AN INTELLIGENT AGENT PROTOTYPE FOR OPTIMIZING STAFF ALLOCATION

BY

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DECLARATION

DECLARATION BY THE STUDENT:

This research thesis is my original work and has not been submitted in any other university or institution for examination or for any other reason.

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DECLARATION BY THE SUPERVISORS:

This research thesis has been submitted with my approval as the university supervisor.

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I dedicate this work to my family for their encouragement and dedicated love for success in my life.

ABSTRACT

Organizational ICT services are becoming more critical and complex and this growing dependency on these services leads to growing requirement for quality ICT services support. Currently, the ICT staff allocation system at KRA does not serve the organization's demands adequately. To address this issue, Intelligent Agents may offer solutions to some major ICT services support at KRA or any organisation by playing the role of staff allocation optimisation assistants. The aim of the study was to investigate the process of ICT staff allocation at KRA and develop a prototype intelligent agent for optimizing staff allocation in ICT services. The objectives of the study were to: examine the ICT portfolio at KRA, establish the current ICT staff allocation system at KRA, find out the challenges of the current staff allocation system at KRA and develop a prototype intelligent agent for optimizing staff allocation. A combination of the Agent Theory and Belief Desire Intention Model were used to guide the study. The study adopted a qualitative case study approach for data collection and actualized through experimental prototyping. The sample population comprised 135 staff out of a population of 4,500 KRA staff. Purposive sampling was used to identify 23 participants from KRA headquarters. This constituted of 1 head of department, I division head, 6 section heads, 10 technical and support staff all drawn from the ICT department. The second cadre constituted of 1 senior manager and 2 end-users from the Support Services department and 2 senior managers drawn from the Domestic Taxes and Human Resources departments. Interviews, open-ended questionnaires and document review were the main instruments for data and requirements gathering. The study employed Prototyping methodology using a bottom-up approach implemented on Django web-based platform for the KRA Intelligent Agent development. The findings revealed that the ICT Department is experiencing problems attributed to uncoordinated, unmanaged and under-resourced ICT services. The study concluded that the changing demands from customers, the need to contain costs and to improve services in business processes requires the application of ICTs supported by optimum staff capacity. The study recommends: effective automation and creative use of ICTs, investing in human resource development and re-structuring the ICT functions that provide both intra and inter-departmental support services. The study further proposes a service delivery process map to guide all the ICT functions in the department. This formed the basis for the development of a prototype Intelligent Agent for optimizing staff allocation for ICT services support. It is further recommended that KRA should adopt the Intelligent Agent prototype with or without modifications in the integration with its existing systems.

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LIST OF ABBREVIATIONS

AI:	Artificial Intelligence
BDI:	Belief Desire Intention
DBMS:	Database Management System
GOK:	Government of Kenya
ICT:	Information and Communication Technology
IA:	Intelligent Agent
IT:	Information Technology
ITIL:	Information Technology Infrastructure Library
KRA:	Kenya Revenue Authority
KSAIA:	Kenya Revenue Authority Staff Allocation Intelligent Agent
RARMP:	Revenue Administration Reform and Modernization Programme
SDC:	Senior Deputy Commissioner
SDLC:	Systems Development Life Cycle
UNCTAD:	United Nations Conference on Trade and Development

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May the Almighty God bless you abundantly!

CHAPTER ONE

INTRODUCTION AND BACKGROUND OF THE STUDY

1.0 Introduction

In our daily lives, when we find ourselves in a position where time and activities overtake us, we seek help in the form of assistants, that is, people who help us perform tasks we could do ourselves, but prefer not to. In this modern age of Information and Communication Technology (ICT), we require an increasingly large number of applications to play the role of such assistants. Systems that can decide for themselves what they need to do in order to satisfy their design objectives. According to Wooldridge (2009), such computer systems are known as Intelligent Agents.

Worldwide today, it has been recognized that organizations are becoming increasingly dependent on ICTs in order to satisfy their corporate aims and meet their business needs. This implies that the growing dependency on services leads to growing requirement for quality ICT services support. According to McDonnell (2014), organizational ICT services and information systems are becoming more critical and complex, as a result, the level of ICT service support and integration becomes even deeper. According to various studies (Ndemo 2016, Gichoya 2005, Wanyembi 2002) most developing countries are characterised by limited ICT infrastructure and shortage of skilled manpower to operate and support their organizational systems. A study by Ndemo (2016), observes that this situation exists largely due to lack of coordination at different levels in making effective use of the ICTs. The author recognizes that a combination of knowledge and ICTs makes a powerful tool for change since ICTs have a great potential to transform organizational business and

provide an enabling environment for the development of technology-based social systems. Another study by Gichoya (2005) justifies this situation by identifying various challenges that affect the successful implementation of ICT projects in the public sector. The author identifies among other characteristics: inadequate ICT budgets, lack of ICT policies and master plans to guide investment, unstable ICT resources and a focus on ICT applications that support traditional administrative and functional business transactions rather than those that focus on organizational efficiency. On his part, Wanyembi (2002) observes that in recent years, ICT has been rapid and challenging top corporate and ICT management. In addition to this (UNCTAD, 2004) observe that new systems have been, and are still being developed, which profoundly affect the ways in which organizations operate.

Although studies in ICTs (Luftman 2011, Wainright et al 2011, CISR 2015) have acknowledged that the successful management of an organization's ICT resources must combine knowledge with a thorough understanding of business strategy to guide the development of information resources, there have not been any indications as to how human resources need to accomplish and manage such ICT resources. The Government of Kenya (GOK) has committed to using ICT in its efforts towards effective and efficient citizen service delivery. However, the extent of demand and the current scale of composition of ICT workforce present both opportunities and challenges (ICT Authority, 2015). In particular, consideration of factors such as the tasks to be performed, how many people to be involved and the required technical skills for such staff in such an organisational perspective is very important. In order to address this disconnect between ICT service delivery and ICT workforce, any ICT department requires different skill sets to provide services to customers that vary in

nature and importance (Hussam, 2015). The author further notes that the focus on ICT functions is important because functions provide specialization and visibility to ICT work which provide the how-to and span multiple roles, sections and ICT staff members.

