exchange data from diversity system. As shown in figure 5.1 it comprises the features that overlap in both implementation and management and organizational levels. Four

levels that influence interoperable of systems from different organization are described in this section. These includes;

(i) Legal interoperability which explain the range of laws, policies, procedures and cooperate agreements that ease the exchange of information between different organizations (eHGI, 2012).

(ii) Organizational interoperability which defines the range of inter and intra organizational process alignment. There must be a standard and scope of information exchange within and outside the law enforcement system boundary. For example, police database retrieved information from insurance entity about the all insured vehicles, or any other issue that requires law enforcement intervene from different sources (Novakouski and Lewis, 2012; eHGI, 2012)

(iii) Semantic interoperability defines the ability to provide precise meaning of exchange information hence produce appropriate results as requested by end user in our case a traffic police force (Novakouski and Lewis, 2012; eHGI, 2012).

(iv) Technical interoperability the ability of two or more systems (communication application technology) to accept data from each other in order to perform the task in hand (Novakouski, 2012, eHGI, 2012).

5.2.3.4 Security and Privacy

The security and privacy issues are also overlap between two levels as indicated in Figure 5.1. Security and Privacy involves both information and ICT facilities, it

includes the measure to safeguard information transmission, mechanism to make sure that information can only be retrieved by appropriate personnel, the procedures of handling the retrieved information, the consequences for misuse the retrieved information, for how long to handle the retrieved information.

5.3 Working Model - Automated Framework

The specific objective number four is to design the working model for vehicle inspection per developed framework. From the Figure 5.1 the implementation level comprises the features that can be automated to a working model. The features include mechanism that enhance traffic police force to enforce road safety rules, and expand capability of investigating and tracking the vehicles involved in crimes.

As shown in Figure 5.2, the process is initiated by the sensing and capturing the vehicle image, whereby vehicle plate number is extracted and converted to the alphanumeric character using a sophisticate software (Optical Character Recognition), then send to Back Office Resources (BOR) to be compared with information from police database and various agencies i.e. TRA, Insurance, etc., the comparing process includes the executing of policies such as speed of vehicle on specific road, insurance validity, worthiness to be on road, road tax validity, etc., for any executed policy that does not meet the required standards the alert message is diverted to the nearest police for action or to the owner (depending on fault).

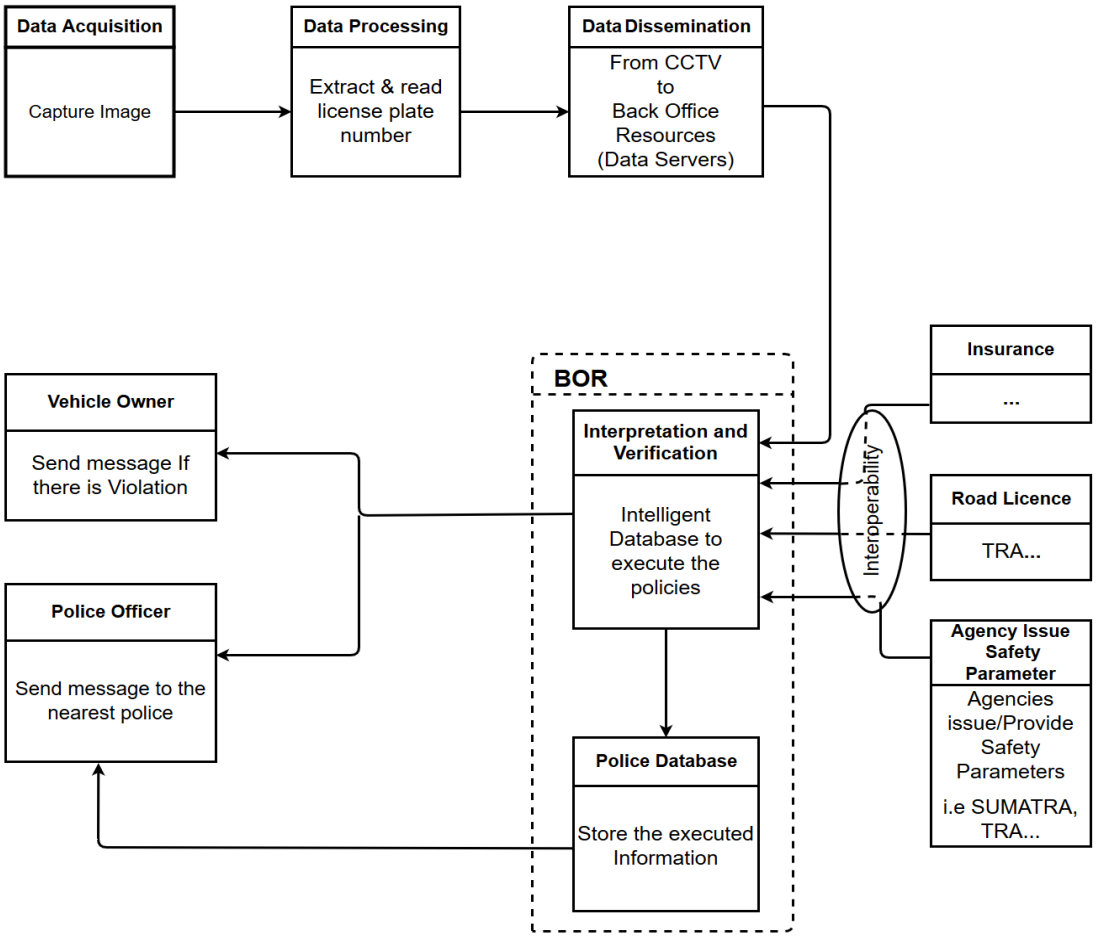


Figure 5.2: Working Model for Vehicle Inspection and Monitoring Automation

5.3.1 Data Acquisition

Data acquisition is initiated by sensor and surveillance camera. The camera captured the plate number in format of video and use character recognition algorithm to read and recognize the plate number.

5.3.2 Data Processing

The system uses the character recognition algorithm to locate the image at front or back view of the vehicle and use this algorithm to extract the number plate from an image. Once the image is extracted the segmentation techniques is applied to identify the individual character from the plate number, and then Optical Character Recognition, relate each character with data in police database.

5.3.3 Data Dissemination

The data shall be dissemination in real time, the dedicated medium is needed and the mechanism to protect the privacy of individuals and public in accordance with the data protection policy.

5.3.4 Back Office Resources

At the back office, there is an intelligent database that executes the vehicle inspection and monitoring policies. According to algorithm if the policy is equal to false, it means there is a violation of road safety rules, this may be either the vehicle is not insured, or vehicle does not have road tax, or is over-speeding, or stolen or defective motor vehicles, for each policy violated the interpretation and verification database is executing the violated policy and send the message.

5.3.5 Police Officer

The nearest police traffic will be informed about the violation that has been occurring. The message including; policy (ies) violated, vehicle registration number, type and model of vehicle, vehicle's colour, vehicle owner, the current location of the vehicle, the action need to be taken, there will be the feature that, the police will need to "check in" the action taken i.e. arrested, fined and etc., and the identification detailed of traffic police.

5.3.6 Vehicle Owner

The intelligent database sends message to the owner of the vehicle, to inform the owner about the violation. The message includes the type of policy violated, the place and time where the vehicle captured, the action to be taken by the owner and other necessary information.