It is therefore, important to harness the power of technology to make smarter and faster decisions (ICT Authority, 2015). Khalil (2001) on the other hand, argues that the computer can be made to represent its unique skills, expertise, and predispositions in terms of character traits and these traits can later be represented directly through communication, appearance and sound as external traits. This in turn causes users to infer traits as internal based on the level of knowledge and thought they possess. This implies that by capturing and representing the capabilities of agents, we can realize several benefits for allocating staff. First, this form of representation makes optimal use of agents' abilities to think, decide, and act on the basis of the external traits. With an intelligent agent, users can employ requests so as to predict and control the actions of their agents. Second, the agent as represented by the capabilities can then successfully perform actions on behalf of an individual. So, based on that, there has been quite an amount of work done on the use of Intelligent Agents towards automating tasks from desktop applications which is evident from literature. There are even commercially available systems, whose authors claim that their products are capable of wide application (Winstanley, 2004). However, this study recognizes that there still exist gaps in the existing systems in the provision of ICT services support.

For the purpose of this study, the intelligent agent will focus on how a computer program can perform some of these actions. The study therefore, sought to investigate

the process of ICT staff allocation at the Kenya Revenue Authority (KRA) and develop a prototype intelligent agent for optimizing staff allocation in ICT services support.

1.1 The Concept of Intelligent Agents

Negnevitsky (2002, p.4) defines Artificial Intelligence(AI) as part of computer science concerned with designing intelligent computer systems, that is, AI can therefore, be described as a field of study that seeks to explain and emulate intelligent behaviour in terms of computational processes (Pankaj, 2010). According to Brooks (1991), AI was initially conceived by Newell and Simon using production systems but the study quickly divided into two streams with John McCarthy and Nil Nillson considered the Neats (using formal logic as a central tool to achieving Artificial Intelligence), while Marvin Minsky and Roger Schanks were considered the scruffs (using a psychological approach to Artificial Intelligence). Later on, Russel & Norvig (1995) entered the argument by describing an environment as something that provides input and receives output, using sensors as inputs to a program, producing outputs as a result of acting on something within that program. Today, the AI community uses this notion as the basis of definition of an Intelligent Agent.

According to Crowston & Malone (1997), the idea of an intelligent agent refers to a system that, when given a goal, can carry out the details of the appropriate computer operations and can ask for and receive advice, offered in human terms, when it is stuck. Other authors have different views on how agents work. For example, Russell & Norvig, 2013, p. 31 define an intelligent agent as anything that can be viewed as perceiving its environment through sensors and acting upon that environment through

effectors. This means that for an agent to act upon any instruction, it requires sensors to perform its task and in order to complete this task, it must respond to its environment using effectors. Mills & Stufflebeam, 2001, pp. 1, describe an intelligent agent as something that is capable of making decisions about how it acts based on experience.

We can therefore conclude that an Intelligent Agent is something that processes internal information in order to do something purposeful on behalf of something else. The field of Artificial Intelligence provides the technical skills for translating desired types of agent behaviours into programming language, related software, and the appropriate architecture (hardware and related software) for implementing the agent in a real or simulated world (Mills & Stufflebeam, 2005).

To-date, a number of significant applications utilising agent technology have already been developed. Mills & Stufflebeam (2005) identify various application areas of Intelligent Agents including: resource allocation, distributed project management, electronic commerce, information retrieval, medical field, military, manufacturing, networking, call centre planning and scheduling among other areas. For example, Fatima & Wooldridge (2001) formulated a policy for the creation of an 'Adaptive Task Resources Allocation in Multi-agent Systems' that allowed a collection of multi-agent organizations to dynamically allocate tasks and resources between themselves in order to efficiently process an incoming stream of task requests. This agent was intended to cope with environments in which tasks have time constraints, and environments that are subject to load variations. It was made up of two key elements: (1) the task allocation protocol that allowed agents to cooperatively allocate their

tasks to other agents with the capability and opportunity to successfully carry them out (2) the resource allocation protocol that could dynamically change the resource allocation to by using ideas from computational market systems to allocate resources to organizations. In another study (Fukunaga et al, 2002) give an inside look into the real-world staff scheduling problems with their numerous complexities using an intelligent agent. According to this study, an agent called 'Blue Pumpkin Director', a staff scheduling system was successfully deployed at over 800 contact centres. The system uses AI search techniques to generate schedules that satisfy and optimize a wide range of constraints and service quality metrics. However, the basic constraints in 'Director' and its predecessors, specify issues ranging from the duration and the possible start times of shifts and off-phone activities in the creation, modification and scheduling scenarios.

Thus, whether you are allocating resources, surfing the Internet, shopping online, seeking a medical diagnosis, planning and scheduling activities, today, intelligent agents appear to be a promising approach to developing many complex applications and thus play a key role in the process. This study therefore, provides additional insight into how organizations can use Intelligent Agents as assistants to re-organise their services and workforce in the ICT departments and be more effective and competitive.

1.2 ICT Services

Luftman (2012) refers to ICT services as operational activities that involve providing, operating and maintaining an ICT infrastructure, and enabling access to information systems, applications and data. This implies that ICT services support is concerned with the effective management of services with respect to coordinating, monitoring

and controlling the ICT resources which deliver services. In the past, internal ICT services providers have sometimes been seen as inward looking and focused on technology, rather than on the requirements of users and customers.

As noted by Gichoya (2005), factors such as vision and strategy, technological change, modernization and globalization geared towards an organization can be used as drivers to encourage or reinforce the successful implementation of ICT resources. On the other hand, factors such as good practice, proper policies and effective coordination of ICT services can be used as enablers that will help to overcome the potential barriers. Whether this has always been justified or not, it is clear that ICT services providers must adopt processes, practices, policies and an organizational structure which will deliver the services their users/customers need (Ramenyi & Brown, 2012).

According to McDonnell (2014), the current organizational structures of in-house providers of ICT services have often evolved over years. The author attributes this to the changing demands from customers, the need to contain costs, to improve services, to be more business-like, and increasingly the need to compete with external companies. All these drivers are compelling ICT directorates to not only look critically at their existing organizational structures but also ensure they remain relevant and appropriate as argued by Bruton Consultancy (2014).

1.2.1 ICT Services Support at KRA

Kenya Revenue Authority's ICT resources are used to tie together the operations of disparate business units so that they can act as a whole which enables ICT to have an

impact on individuals, organizations and society at large. This further entails provision of the essential framework for the Authority to maintain stakeholders' confidence in their services. In KRA, ICTs are a key component in enhancing global competitiveness and encouraging and supporting innovation (Kenya Revenue Authority, 2010).

In order to offer better single-window services to taxpayers and other stakeholders, KRA is divided into five Regions namely: (1) Rift Valley Region, (2) Western Region, (3) Southern Region, (4) Northern Region and (5) Central Region with the headquarters situated in Nairobi, Times Tower. Currently, ICTs are incorporated to support services in order to enhance revenue collection both internally and externally (KRA ICT Structure 2013/2014). Figure 1.1 presents the organizational structure that portrays KRA in terms of revenue collection and other services support functions.

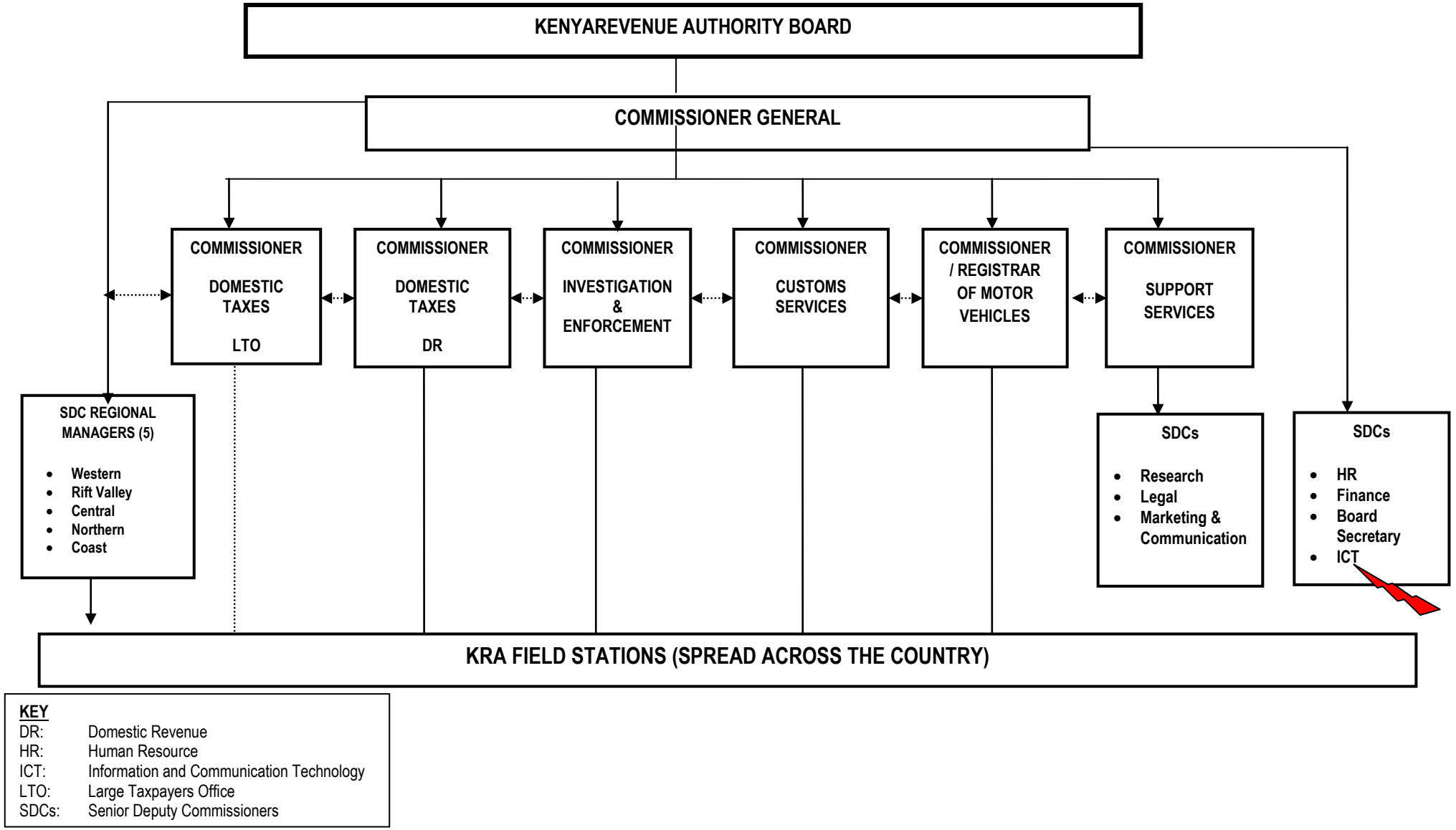

Figure 1.1: Organizational Structure of KRA (Source: KRA 4th Corporate Plan)

From the KRA Organizational Structure above, it is evident the ICT Department plays a key role to maintain all the support services for the entire organization in terms of business processes, information systems, operations and for delivery of services to its users/customers.

The automation of KRA's functions and processes in relation to revenue collection was facilitated by the Revenue Administration Reform and Modernization Programme (RARMP) based on the Information Technology Infrastructure Library (ITIL) framework. RARMP commenced in 2004/05 with the objective of transforming KRA into a modern, fully integrated and client-focused organization.
As further observed by KRA (KRA Revised ICT Structure 2012), there is need for planning and ensuring innovative maintenance of all its organizational ICT resources hence the need to acquire and maintain adequate staff to deliver quality ICT services which will meet the needs of customers, be appropriate to the business environment and also represent value for money.

1.2.2 The KRA ICT Portfolio

According to Center for information Systems Research (CISR, 2015), organizations invest in ICT to achieve four different management objectives: (1) strategic (to gain competitive advantage), (2) Informational (to provide management information), (3) Transactional (to process transactions and cut costs) and (4) Infrastructural (to provide shared services and integration). Hence, just as investors have portfolios to address their multiple investment objectives, it is necessary for organizations to have portfolios of information technology investments. ICT Portfolio refers to a collection of ICT investments, infrastructure and other resources of an organization's ICT

directorate/department (CISR, 2015). For the purpose of this study, the term refers to the technologies, projects, programs, policies and guidelines, operations and ICT services at KRA's ICT department which are managed as a group in a coordinated fashion to achieve the organizational strategic objectives.

The organizational structure adopted by KRA depends on its particular circumstances such as provision of services from a common point to other areas or devolution of responsibilities for services to business areas. It is important to note that organizations vary too much for any guidance to be given with confidence on how many staff will be required in ICT services since numbers will depend on particular circumstances such as organizational-wide infrastructure, personnel to be offered support, scope of service delivery and the structure of the organization in general. This is a clear indication that for an existing organization like KRA, the number of staff required can often be judged by how functions will be grouped on the ICT structure, breaking down current work into tasks and identifying the time taken to carry out such tasks. This can also be said to include control over changes required during the implementation as well as day-to-day running of the ICT infrastructure. However, all these will entirely depend on KRA's ability to provide the necessary ICT infrastructure and also to ensure the ICT Portfolio is balanced to achieve alignment with the business strategy and the desired combination of the organizational short and long term goals.