5.3.7 Algorithm for Vehicle Inspection and Monitoring

The algorithm that captures and processes the vehicle plate number involves several steps that are created by sophisticated lines of software codes. The steps of the algorithms to identify a license plate number, includes locating and extracting the number from the captured vehicle license number image. The orientation and adjust the plate size (adjust the angular skew) to the optimum size. The next process is commonly known as normalization whereby the extracted plate number is regulated in brightness and contrast to bring a standard form. Then, a segmentation of the extracted individual character that is ready to be processed by the optical character recognition follows. The stage of optical character recognition includes the translating of recognized character into readable format to be conveying to the police office storage facilities for comparison, verification and interpretation. At the traffic police storage facility, the variety policies are executed for any road safety violation the message are diverted to the nearest police receiver, in some cases the vehicle's owner will be informed as well.

5.3.8 Pseudo code for Inspection and Monitoring

Pseudo code used by acquisition device at field/traffic station to realize algorithm (Figure 5.3a) is shown as follows:

1. Initialize
2. Capture vehicle image
3. If captured
4. Extract number plate location
5. Set the plate number at optimal size

6. Segment and Recognize characters
7. Display recognized digital plate number
8. End if
9. If number extracted is readable
10. Establish Connection
11. Enter sending state and send the number to the Police storage facility
12. End if
13. Return

Pseudo code used by Police storage facility to realize algorithm (Figure 5.3b) is shown as follows:

1. Initialize
2. Establish connection with field/traffic station
3. If connection established
4. Enter receiving state and Receive plate number from field/traffic station
5. Perform comparison, Interpretation and verification
6. End if
7. If policy is false
8. Establish connection to the car owner and nearest police receiver
9. Enter sending state
10. Record to the database and send information to the car owner and nearest police
11. End if
12. Return

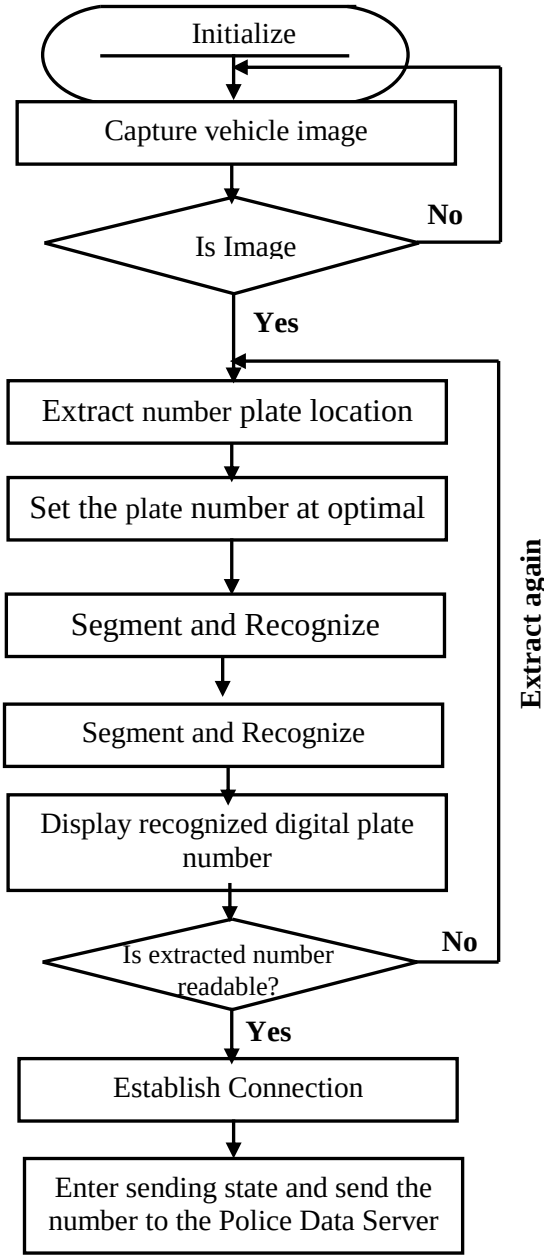


Figure 5.3(a): Algorithm Indicating Device at Field/Traffic Station that Capture and Process Vehicles Information

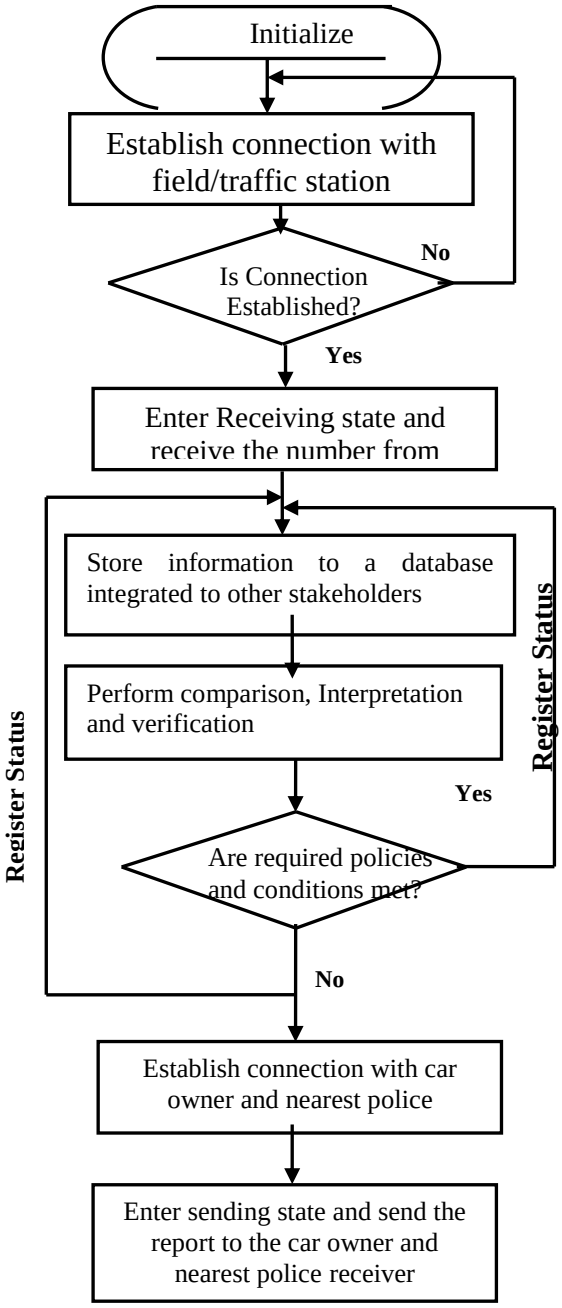


Figure 5.3(b) Algorithm at the Back-Office Resources/Facility that Verify and Interpret the Validity of Captured Information

5.4 Exemplification of System Implementation

In this section, we present the automated vehicle inspection and monitoring model. This is in response to the fourth objective of the research, which was to **design a**

working model for vehicle inspection and monitoring (see section 5.2). Based on the factors identified in the framework, particularly at the implementation level in section 5.3, the model includes algorithms for the automated processes that take place from the automatic scan/capture of a vehicle to the traffic police being informed about the violation (see Figures 5.3a and 5.3b).

The simulator consists of three buttons labelled choose a car, choose a selection and choose an incident. Choose a car button represent a vehicle captured by a camera. Its modern camera can capture up to 1,800 vehicle plate numbers per minute in a speed of 120-160 miles per hour (Roberts & Cassanova, 2012). In the simulator, the incident is initiated by clicking a camera button representing, after which the system logs the incident. Figure 5.4 illustrates how the system scans/captures and processes a vehicle information for further action.