1.3 Statement of the Problem

According to McDonnell (2014), ICT Services are supposed to be structured to help facilitate the user to effectively and efficiently achieve their goals. This means that the

ICT department exists to provide services to its customers that vary in nature and importance, and therefore, these services require different skill sets from its providers. It is therefore, necessary not only to decide the best person to provide the ICT support services, but also to foresee how the entire ICT department team will work together and fulfil their final goal. Ideally, a qualified ICT manager is required to study the objectives, goals and the tasks to be performed by each of the staff. Thus, according to Hussam (2015), it is important to consider the following: defining clear roles and responsibilities for the delivery of ICT services; maintaining or enhancing ICT service levels to business users defining clear roles and responsibilities for the delivery of ICT services; and allocating the necessary staff for maintaining or enhancing ICT service levels to business users. In relation to this, Luftman (2012) further considers two factors: (1) personnel-specific – factors related to capabilities, experience, personality and past experience and (2) domain-specific – factors that involve features of a specific task to be performed that include the cost, safety and sub-processes.

Based on the investigation of this study, this situation has not been fully achieved by KRA's ICT department. To begin with, the current staff allocation system at KRA ICT department for delivering ICT support services to a diverse set of users (employees, senior management and customers) is a complex challenge. At the same time, the system does not address many fundamental issues from personnel resource allocation to quality assurance and accountability. In addition, the current staff totalling 122 does not serve the organization's demand with the degree of satisfaction required. This leads to significant unco-ordination of the limited ICT staff to monitor the ICT infrastructure and critical business and support systems, which means that their utility values cannot be ascertained. Finally, lack of staff rotation based on their

areas of specialization lead to lack of staff allocation optimization. As a result, there is the uncertainty regarding the distribution of work causing a lot of duplication and conflicting activities offered by the ICT staff leading to further consequences of staff idleness, unclear and uncoordinated ICT services. As a result of this, the challenges in allocation of staff further hindering KRA's main goal of generating revenue for the government. Due to the foregoing problems, there is need to re-organize the current staff allocation system. First, by finding out any staff shortages and surpluses thus enhance work distribution and secondly, to determine a proper and appropriate staff allocation system to offer optimum ICT support services in order to contribute to the stability and reliability of KRA's intrinsic infrastructure. In response to these problems, this study set out to investigate the ICT staff allocation process at KRA and provide a solution by developing a prototype intelligent agent for optimizing staff allocation in the delivery of ICT services.

1.4 Aim of the Study

The aim of the study was to investigate the process of ICT staff allocation at KRA and develop a prototype intelligent agent for optimizing staff allocation in ICT services.

1.5 Objectives of the Study

The following were the objectives of the study:

1. To examine the ICT Portfolio at KRA;
2. To establish the ICT staff allocation system at KRA;
3. To find out the challenges of the current staff allocation system at KRA;
4. To develop a prototype intelligent agent for optimizing staff allocation.

1.6 Research Questions

The study was guided by the following research questions:

1. What is the current situation of ICT infrastructure and investment at KRA?
2. What is the current ICT staff allocation system at KRA?
3. What are the problems hindering the ICT Department in the allocation of staff for the provision of ICT services support?
4. How can an intelligent agent be used for optimizing staff allocation to support ICT services?

1.7 Scope of the Study

The study was confined at KRA's Head Office, Nairobi. KRA was established by an Act of Parliament, Cap. 469, Laws of Kenya, on 1st July, 1995, for the purpose of enhancing the mobilization of government revenue, while providing effective tax administration and sustainability in revenue collection (Act of Parliament, 1995). The study mainly targeted KRA staff at the ICT Department but also included samples of informants dealing with issues on KRA human resource and service delivery that included: the Human Resource, Support Services and Domestic Taxes departments. Rather, the study was not concentrated on the general applications of ICTs at KRA.

The Intelligent Agent Prototype was built based on the following components: incremental knowledge formation process, the knowledge base and the inference engine as adopted from El-Nady, Nabil, Khalil & Elmahalawy (2000). This therefore, means that for allocation of staff , referencing was implemented using an opportunistic search approach as opposed to a generalization search approach based

on the KRA database of knowledge in particular, the ICT department's requirements of staff, professional qualifications, skills, job descriptions, functions and roles.

1.8 Limitations of the Study

Following were the limitations of the study:

1. The sample size was based on the qualitative research method, which does not collect numeric data from a representative sample of the target audience. The choice of participants depended upon the recommendations made by the key informants.
2. Due to some organizational policies and restrictions to engage the public on organizational matters, the researcher was only allowed to interview three members of the ICT Department. To further address this, questionnaires were administered to selected staff for additional information. Further, the opinions expressed by the participants reflected the real situations at the regional offices since all the functions provided at the ICT Department were a reflection of regional offices.
3. It is worth to note that the Intelligent Agent prototype being a computational system, has practical limitations that limit the information it can access and the computations it can perform. In order to make recommendations and act autonomously and proactively, the Intelligent Agent prototype has to be equipped with a priori knowledge about certain features of its environment.
4. There is limited literature on Intelligent Agents in particular, for allocation of staff capacity because the field of Artificial Intelligence is still developing. However, both the Intelligent Agent Theory and the Belief Desire Intention Model sufficiently guided the study.

1.9 Significance of the Study

It is expected that the outcome of the study will have implications to various stakeholders. Firstly, the intelligent agent could be used in planning and managing ICT staff for the purpose of optimizing ICT staff allocation. This is by way of improved employee satisfaction, reducing workforce administration overhead, coordination of the ICT department and provision of accountability of the staff and service delivery. Secondly, it is hoped that the intelligent agent prototype developed will be of interest to ICT professionals and Researchers. It will add to the body of knowledge in the area of artificial intelligence especially so in the area of allocating staff capacity for ICT services support. The study can also serve as authority for future research and scholarly work. Lastly, in terms of policy implications, it is envisaged that the results can be utilized in the development and streamlining of ICT structures including the job descriptions, staff requirements, qualifications and skills.

1.10 Definition of Operational Terms

ARTIFICIAL INTELLIGENCE: This refers to part of computer science concerned with designing intelligent computer systems that is, systems which exhibit characteristics we associate with intelligence in human behaviour which include understanding languages, learning, reasoning, solving problems.

HUMAN/STAFF CAPACITY: This refers to the maximum or optimum number of people that can be suitable to perform work. For this study, the term will be used interchangeably with Staff Capacity which refers to the optimum number of staff suitable to perform ICT functions and services at KRA.

ICT DIRECTORATE/DEPARTMENT: This refers to a division in an organization that provides technical, strategic and policy advice on ICT matters and the implementation of various ICT work processes, procedures and other administrative related matters.

ICT INFRASTRUCTURE: This refers to a range of technologies that include hardware, software, networking and implementation. These services are essential to the everyday mechanics of an organisation and are integral to effective service delivery.