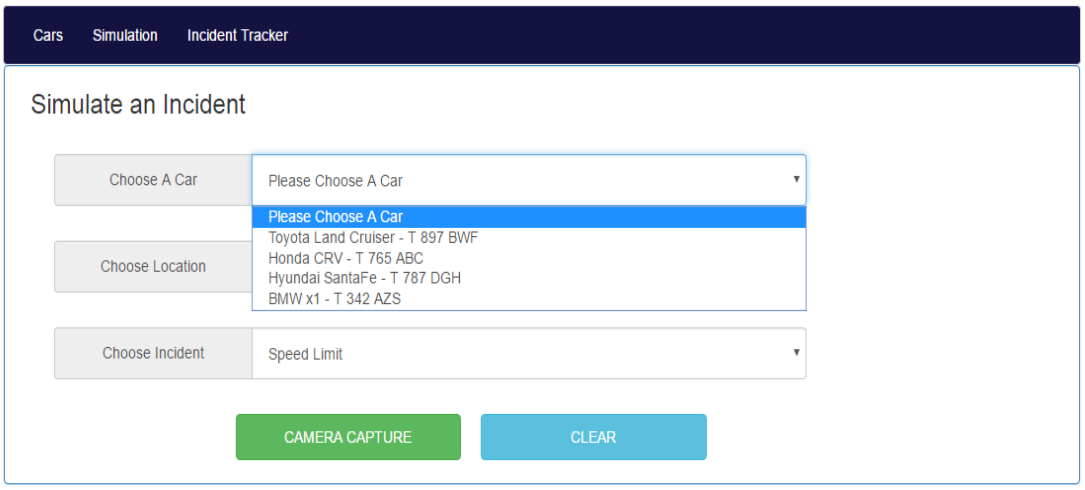


Figure 5.4: A Drop Menu of a Selected Vehicle its Location and Speed

In real scenario Figure 5.4 is showing that a series of vehicles passing in front of camera are automatically scanned and processed for action (1,800 scanned vehicles per minute).

The choose location button shown by Figure 5.5 identifies the location where the vehicle was scanned. The location of incident is enables traffic police to intervene in case of any road safety violation.

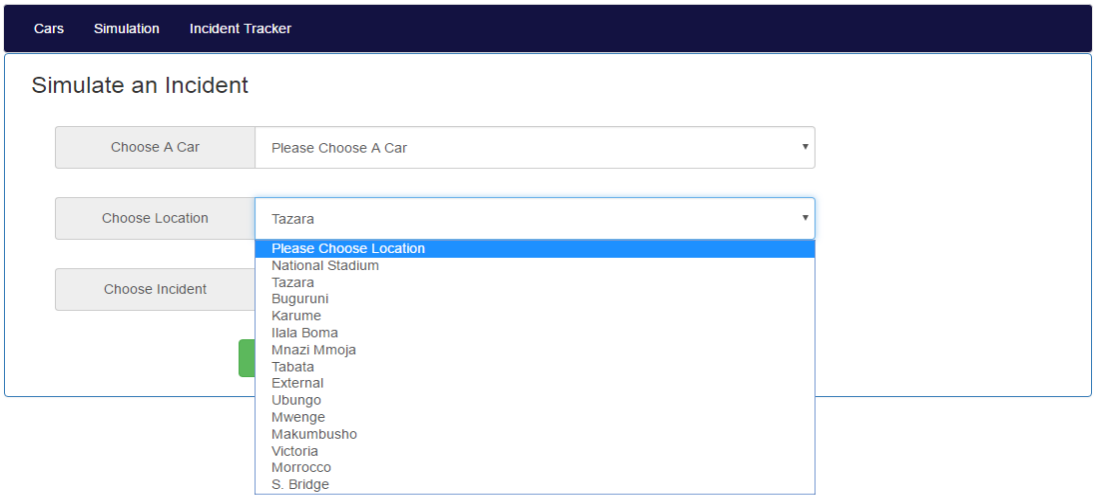


Figure 5.5: Location where the Vehicle is Captured

Generally, the incident (road safety violation), vehicle information, location, camera ID is next disseminated to Back Office Facilities (BOF) for verification and identification. Figure 5.7 shows that for any violation, the intelligent database search the nearest police by calculating and relating the coordinates where the police are located. Then, the incident is tagged to police located to the area where the interesting vehicle is heading.

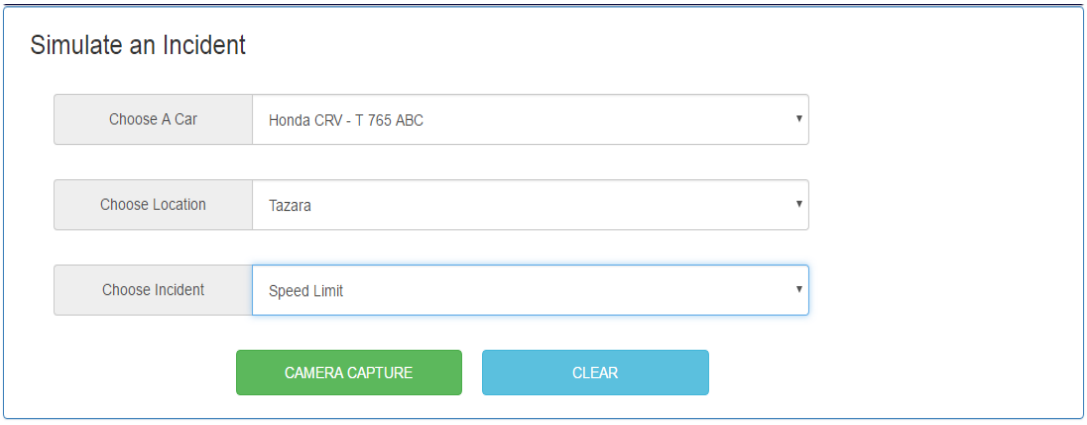
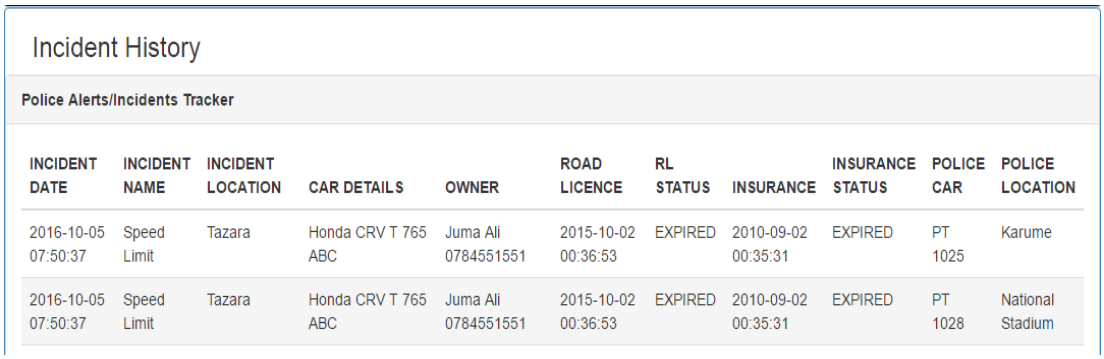


Figure 5.6: Vehicle Information (Registration Number) Automatically Scanned

For instance, the incident dated 2016-10-05 in Figure 5.6, involved Honda CRV with registration number T 765 ABC, which was found to be lacking both insurance and road license. The location of the incident was Tazara. The system next determined the location and sent the message to a traffic police with number PT 1025 who was at Karume and PT 1028 at National Stadium.