ICT PORTFOLIO: This refers to a collection of ICT investments, infrastructure and other resources of an organization's ICT directorate/department. For this study, the term refers to the technologies, projects, programs, policies and guidelines, operations and ICT services at KRA's ICT department which are managed as a group in a coordinated fashion to achieve the organizational strategic objectives.

ICT SERVICES: This refers to the activities of an organization's ICT directorate/department used in the provision, operating and maintaining an ICT infrastructure and enabling access to information systems, applications and data.

ICT SERVICES SUPPORT: This refers to the provision of assistance to facilitate the users of computer infrastructure, web technologies, information systems, applications and data.

INFORMATION AND COMMUNICATION TECHNOLOGY: This refers to a tool that comprehends technologies that can process different kinds of information including voice, video, text, data and facilitates different forms of communications.

INFORMATION TECHNOLOGY INFRASTRUCTURE LIBRARY (ITIL): This refers to a framework made up of a set of practices that provides guidance to organizations and individuals on how to use IT as a tool to facilitate business change, transformation and growth. The framework focuses on best practices on: service strategy, service design, service transition, service operation and continual service improvement.

INTELLIGENT AGENT: This refers to software that assists people and act on their behalf by allowing people to delegate work that they could have done. This means that IA can perform repetitive tasks, remember things that people forgot, intelligently coordinate, analyse and summarize complex data, filter important information and even make recommendations to the end-users.

STAFF ALLOCATION: This refers to the process of distribution of staff according to a plan. To designate or to select a specific person to undertake an assignment or perform a given task.

STAFF OPTIMIZATION: This refers to the practice of improving the overall efficiency of staff by monitoring various activities in various positions and then aligning the right number of staff within these situations or resources.

PROTOTYPING: This refers to the activity of creating a software model that is used as a basis of developing the final software. It is a method used when it is difficult to obtain user requirements, hence, user keeps giving feedback from time to time. The outcome is an incomplete early version of an early approximation of the final product.

RAPID APPLICATION DEVELOPMENT: Rapid Application Development (RAD) refers to a highly interactive systems development methodology that respond to the need for faster and high quality development through simultaneous prototype revisions which bring the system closer to what is needed.

STAFF PROFILE: This refers to a description of work function for organizational staff that includes job descriptions, job responsibilities and required qualifications associated with the staff position.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews the relevant literature related to the study. The first section provides theoretical framework and conceptual framework with particular emphasis on the Belief Desire Intention (BDI) model and the Intelligent Agent Theory that have been identified to be related to the study. This is followed by a discussion of topics related to ICT Services and Intelligent Agents.

According to Cresswell (2014), a literature review is a text of a scholarly paper which includes the current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. It helps researchers learn what others have written about a particular topic (Frankel & Wallen, 2003). The study adopted both conceptual and systematic review of literature methods. More so, a combination of the Agent Theory and Belief Desire Intention (BDI) model was used to guide the identification of the variable factors influencing the allocation of human capacity in ICT services support at KRA. The chapter therefore, explores the issues contained in the research problem and objectives of the study as stated earlier in chapter 1.

2.1 Theoretical Framework

The essence of a theory is to be a descriptive of a model. When we have an idea about how part of reality can be regarded, we form a theory consisting of axioms that describe what we believe are true, that is, and our beliefs constituting the model.

Hence, the purpose of a theory is to be predictive and to give us more information of how the world is organized from the point of view of our beliefs (Wooldridge (b), 2009).

2.1.1 Agent Theory

Agent Theory developed by agent theorist Michael Wooldridge was adopted to guide the identification of relevant variables in the study. The author regards an agent theory as a specification for an agent; agent theorists develop formalisms for representing the properties of agents, and using these formalisms, try to develop theories they are able to capture desirable properties of agents. The aim of agent theory is to define and understand the distinguishing features of computer agents. Hence, the starting point is the notion of an agent as an entity which appears to be the subject of beliefs, desires, intentions, goals and plans.

According to Russell & Norvig (2013, p. 31), *an agent is anything that perceives an environment through sensors and acts upon it through effectors*. This definition of agent covers a broad spectrum of machines, (which do not learn anything new) to worms (which can actually learn a small repertoire of behaviours) to humans (with the greatest learning capacity, so far, on earth). An agent perceives an environment by employing sensors to gather information about its world. For example, a touch screen, a keyboard and a video camera can function as sensors, if they are linked to an agent program. At the response end of the system, effectors are the instruments used by the agent to act on its environment. A monitor, a printer, and a robotic arm are examples of effectors. According to the Agent Theory, it is evident that it is when relevant information is not effectively accessible that an agent may need to store information

and be equipped with a priori knowledge about certain features of its environment. If the environment is deterministic, the future state of affairs is deducible from the current state of affairs, hence, nothing is left to chance. The sensors must be appropriate to the sort of objects with which the agent is designed to interact. Meaning that whatever the sensors, the history of all perceptors sensed by the agent is critical to its future interaction with the environment.

The relevance of this theory to the research is that the KRA intelligent agent is expected to react to its environment by sensing and effecting. By complicating the relation between sensing the environment and effecting the environment, the researcher built up a concept of agency to the level of intelligence that was able to accomplish the following: (1) sensing included the description of all the KRA Intelligent Agent components to be processed by the inference engine. For example, to identify the necessary skills required for each function/role, assess the workload of each staff, prioritize the tasks in terms of the importance and urgency of each function and finally estimate the duration of each task. (2) effecting entailed the functionality of the system which meant whom to assign the task and what tasks to perform. For example, the reports generated from the system can help the ICT manager to determine whether the ICT department's structure require fewer or more people and also to determine the options for re-deployment or redundancy so that the information can be communicated to the Human Resource Department and the Senior Management at the ICT Department for planning further assignments of staff. Ultimately, this means that by sensing and effecting the environment, the system must consider the capabilities of specific mangers for example, to decide on the number of staff at the support levels based on career paths and succession planning and the need

for such staff in the department. More importantly, the concept can be used to assess the number of staff required to complete tasks depending on particular circumstances such as their designation, current workload, legality of the task, services to be offered, the duration of the task and finally the priority of each of the tasks to be performed.