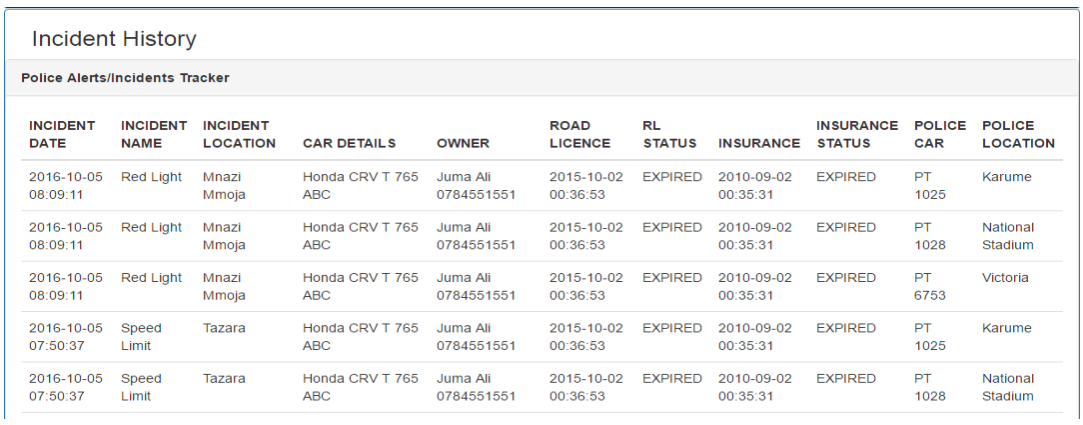
Incident History

Police Alerts/Incidents Tracker

INCIDENT DATE	INCIDENT NAME	INCIDENT LOCATION	CAR DETAILS	OWNER	ROAD LICENCE	RL STATUS	INSURANCE	INSURANCE STATUS	POLICE CAR	POLICE LOCATION
2016-10-05 07:50:37	Speed Limit	Tazara	Honda CRV T 765 ABC	Juma Ali 0784551551	2015-10-02 00:36:53	EXPIRED	2010-09-02 00:35:31	EXPIRED	PT 1025	Karume
2016-10-05 07:50:37	Speed Limit	Tazara	Honda CRV T 765 ABC	Juma Ali 0784551551	2015-10-02 00:36:53	EXPIRED	2010-09-02 00:35:31	EXPIRED	PT 1028	National Stadium

Figure 5.7: The Window Showing the Relay of the Message to the Nearest Traffic Police

The vehicles incidents are reported from various areas. Accordingly, the designed system needs to be able to integrate the reported incidents for comprehensive overview and decision making. Figure 5.8 represents a police alert tracker reporting various incidents from Dar es Salaam region. The Comprehensive view of figure 5.8 is enhanced through interoperable of diversity system as it needs to fetch the data from diverse sources such as Insurance, TRA and police database.



Incident History

Police Alerts/Incidents Tracker

INCIDENT DATE	INCIDENT NAME	INCIDENT LOCATION	CAR DETAILS	OWNER	ROAD LICENCE	RL STATUS	INSURANCE	INSURANCE STATUS	POLICE CAR	POLICE LOCATION
2016-10-05 08:09:11	Red Light	Mnazi Mmoja	Honda CRV T 765 ABC	Juma Ali 0784551551	2015-10-02 00:36:53	EXPIRED	2010-09-02 00:35:31	EXPIRED	PT 1025	Karume
2016-10-05 08:09:11	Red Light	Mnazi Mmoja	Honda CRV T 765 ABC	Juma Ali 0784551551	2015-10-02 00:36:53	EXPIRED	2010-09-02 00:35:31	EXPIRED	PT 1028	National Stadium
2016-10-05 08:09:11	Red Light	Mnazi Mmoja	Honda CRV T 765 ABC	Juma Ali 0784551551	2015-10-02 00:36:53	EXPIRED	2010-09-02 00:35:31	EXPIRED	PT 6753	Victoria
2016-10-05 07:50:37	Speed Limit	Tazara	Honda CRV T 765 ABC	Juma Ali 0784551551	2015-10-02 00:36:53	EXPIRED	2010-09-02 00:35:31	EXPIRED	PT 1025	Karume
2016-10-05 07:50:37	Speed Limit	Tazara	Honda CRV T 765 ABC	Juma Ali 0784551551	2015-10-02 00:36:53	EXPIRED	2010-09-02 00:35:31	EXPIRED	PT 1028	National Stadium

Figure 5.8: Vehicle Processed by Intelligent Database from Various Location

5.5 Summary

The framework consists of factors presented in three blocks: strategic, management/organization and implementation level. These blocks consist of the elements that fit in technological and non-technological factors that are important in adoption of auto inspection and monitoring. By using the implementation block, the working model was developed, then from working model the algorithm was designed and finally the auto inspection and monitoring simulation was implemented.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The aim of the study was to contribute in bridging the gap between the technological (ICT) developments and the poor vehicle inspection and monitoring processes performed by the Tanzanian traffic police force. For this contribution, the study primarily identified factors influencing adoption of ICT by law enforcement entities, particularly the Traffic Police Department, and to provide a framework for enhancing the adoption of ICT. The study also developed a model for automation of vehicle inspection and monitoring processes to illustrate the key ICT applications emerging from the framework. This chapter revisits the research questions presented in Chapter 1 with the solutions provided to each question along the course of this study. The chapter then provides final recommendations based on the work done in this research work. Finally, the chapter concludes with suggestions for further studies based on research objectives.

6.2 Revisiting Research Objectives and Questions

For the purpose of achieving the aim of the study, four specific objectives were developed:

(i) The first objective set to identify the aspects necessary for ICT adoption in law enforcement through vehicle inspection and monitoring. According to this objective, the following question was formulated; what are the aspects necessary for the adoption of ICT in vehicle inspection and monitoring? The responses for this question are; there are technological and non-technological

aspects that are necessary for ICT adoption. These includes availability of ICT policy and strategies, presence of skilled Human resources, interoperability, Management Support, Investment on ICT, Infrastructures, ICT sophisticated equipment, Security and privacy, staff awareness and training. The researcher acknowledges the mentioned aspects as they are essential to contribute solution for the problem highlighted.

(ii) The second object set to examine the factors that influence adoption of ICT by law enforcement entities in Tanzania. According to this objective the following question formulated; what are the factors that might influence the adoption of ICT by law enforcement entities in Tanzania?

The factors that influence the adoption of ICT by law enforcement, can be categorized into the three levels, these includes; Strategic level, Management and Organizational level and implementation level.

Strategic level

The level involves formulating, specifying and designing the strategic plans to adopt ICT according to the organization goal. The specific factor on this level is defined as;

(i) ICT Policy and Strategy which identify and outline the course of action that need to be considered while deployed ICT innovation in specific organization.

Management and Organizational level

The specific factor on this level includes;

(i) Top management (senior officers) are engine power in strategize the initiative of ICT adoption.

(ii) Investment on ICT department and financial support will enhance law enforcement entities to conduct training and to purchase ICT facilities hence increase ICT adoption.

(iii) Staff awareness of the potential benefits accrued by ICT. The interviewee suggest that the awareness can be achieved through exposure visit and seminars, this will create positive attitude on the staff's inclination to adopt ICT

(iv) Skilled Human Resources – The study shows that staffs with higher level of education are adaptable to technologies than those with lower level of educations. Moreover, top management can easily invest much on ICT where there are skilled personnel.

(v) Interoperability – police work involves the process of accessing information from diversity sources, as explained in section 5.2.3.3, system interoperability is crucial as it provides the principles of use and exchange data from diversity system

Implementation level

The comprises the four factors, two of them which is security and privacy already described on section 5.2.3.4, while interoperability is another factor that described on section 5.2.3.3, other factors include;

(a) Infrastructure - the network infrastructure that facilitating the transmission of data is vital. The installation of national fibre optic provide advantages having the reliable data transmission network hence increase adoption.

(b) ICT Equipment – the digital facilities initiate the sensing and capturing of real world object (vehicle) and convert it into conceptual resource or virtual and transmit as a signal to BOR, to be verify and interpret, then send feedback to the traffic police on field for action, these includes; CCTV cameras, databases, information receiver (devices/interface used to receive the feedback from BOR), and all other digital devices

(i) The third objective focused to develop a framework that will guide the adoption of ICT by law enforcement entities in Tanzania. The question was, are there similar frameworks that have been developed in similar context? The answer was; there very limit evidence regarding the framework for the vehicle inspection in context of Tanzania, the research develops the framework that combine both technological and non-technological aspects then by using the features and aspects mentioned, the system based on technological aspects based on framework developed. The research trusts the framework as it will overcome the challenges faced by police traffic force.

(ii) The last objective focus to design the working model for vehicle inspection per developed framework. The question formulated was

(iii) How can the framework (in research question iii) be implemented to achieve the inspection and monitoring processes? The answer was; the framework comprises the features that intertwine the technologies and organization or business processes to achieve the vehicle inspection and monitoring purpose was implemented as described in Figure 5.1. To implement the working model, the research extracted the implementation level in framework developed as it presenting the technological aspects through which the working model can be

developed. The pseudocode that shows the activities performed during inspection and monitoring was developed. From the pseudocode then the algorithm to define the set of procedures/instructions that express the execution of operation during inspection and monitoring was designed see Figure 5.3a indicating the procedures involves capturing, extracting, segmentation and dissemination the processed data, while Figure 5.3b show the back office facilities that interpret and verify if the vehicle meet the safety policies, if not then the message is diverted to nearest police, in some case the owner may be communicated as well.

6.3 Recommendations

This study finds the factors influencing the adoption of ICT in traffic police force, develop framework and propose the pseudo code and algorithm of the working model that will assist to curb down vehicles accidents and crimes. From the findings number of recommendations were delivered, these includes:

(i) Formulate ICT policy and strategy that cover the all technical and non-technical aspects for the ICT adoption by law enforcement. The policy should involve the level of collaboration and coordination with agencies issues safety parameters.

(ii) Top management need to understand the management of technological changes which focuses on both organizational context and technological context. Change management encompass organizational behaviour, user behaviour and system processes, in most cases top management are much concentrating on technical aspects rather than organizational aspects hence decrease adoption.

(iii) Strengthen ICT capacity by creating ICT expertise, awareness among law enforcement police regarding potential application of ICT in vehicle and inspection.

(iv) The mechanism to test roadworthiness aspects and exhaust emission of vehicles need to be implemented. There should be garages that authorised by vehicle inspectorate to perform safety test and road worthiness of vehicles. The test should cover all features that are crucial for the vehicle to be safe driven on the road. Once the test is performed the results is recorded on digital system.

(v) To increase connectivity, there is a need of explore the mechanism whereby mobile network can support real time data collection and transfer to police database via national fibre-optical.

6.4 Future Research

The future research need to focus on the way adoption of ICT standards should ensure the interoperability of systems among other law enforcement entities, and other law enforcement in East African Community and other worldwide law enforcement system

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APPENDICES

Appendix 1: Interview Guide

THE OPEN UNIVERSITY OF TANZANIA

FACULTY OF SCIENCE, TECHNOLOGY AND ENVIRONMENTAL STUDIES

ICT DEPARTMENT

Research Title: Framework for Adoption of ICT by Traffic Police Force in Vehicle Inspection and Monitoring Automation: A Case Study of Tanzania

Student: Elia Elisante Lukwaro

Supervisors:Dr. Jim James Yonazi

Introduction

The adoption of ICT in vehicle inspection by law enforcement is still the knowledge gap that this study needs to fill. In this regards, the process of introducing ICT in law enforcement needs to be well guided and informed. Otherwise, limited results may be achieved and loss of time and other resources incurred.

Through your experience, expertise and knowledge we expect that, this interview guide facilitate the identification of aspects, factors and hence assist to develop a

framework that will guide the adoption of ICT by law enforcement entities. We assure you that all information obtained in this study is only for educational purpose and will remain confidential

Question 1:

Can you please tell me about yourself, including your career rank, and your daily responsibilities?

Probe: For how long have you been in this position?

Probe: Do you have any previous working experience in ICT field?

Question 2:

Please tell me in measure of poor, average, good, and very good, how the management of your organization has been helpful in the adoption of ICT for vehicle inspection.

Probe:what are the causes leads to this?

Question 3:

In a scale of 1 to 5, where 1 is very low and 5 is very high, where will you place the extent to which your organization use ICT to perform Vehicle inspection?

Probe:In your opinionswhatmight be the reasons for this condition?

Probe:Do you have plans to adopt ICT in vehicle inspection

Question 4:

Please tell me, have you ever use ICT in verifying the validity of inspected parameters i.e. insurance, vehicle worthiness, driving licence and road tax

Probe:How do you check the authentication of insurance, vehicle worthiness, driving licence and road licence?

Probe:In your opinionswhatmight be the reasons for this situation?

Question 5:

How do you tracking the traffic violation (i.e. over speeding vehicle) and stolen vehicles

Probe:Are there any suggestions that you think can facilitate the law enforcement to track the over speeding and stolen vehicles

Probe:Do you think if ICT is committed for vehicle inspection, could it reduce vehicle crime and accidents?

Probe:Please explain to me issues that need to be addressed that ICT can be adopted to facilitate vehicle inspection?

Probe: Are there any issue that could challenge the adoption of ICT to facilitate vehicle inspection in police force?

Probe: How could these tissuesbe addressed?

Question 6:

Is there any relationship between adoption of ICT and availability of reliable electricity?

Question 7:

Are there any suggestions and measures that you think may favour the adoption ofICT in vehicle inspection?

Question 8:

Are there any suggestions/measures on the issues provided at 7?

Question 9:

Does the suggestions/measures given on 7 above relevant to patterns, concepts, properties and dimension of vehicle inspection?

Appendix 2: Face to face Interview Guide

THE OPEN UNIVERSITY OF TANZANIA

FACULTY OF SCIENCE, TECHNOLOGY AND ENVIRONMENTAL STUDIES

ICT DEPARTMENT

Research Title: Framework for Adoption of ICT by Traffic Police Force in Vehicle Inspection and Monitoring Automation: A Case Study of Tanzania

Student: Elia Elisante Lukwaro

Supervisors: Dr. Jim James Yonazi

Q1. Introduction (Researcher + Interviewee) …….

Q2. To what extend do you use ICT in your daily activities

……

Q3. Do you think police traffic force needs ICT for vehicle inspection? …….

Q4. In what situation are you most likely use ICT?