2.1.2 Belief Desire Intentions Model

The study was further guided by the BDI Model developed by Georgeff, Pollack, Tambe, & Wooldridge (1999). The BDI model is a popular model for intelligent agents and has its basis in philosophy (Padgham & Winikoff, 2005). According to the authors, the model offers a logical theory of practical reasoning which defines the mental attitudes of Belief, Desire and Intention using a modal logic; system architecture; a number of implementations of this architecture, and applications demonstrating the viability of the model. Winikoff, Padgham & Harland (2001) present the central concepts in the BDI model as presented in Table 2.1:

Table 2.1: Concepts of BDI Model

Beliefs	A local knowledge base that represents information about the environment; - The beliefs should be informative.
Desires	What the agent is trying to achieve and represents the objectives to be accomplished, possibly with each objective's associated priority/payoff: - The desires should be motivational.
Intentions	The currently adopted plan and represents the currently chosen course of action; - Intentions should be deliberative.
Plans	The pre-determined sequences of actions and means of achieving certain future states. - Plans are an abstract specification of both the means for achieving certain desires and the options available to the agent.

The above concepts of the BDI model are relevant to the study as follows: the intelligent agent will require actions that are something which the agent does; in this case, an action is basically an agent's ability to effect its environment such as analyze information and generate feedback. In this regard, the first objective will be achieved, that is to examine the ICT Portfolio at KRA so as to understand the various ICTs that are being utilized in the Authority, and also to understand how staff allocation on various ICT services is carried out to support the Authority's business processes.

Secondly, the intelligent agent require a percept, that is, an input from the environment, that is, information from the users such as capture information and submit information. Here, the agent may also obtain information about the environment through sensing actions. In this regard, the second study objective was relevant since there was need to establish the staff allocation system in the ICT Department, so that the tasks to be allocated to staff match their section roles/functions. Thirdly, the intelligent agent required making decisions; in this case, these were questions which the intelligent agent must answer, such as: Which action shall I perform now? Which goal do I work on now? How shall I attempt to realise this goal? Which staff should be allocated to perform a particular task and for how long? Mechanisms to answer these kinds of questions were core KRA Intelligent Agent processes. Lastly, a goal is something the agent is working on or towards in this case, the last objective of the study was to develop a model intelligent agent for optimizing staff allocation to provide ICT support services. Goals therefore, give the agent its autonomy and proactiveness. Hence, if a plan for achieving the goal fails then the agent will consider alternative plans for achieving the goal in question. These

concepts (actions, percept, decisions, goals, plans and beliefs) are related to each other via the execution cycle of the prototype intelligent agent.

2.1.3 Shortcomings and Criticisms of Agent Theory and BDI Model

As mentioned earlier in the study, Intelligent Agents are autonomous, reactive, and proactive and also have social ability. Researchers in this area are primarily concerned with the problem of constructing software or even hardware systems that will satisfy the properties specified by agent theorists. According to Norling (2004), it could be argued that the principles of the Agent Theory and BDI Architecture have therefore, remained essentially unchanged since they were established in the mid 1980s. In a study by Wooldridge and Jennings (2000), the researchers present a survey of what is perceived to be the most important theoretical and practical issues associated with the design and construction of intelligent agents. They argue that similar theories and architectures need to be developed in order to address the shortcomings that both the Agent Theory and the BDI model fundamentally fail to address. Based on this argument, studies have criticized some of these shortcomings and also offered suggestions on how to improve the situation. Table 2.3 gives a brief summary of some of the selected key shortcomings/criticism of the Agent Theory and the BDI model.

Table 2.2: Shortcomings and Criticisms of Agent Theory and BDI Model

Author(s) and Model Name	Journal /Article Title	Key Problems/Criticism/Gaps
Norling, E. (2004) Folk Psychology for Human modelling	Folk Psychology for Human Modelling: Extending the BDI Paradigm	• That BDI lacks a standard approach to knowledge acquisition and encoding. This is so because eliciting knowledge from the subject(s) to be modelled and translating that knowledge into a form that can be encoded into the BDI framework is a challenging task. • That using the Agent Theory, there are problems of interfacing a BDI model with a simulated environment. This entails a mismatch between the environment under which the intelligent agent is build and a representation used by the intelligent agent. • That the BDI model has interface timings when it has to react to stimuli based on the Agent environment.
Muller, Heuvelink, Both (2008) Soar model of human cognition	Implementing a Cognitive Model in Soar and ACT-R: A Comparison	• That Agent theory and BDI architecture is becoming somewhat dated - the principles were established in the mid 1980s and have remained essentially unchanged. • That BDI model not suited for real time reasoning compared to the Practical Reasoning System a well known BDI architecture that can perform complex tasks in dynamic environments. • That BDI not viewed as a utility-maximizer in the economic sense in comparison to the Soar model of human cognition which has been successful in understanding intelligent agent's interactions. • That BDI has no forward planning mechanisms (no look-ahead). This is so because the already adopted plans have been designed as an Agent to use up all the limited resources, so the actions cannot be reversible.
Chin Kim et al (2014) Practical Reasoning System (PRS)	Agent Architecture: An Overview	• That BDI is not well suited to certain behaviours: this model is inappropriate for building systems that must learn and adapt their behaviour according to their environment. • That although BDI has the psychological reasoning which is a natural abstraction of natural reasoning, using the agent theory, an intelligent agent's reasoning is reduced to an entity intended to correspond to beliefs about the situation, its goals that it wishes to achieve and its understanding of the possible courses of actions to the world. In this case, entities will only select particular courses of action to perform that are available to the agent.

According to one critic (Norling, 2008), the Soar Model of human cognition which appeals to both cognitive psychology and practical applications for rationalizing design decisions has particularly been successfully used in understanding intelligent agent interactions hence viewed as a utility-maximizer in the economic sense. On the other hand, the BDI model that appeals to the logic and philosophy has particularly been successfully in reasoning of a single rational agent lacking the ability for learning from past behaviour and thus adapting to new situations. This means that both the Agent Theory and the BDI models should therefore, include essential components necessary for forward planning so as to cope with the real world situations. For example, the execution of tasks by the KRA Intelligent Agent may take longer than forward planning thus leading to actions having undesirable side effects if unsuccessful. In order to avoid this, the frequency with which the behaviour of the KRA Intelligent Agent System is designed should be frequently changed so as to accommodate new information that comes to light or even new competitive pressures that emerge from the environment and the real world.

Other critics (Pozna, et al 2011) argue that the interaction within an intelligent agent can either happen directly or indirectly. This occurs through the agent reasoning mechanism based on the trustworthiness feature of Intelligent Agents (which means that agent will not deliberately communicate false information). Other concerns include: practical reasoning- this is reasoning towards actions and theoretical reasoning- which means deriving knowledge from one's beliefs (Liu, Helfenstein & Wahlstedt, 2008). This further implies, that intelligent agents are able to make rational decisions, that is, blending proactiveness and reactiveness thus showing rational commitment. By so doing, the KRA Intelligent Agent will be required not only to

implement the tasks delegated to them by human users but also satisfy users on a cognitive level (Liu, 2010).