Q5. In your opinion, do you think the top management have a plan to install ICT in vehicle inspection? ……

If yes! How do you know that ……

Q6. How do you inspect the validity of safety parameters?

…….

Q7. Have you ever think about the use of mobile infrastructure to facilitate the vehicles inspection? …… (If yes go to Q8 if no go toQ9)

Q8. How can this be implemented? Can you identify a specific area where vehicle inspection can utilise the mobile infrastructures?

……

Q9. Do you have any suggestion that you think will influence the adoption of ICT in vehicles inspection?

……

Probe: Is it compatible with current situation? It is achievable?

……

Appendix 3: Questionnaire

THE OPEN UNIVERSITY OF TANZANIA

FACULTY OF SCIENCE, TECHNOLOGY AND ENVIRONMENTAL STUDIES

ICT DEPARTMENT

Research Title: Framework for Adoption of ICT by Traffic Police Force in Vehicle Inspection and Monitoring Automation: A Case Study of Tanzania

Student: Elia Elisante Lukwaro

Supervisors: Dr. Jim James Yonazi

Dear Respondent

Thank you for agreeing to participate in this survey. Your participation in this study is highly valuable. Any information obtained in this study is only for educational purpose and will remain confidential.

This survey is design to collect the information about the factors influencing the adoption of ICT by law enforcement entities (the case of traffic force). It will take approximately 10 minutes to complete the questionnaire.

Respondent Information

1. Job title …….
2. Organization name ……

Issues and knowledge of the factors influencing ICT adoption

3. Which one of the following categories best describe the daily use of ICT technology in your career
4. An intermediate user ☐a fairly experience user ☐A very experienced user ☐
5. Top management can highly influencing the adoption of ICT in organization
6. Strongly Disagree ☐Disagree☐ Agree☐Strongly Agree ☐Neutral ☐

What are the factors that leads to the successfully adoption of ICT in your organization?

Issue 1……

Issue 2……

Issue 3……

Issue 4……

Issue 5……

Issue 6…….

What are the ICT that you think will fit the purposes of vehicle inspection and monitoring

ICT 01……

ICT 02……

ICT 04…….

ICT 05……

ICT 06……...

ICT 07……...……

ICT 08……...……

ICT 09…….……..

1. What are the factors inhibitors/hinders the Tanzanian law enforcement entities to adopt ICT in vehicle inspection and monitoring?

Factors	**Measure:** *please tick, the best scale on each row according to your opinion*				
	Very Low	**Low**	**Medium**	**High**	**Very High**
i. Lack of skill to use ICT					
ii. Lack of training					
iii. Lack of ICT equipment's					
iv. Lack of technological infrastructure					
v. Lack of reliable power					
vi. Inability to buy ICT equipment					

2. How do you consider network infrastructure in Tanzania, please think about the mobile infrastructure as well
3. Very weak ☐Weak☐Neutral ☐Very strong ☐Strong☐
4. Police traffic force understand the useful of ICT technology in vehicle inspection
5. Strongly Disagree ☐Disagree☐ Agree☐Strongly Agree ☐Neutral ☐
6. Can you please write briefly, how police traffic inspects the validity of safety parameters? .i.e. Insurance, Speed, Road Licence, Vehicle worthiness

7. Due to the presences of well-established mobile network, do you have suggestion that you think, mobile network can facilitate the ICT in vehicle inspection.

8. Briefly write what do you think can be done to adopt the ICT in vehicle inspection

****THE END****

Appendix 4: Focus Group Discussion Guide

THE OPEN UNIVERSITY OF TANZANIA

FACULTY OF SCIENCE, TECHNOLOGY AND ENVIRONMENTAL STUDIES

ICT DEPARTMENT

Research Title: Framework for Adoption of ICT by Traffic Police Force in Vehicle Inspection and Monitoring Automation: A Case Study of Tanzania

Student: Elia Elisante Lukwaro

Supervisors: Dr. Jim James Yonazi

Introduction

This presents the procedures followed in FGDs and summarised the issues raised regarding the aspects and factors influences the ICT adoption by law enforcement entities especially Traffic Police Force.

Procedures

1. Research Introduced himself and introduce the purpose of discussion
2. The researcher projects the questions, to be answered by participants. The questions include.
   (a) Can you discuss briefly the reasons why do you think ICT is important to vehicle inspection and monitoring

(b) Discuss briefly what do you think can be done to adopt the ICT in vehicle inspection and monitoring. Or what are the issues necessary to the adoption of ICT for the vehicle inspection and monitoring

(c) Can you outline the typical Tanzania ICT issues that you think can influence the ICT adoption by Traffic Police Force?

3. The researcher ensure that the discussion was kept on course and each participants got fair chance to participate
4. At the end the researcher measures the relevant to patterns, concepts, properties and dimension to the vehicle inspection and summarised the feedback.

Summary of FGD feedback

(a) Readiness – prepare the ICT Policy and Strategies

(b) Study tour - Need exposure to the developed country, cause they advanced in ICT

(c) Human resources with ICT skilled

(d) Need to identified and provide the recognizable names to all roads

(e) ICT Equipment's i.e. Gadgets, CCTV Cameras, Servers, Networks

(f) Power supply (Electricity)

(g) Network Infrastructure

(h) Investment on ICT

(i) Mechanism of dealing with all vehicles include bajaji, motor cycle, et cetera, about plate number recognition

(j) Platform that police will use to fetch and process data quick

(k) Plan ICT training to all police force

Appendix 5: Transcribe and Summarised the Respondents Feedback and Identification of Key Issues

Question number	**Respondent feedback**	***Key Issues identified***	***Code Assigned***	***Memo (Author observation, document analysis and interviewees' experiences)***
1	*ICT Project Supervisor, Police Officer, TAA, Police, Insurer, computer Technician, Computer programmer, Computer network technician, head of smart card, System Analyst, Head Information Resources Management, System analyst, System Developer*	**Respondents are from different background other are expertise in ICT some have basic knowledge on ICT**		The demographic of the respondents, includes the expertise and some with basic knowledge of ICT.
2	*ICT intermediate users, a fairly experience user, a very experience user*	**Most of respondents about 40% are a fairly experience users, while 10% are very experienced users while 50% are intermediate users**		The study indicates, still large number of staffs have a less experience in ICT. Accordingly, there is a needs of enough ICT equipment's, seminars, workshop in order to rise ICT experience, hence increase ICT adoption
3	*''I think lack of* **investment funds** *and well developed IT infrastructure.'' ''Lack of* **investment** *on ICT''* *'''Government* **initiatives** *on* **removing tax** *on*	**Investments** **Tax free on ICT Equipment's**	''O01F'', ''P01F'', ''P02F'', ''P03F'',	Financial support is one of the key factors influence the adoption of ICT. Financial support

	some ICT equipment.'' *''Enough* **fund to support** *CT project''.* *''Government must* **invest on ICT''**	**Financial support**	''P03F'', ''S02F'' ''O02F''''O03F''	assist in variety operational and managerial activities such training, purchase ICT equipment's and research, hence increase adoption.
4	*''yes! mostly in checking the speed violation* *"we inspect; insurance – visual inspection, vehicle worthiness – visual inspection, Road Licence - visual +special USSD Code (TRA), Speed – use of speed radar/LIDAR/laser"*	**Visual inspection** **Special USSD code** **Speed radar**		Currently the traffic police are inspecting vehicle visually, special USSD code and speed radar, this modality is not efficient as is controlled by human feelings**. Accordingly, ICT adoption is crucial for automated inspection and monitoring**
5	*"Currently depend on speed radar"* *"for stolen vehicle – eye witness if available, random check. For speeding violation – feelings, speed radar"* *"Suggestions – needs the automated ICT systems, CCTV cameras" ''I think ICT will assist to eradicate crimes and accidents – because will be able to track and monitoring''* *''a lot of issues need to be addressed, these*	**Speed radar** **Eye witness** **Speed radar**		Currently traffic police depend on eye witness, sometimes suspected mobile use to trace the stolen vehicles, and for road rules violation are mostly controlled by feelings of an office on duty, I mean

	includes skilled human resources, Network Infrastructure, ICT's, financial support, power supply and et cetera ''			
6	*''it true there is close relationship, if no sustainable power you can use ICT equipment's''''* *Actually; like other developed country we are lacking the sustainable* ***supply of power''*** *''We have rule and regulation that need to compliance via ICT so,* ***electricity is compulsory*** *to run our business''.* *''Sometimes we use our own* ***generator to supply power,*** *and this is challenging but soon I am positive that Tanzania especially here in Dar es salaam there will be a reliable supply of power''.* *"Tanzania need Nuclear for generation Power, that is when electricity will be reliable"*	**Supply of power''** **Electricity is compulsory** **Generator to supply power,**	''P02E'' ''P01E'' ''P03E''''P04E''''O01E'' ''O02E''''O03E''''O04E''''O05E''''O06E'' ''S01E''''S02E''	Lack of sustainable power supply, affect the adoption of ICT. One of the key barrier undermine the adoption and usage of ICT in developing country is the unsustainability of power supply. **Accordingly, the constant and sustainable supply of electricity increase the adoption of ICT**
7	*''we need to invest much on* ***infrastructure****''* *''Inadequacy of* ***infrastructures****''* **''Mobile or wireless network** *will facilitate the adoption and use of ICT in vehicle inspection and monitoring because it exists in wide areas in Dar es salaam''. ''I first recommend the use of* **mobile network** *which is well established in Tanzania''* *''Is true* **mobile network** *can assist to capture*	**Infrastructure** **Mobile network infrastructure**	''O01I'' ''O02I'' ''O03I'' ''O04I'' ''O05I'' ''S01I'' ''S02I'' ''S03I'' ''P01I'' ''P02I'' ''P03I'' ''P04I''	Internet connectivity and network infrastructure is prerequisite to the adoption of ICT. However, the advent of wireless network infrastructure and national ICT broadband backbone has somehow indicated to minimise if

	data and the **use TTCL National ICT Broadband Backbone to link with central database'** *'Yes, the* **mobile network** *is reachable and available everywhere through the country, so it is advisable to use* **mobile network** *rather than building another network infrastructure''* *''Yes, the* **mobile** *can facilitate the automated inspection and monitoring for vehicle inspection.''* *''investment on Infrastructure''* *'' This is true that* **mobile network** *will facilitate vehicle inspection and monitoring. However,* **telecom companies** *are commercial you will need to negotiate the charges of* **transmit your data***.''* *''Let vehicle inspection and monitoring initiatives* **use, existing infrastructure***e.g.* **Mobile network***, TRC/TRL''*		'' S03I'' ''P01I''	not to eliminate the connectivity and network infrastructure challenges. **Accordingly, network infrastructure influences the adoption of ICT**
8	''Supportive organization **policy** for adoption of IT.'' ''Create ICT policy for vehicle inspection'' ''**Security and privacy** *issues''* ''Reliable **strategies** regarding ICT from top	**Supportive Policy for ICT adoption** **Security and privacy Strategies**	''O01P'' ''O02P'' ''O04P'' ''O05P'' ''O06P'' ''O07P'' ''O08P'' ''O09P''	The adoption of ICT is vital for quality services to the citizen. However, ICT Policy and Strategies is essential for ICT

	management'' ''May be because we are independent authority, so we can make our own decision and make our own **strategic plans''** ''The successful adoption of ICT is due to the **policy** that compliance with our **rules and regulations**.'' ''The successful adoption of ICT in our organization is due to our vision, and five-year strategic plan.'' 'The **strategies** need to be designed and implemented for the successful adoption of ICT.'' *''It can also be a* **policy issues or Corporate Social Responsibility** *issues''* *''Creation of ICT vehicle* **inspection policy''** *''Inspection and monitoring can be enhanced by the aid of GPS to track the vehicles.''* *''Well established* **guidelines/rules***.''* *'' Enforcement of* **guidelines /rules***.''*	**Ability to develop Strategic plans** **ICT policy compliance with routines** **Strategic plan** **Design and Implement Strategies** **ICT vehicle inspection policy**	''S01P'' ''S02P'' ''S03P'' ''P01P'' ''P02P'' ''P03P''	adoption as it is taking into account organizational and operational issues, and incorporate quantitative targets, timeframe, monitoring and evaluation mechanism for the potential deploying and adoption of ICT. **Accordingly developing ICT policy and strategies increase adoption**
	''We have the **IT expertise's** *that fulfilled our needs''* *''One factor contribute to this is a lack of***IThuman resources***''* *''It seems* **Staff knowledge in ICT** *is still low''* **''Training the staff** *on the importance of ICT''*	**IT skilled** **IT human resources** **Staff knowledge in ICT** **Staff Training** **Training**	''O01T'' ''O03T'' ''O08T'' ''O04T'' ''S01T'' "" P03T" ''O01T'' ''S01T''	The knowledge about ICT in most of staffs is still low. The adoption of ICT is difficult without having appropriate ICT skilled staffs.

	'' Staff need to be **train** *and encourage in how to use technology. ''The Ministry of internal affair especially when recruit the staffs on vehicle inspection and monitoring department, should consider* **either skilled or semi-skilled personnel''** **'Skilled personnel in ICT** *vehicle inspection''* *''Police officers need to* ***be trained*** *on how to use vehicles* ***tracking devices*** *like those used in UK, USA German, at cetera…'''Need* **capacity building** *regarding ICT''.''Presence of* **IT skilled and ICT expertise** *in a traffic police force''. ''Not common,* **need training on the use of ICT** *in vehicle inspection and monitoring.'' .''Conducting* **seminars and training** *on traffic unit about the use of ICT in vehicle inspection.''* *''Use the* **outsource (skilled IT) and internal IT expertise**. *''* *''Provide* **training on Police Traffic** *officers on ICT*	**Skilled personnel** **Training**	''O06T'' ''S03T'' ''S02T'' ''S03T'' ' "O05T" "O07T" "P04T"	**Accordingly, ICT skilled staffs influenced ICT adoption**
	'' **Staff awareness** *on ICT and how to use it.''* *''**positive attitudes** to technology''* '' Arrange exposure visit, to learn and raise awareness''	**Staff awareness** **Positive attitudes** **Study tour, raise awareness** **CEO**	S01A, SO2A, P01A P02A	One of the factor influence the ICT adoption is awareness of the benefits and generally the application of ICT in