In order to try to address some of the above stated shortcomings, this study demonstrates how Agent Theory and the BDI Model can further be extended to incorporate the psychology and human practical applications using the KRA Intelligent Agent. In reference to the fourth objective of the study, I believe I have made contributions adopting both the theory and model and also trying to incorporate psychological, philosophy and logic into a practical application. I have demonstrated this in while designing the KRA Intelligent Agent in Chapter 5 of the study.

The KRA Intelligent Agent has been designed using: (1) an incremental knowledge process that entailed acquisition of dynamic knowledge from staff, updating this knowledge base and making generalizations and sub-generalization concepts (2) this knowledge can later be searched using an opportunistic search approach and (3) the inference engine is used to process the user requests and to select which rule (using the IF THEN rules) to apply to solve a given problem for staff allocation. This means that the KRA Intelligent Agent's application includes practical reasoning: this is human practical reasoning towards the IAs actions that involve two activities namely: (1) deliberation - the IA decides what state of affairs need to be achieved and (2) means-end reasoning- the IA decides how to achieve these states of affairs. This essentially means that the KRA Intelligent Agent will be required not only to implement the allocation of tasks delegated by the ICT Manager, but also satisfy customers on a cognitive level by making rational decisions. As pointed out by Wang & Ruhe (2007), intelligent agents should be able to make rational decisions by

blending proactiveness and reactiveness, thus showing rational commitment to the decisions made in the face of the changing environment.

There are several reasons that intelligent agents will be part of most if not all future applications developed. For example, today, mobile and desktop applications are becoming so rich in features, so that users can master only a small part of their capabilities. Intelligent agents will therefore, mask the complexity and help the user do what is necessary. Secondly, the Internet technology has bombarded us with what is termed as information overload, meaning that sources of information are increasing, and their content is also increasing. Intelligent agents will in this case help us do data mining as well as help users locate the most productive mines. Additionally, the rapidly increasing use of the Internet and the World Wide Web is creating a much more complex computing environment such as Cloud Computing. This therefore, implies that users are now moving from simple connections to the complex world of multiple servers and services interconnected like a highway network where everything is available. It is therefore, clear that intelligent agents will make a cohesive whole out of this modern and complex world of technology.

The degree of success of developing an Intelligent Agent to allocate tasks for ICT service support is very much dependent on the influence of the Agent Theory and the BDI Model concepts discussed earlier. These factors are interdependent and together influence the outcome of the KRA Intelligent Agent prototype with given unique characteristics or features as presented later in Chapter 4 and 5 respectively.

2.2 Information and Communication Technologies Services Support

The substantial value added utility of ICT in the provision of, and access to, information services for improved planning and organizational management has become more widely recognized (Korongo & Gichoya, 2010). To this end, it can be argued that the overall benefits from a well designed ICT directorate is in ensuring business areas receive services that match their requirements. Drawing significance to this, McDonnell (2014) states that, ICT directorates should be judged against three main criteria. Firstly, service delivery should be according to business needs and agreed standards and this also includes customer satisfaction and the style and level of customer interaction. Secondly, the cost of services delivered should be as economically and efficiently as possible. Thirdly, the ICT directorate should be flexible in that it can respond to changes in current and future business needs.

This premise underscores the need for comparing existing KRA ICT staff numbers and skills with the structure in order to identify any shortages and surpluses for provision of ICT services as envisioned in objective three of the study. Hence, establishing a structure which will support good communications with customers must be a prime aim of ICT service providers such as the KRA ICT department.

2.3 Intelligent Agents

The term Intelligent Agent has been variably defined in the literature and this indicates that agent software can perform repetitive tasks, remember things that people forgot, intelligently coordinate, analyse and summarize complex data, filter important information and even make recommendations to the end-users. To flesh out a particular agent, Khalil (2001) argues that the computer can be made to represent its

unique skills, expertise, and predispositions in terms of character traits and these traits can later be represented directly through communication, appearance and sound as external traits, which in turn causes users to infer traits as internal based on the level of knowledge and thought they possess.

In another study, Crowston & Malone (1997) uses the term agent as a comparison of an agent to hardware or (more usually) a software-based system that enjoys the following properties: *Autonomy*: agents operate without the direct intervention of humans or others and have some kind of control to their actions and internal states. *Social ability*: agents interact with other agents including human beings through some kind of agent-communication language. *Reactivity*: agents perceive their environment which may be the physical world that includes a user, a collection of other agents, the Internet, or even all of these combined and respond in a timely fashion to changes that occur in it from such environments. *Pro-activeness*: agents do not simply act in response to their environment, they are able to also exhibit goal-directly behaviour by taking the initiative to interact without direct intervention. By capturing and representing the capabilities of agents, we can realize several benefits for optimizing staff allocation. First, this form of representation makes optimal use of agents' abilities to think, decide, and act on the basis of the external traits. With an intelligent agent, users can employ requests so as to predict and control the actions of their agents. Second, the agent as represented by the capabilities can now successfully perform actions on behalf of an individual. This concept is further represented in Figure 2.1.

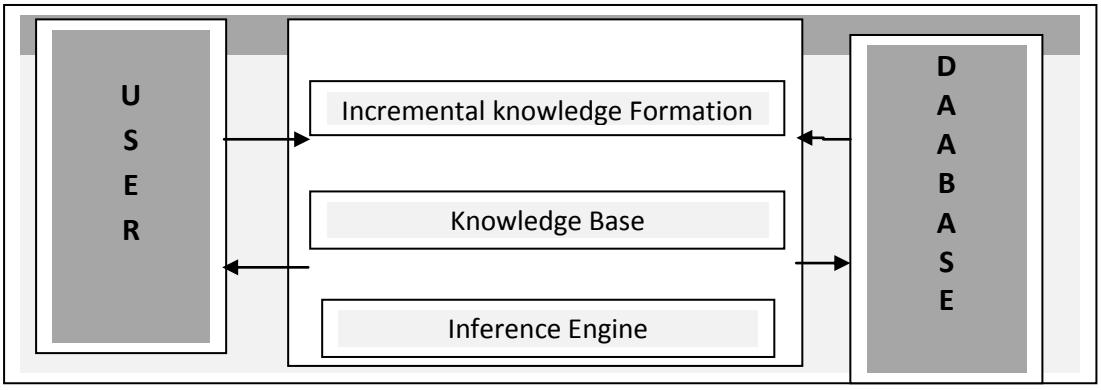

Figure 2.1: The components of the Intelligent Agent System
Source, El-Nady et al (2000)

According to the above diagram, we can describe the framework of the intelligent agent using the following components:

1. *Incremental Knowledge Formation Process*: this process acquires knowledge from the expert accompanied by the information retrieved from the analyst.
2. *The knowledge Base*: is a dynamic knowledge base represented in a form of hierarchy.
3. *The Inference Engine*: is used to search for the knowledge.
4. *Database*: is a collection of all inter-related organizational data.
5. *User*: is the end-user of the intelligent agent.