	*''Most of CEO's not***aware***with the potential benefits accrued by ICT. ''* *'I think* ***awareness of the technology (ICT)*** *needed*	**awareness**Awareness of the technology	O01A, O014A	task on hand. The awareness of the benefits of ICT, create the positive attitude on the staff's inclination to adopt ICT.
	''Top management ensure they are setting the budget for ICT resources'' *''This is because of the* **support from top management.''** *''However still the involvement and* **support of the government's top officials** *will highly influence the adoption''* *''Top management commitment.''* *''the management attitude toward ICT harness the adoption''* *''the commitment of top officials in changing the organization by accepting the modern Technology, however this will only be succeed through well informed by the advantages accrue by ICT''*	**Management ensure resource availability.** **Management Support** **Top official support** **Top management involvement** **Top management commitment** **Top management well informed**	''O01M'' ''O02M'' ''O03M'' ''O04M'' ''S01M'' ''S02M'' ''S03M'' ''P01M'' ''P02M''''P03M''	The management have high position to initiate and support the adoption process of ICT. Once top management install with awareness of the potentials accrue by ICT, they will support the stages needed for ICT adoption. **Accordingly top management influence the adoption of ICT**
9	*''Lack of* **standards, policy** *that already in place to enforce standards in back end applications, i.e. vehicle inspection* ***need to access data from variety agencies*** *such as insurances, TRA and et cetera, I don't think if there is* **any rules to accomplish** *this''* *no* ***integrations due to heterogeneous system***	**Standards allow data exchange** **Ability to access data** **Automatically data access**	''O01X'' ''P01X'' ''O02X'' ''O03X''	The environment within which vehicle inspection and monitoring operated is complex as it needed data from different sources. At the moment some agencies i.e.

	Organizations involves must be willing to allow traffic police to ***automatically accessing*** *a particular data''* *''Lack of* ***ability to exchange data*** *in same of stakeholder's i.e. insurance as I know police need information from TRA, Insurance et cetera in order to make certain decisions so…,* *''ICT alignment with daily routines''* *'Police need data from various source, so there is a* ***need of the technical standards*** *that allow exchange of data''* *''There is a need* ***to set the standards*** *for back end applications''*	**Compatibility with daily routines** ***Need of the technical standards***	''O04X'' ''S01X'' ''S02X'' ''S03X'' ''P01X'' ''P02X''	Insurance companies, their back end applications are neither compatible nor interoperable with police system. **Accordingly enforcing the level of system standards to the firms issuing parameters i.e. insurances, vehicle worthiness, vehicle's card, et cetera, increase adoption**
	''This is multi-sector issues. You will need to have a **central database or link up various information systems** *to accomplish your purpose. Example Tanzania Port Authority, TRA, Ministry of Transportation, TCRA, Vehicles owner, Insurance companies and et cetera''* *''* **Integrated system** *to monitor and retrieve data needed by police''* ***Digital devices*** *with ability to detect unlawful driven vehicles,* ***tracking systems*** *must be installed in vehicles''* ***Intelligent equipment's*** *that can recognizes vehicles in real environment and provides information in real time*	**ICT Equipment's** **Integrated system** **Intelligent equipment** **Digital devices** **supportive equipment**	''O01Q'' ''O02Q'' ''O03Q'' ''O04Q'' ''O04Q'' ''O05Q'' ''O06Q'' ''O07Q'' ''O08Q'' ''O09Q'' ''O10Q'' ''S01Q'' ''S02Q'' ''S03Q'' ''P01Q'' ''P02Q'' 'P03Q'' 'P04Q''	Vehicle inspection and monitoring involves the accessibility of various source of data. There is need of intelligent devices that need to capture the real object in real environment and convert to the conceptual environment, for comparing and hence send back for decision making. These intelligent devices or sophisticated

	Need to propose a ***computer system*** *that can detect the vehicle and report to law enforcement officers* *''If we need ICT in vehicle inspection we need to plan about those* ***devices that detects*** *all vehicles breaking road safety regulations''* *yes, need to be designed to fit our context because I don't think if you can capture the plate number of bodaboda by using European technology''* ***supportive equipment*** *will increase the rate of adoption''* *'' the automatic plate number* ***recognition system*** *need to be adopted to read the vehicle number in a real environment and transform in a mechanism where police can be use''* ''**Mobile network** *will automatically facilitate the* **communication** *between users (police traffic) and* **central database were information** *are kept.''* *''***Develop the guidelines** *that will smooth the operations* *'' Use the gadget such as smart phone through* **mobile network** *to check and receive order regarding the vehicles in hot list I mean vehicle of interest; missing valid discs, stolen, or speed violation).''* *''Yes, we need the* **integrated database**,	**plate number recognition system** **'Develop the guidelines**		devices are hardware and software. **Accordingly availability of sophisticate ICT Equipment's increase the rate of adoption.**

	because there a lot forging registration sticker'' ''The android smart phones can be used as a user interface to **check and received the information** *of the vehicle in question''*			
	''need to know about the ***security of data*** *and* ***overall system*** *while accessing, sending, retrieving.''* *''on other hand there must a way of* ***protect the data*** *and* ***system against*** *vandalism''* *''the other thing is the* ***protection of devices****, as I know CCTV cameras will be install with other ICT equipment's...", Data* ***privacy*** *guidance is needed, 'police will be able to access data, originated from variety source, will they be trusted to keep the* ***integrity and privacy while*** *processed the individual data?.''*	**Security and Privacy** **Protect devices against vandalism**	''O01S'' ''O02S'' ''O03S'' ''O04S'' ''S01S'' ''S02S'' ''S03S'' ''P01S'' ''P02S''	Security involves both protection of data and protect Equipment's against vandalism. The security and privacy of data is ethical issues. As the officer on road will be able to access the information of individuals, the guideline regarding the integrity and privacy is crucial because will influence others organization to support the sharing of information with police traffic system hence increase ICT adoption

Appendix 6: Research Clearance Letter

JAMHURI WA MUUNGANO WA TANZANIA
WIZARA YA MAMBO YA NDANI YA NCHI
JESHI LA POLISI TANZANIA

Anwani ya Simu: "MKUUPOLISI"
Simu Nambari: 2110734

Unapojibu tafadhali taja

Inspekta Jenerali wa Polisi
Makao Makuu ya Polisi,
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DAR ES SALAAM.

Kumb. Na. PHQ/C.22/3/VOL.II/12 **30/06/2015**

The Open University of Tanzania,
Directorate of Research, Publications,
and Postgraduate Studies
S. L. P. 23409,
DAR ES SALAAM.

Yah: **OMBI LA KUFANYA RESEACH CLEARANCE Reg. HD/S/159/T.13**
MR. ELIA ELISANTE LUKWARO

Rejea barua yako ya tarehe 03/06/2015 kuhusu kichwa cha habari hapo juu.

Inspekta Jenerali wa Polisi amekubali kufanya utafiti juu ya mada aliyoomba mtajwa hapo juu "Factors Influencing Adoption of ICT by Law Enforcement Entities in Tanzania. The case of Traffic Police Department".

Tafadhali aandae maswali ambayo atahitaji taarifa zake na awasilianae na Kamanda wa Polisi kikosi cha Usalama Barabarani ili kupata taarifa hizo.

Nawasilisha,

J. S. N. Mugendi – DCP
Kny: **INSPEKTA JENERALI WA POLISI**
INSPEKTA JENERALI WA POLISI
TANZANIA

Nakala:
Mkuu wa Kikosi cha Usalama Barabarani
Makao Makuu ya Traffic,
DAR ES SALAAM. **– kwa taarifa**

Mr. Elia Elisante Lukwaro

Date: .....……

Signature: .....

Name:

.....

CANDIDATE

Comments by Supervisor.....

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Date: .....

Signature:

.....

Name:

.....

SUPERVISOR