It is clear that Intelligent Agents have the potential to change the way we design, visualise, and build software in that agents can naturally model actors (Pankaj, 2010). Actors, for example, staff and ICT services are required to accomplish tasks at KRA and are real world entities that can show autonomy and proactiveness. Additionally, social agents naturally can model human organisations including business structure and processes.

2.3.1 The Intelligent Agent Architecture

The intelligent agent architecture was built upon three main subsystems as identified by El-Nady et al (2000) as shown in Figure 2.1. Maes (1994) further provides two approaches that have been used to build intelligent agents in the past. One is to force the end-user to provide the necessary skills by programming the agent and the second approach is to provide the agent with a priori domain-specific knowledge about the application and user. Wooldridge (2009) on the other hand, provides a third approach which is to build into the agents the ability to learn required skills from experience. In this last method, the agent can be trained by the user. The Intelligent Agent for allocating staff at KRA incorporated the above approaches to develop a system that help in decision making as further demonstrated in the system development in Chapter 5 of this study. Hence, the system is able to automatically generate modifications based on an analysis of the data provided therein.

2.3.2 Application and Examples of Intelligent Agents

In a study, Hopkins (2016) found that, ICT solutions powered by intelligent agents will very soon result in a redistribution of jobs. The author asserts that the use of digital assistants and chat bots such as Apple Siri and Facebook Messenger have already displaced human beings. Companies like Google and Facebook are now utilizing top talent and using big data to train algorithms that will power all kinds of new services in their systems including: convert unstructured data represented as images and videos into insights that include labelling of objects in such images.

Following are some examples of applications of intelligent agents: *Customer Help Desk*: a customer asks a frequently asked question, the customer is only required to describe this in form of a question and leave the rest to the intelligent agent. The agent will then automatically search the most likely possible answer from the appropriate databases (such as website, mobile database, distributed database, corporate database, cloud database), then present a consolidated answer with the most likely answer first. Thus, instead of organizations hiring help desk consultants, or having the customers search through the Internet for answers, agents will take up the role and help customers find and filter information. *Web Browsers*: intelligent agent such as an IBM Web Browser incorporated in various web browsers such as Chrome, Safari, Mozilla Firefox, is an agent which help users keep track of what website they visited and customize view of the web by automatically keeping a bookmark list, and a history of sites visited ordered by how often and how recent the user visits the site. Users are also notified when sites they prefer are updated, and furthermore, the agent can also automatically download pages preferred by users to later browse offline.

Intelligent agents have also been applied in organization of staff activities. Winstanley (2004) developed an intelligent agent known as the Staff Work Allocation Tool (SWAT) for use in the provision of healthcare services, a nurse roster system which entailed using a strategy of distributing the computational effort required in the nurse duties scheduling processes. Using the object-oriented approach, the study defined an agent called ‘Nurse’ using three subclasses with a common architecture. In producing the nurse roster, the administrator was given a task of allocating staff to shifts based on the skills and their qualification profile. The ‘Nurse’ Agent was purposely used for maintaining the nurses’ profiles and had the capability of learning the environment.

Further, the administrator was fully cognisant of all requirements and constraints which controlled the nurse schedules. However, the nurse scheduling was characterised by a great deal of local negotiation amongst the staff.

In another study titled "The Use of Intelligent Agents to Manage Human Resources in the Design of Chemical Processes' (Aldea, Lòpez, & Bañares-Alcántara, 2000), the approach was to model social and skill behaviours of the human expert using three agents within a working team. The manager agent was a qualified manager, required to study the social, professional and personal skills of each staff (engineer and technician) in the department and then decides the best engineer and or technician to be recruited to perform a particular task. Some factors were related to a particular staff while others were domain-specific and using his experience, the manager was able to elaborate the adequate working teams. This study demonstrates that Intelligent Agents can optimise the activities of teams by coordination. One of the challenges with the system however, was that experts involved were of different backgrounds and hence used different vocabulary. This shows that the capacity of such an intelligent agent is limited by its knowledge and its perspective. Thus, such an agent only specializes in solving a particular aspect of the problem since the agents were not able to interoperate and coordinate with one another.

Further, intelligent agents can also be applied in organizations for optimized service delivery especially so in today's competitive marketplace, where it is believed that customers hold the power. In order to address the challenges of service delivery optimization that mainly include: underutilized workforce, backlog of work, proliferation of customer-facing channels and systems and lack of operational

insights, Genesys Telecommunications Laboratories (Genesys, 2012), designed an intelligent agent known as Genesys Intelligent Workload Distribution (iWD) for this purpose. The iWD was specifically designed for Contact Centres to enable enterprise-wide customer service delivery. The system spans around three main areas: capturing tasks, calculating task values and distributing tasks to resources in the front and back office as present in Figure 2.2.

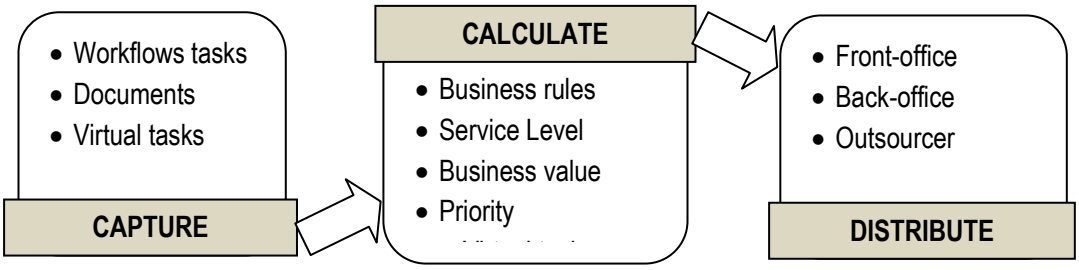

Figure 2.2: Functionality of iWD as adopted from Genesys (2012)

The three functionalities of the iWD includes four key pillars: (1) increase employee performance across the enterprise: by managing tasks from single to global tasks lists across all channels and systems, the intelligent agent proactively distribute tasks to the right resource, at the right time, and at the right location. (2) adhere to internal service level objectives: this will enable an organization to be managed based on service level of the task and value to the organization versus the underlying system work-bin or channel. (3) increased agility throughout the organization: this is to enable an organization to continue investing in business applications, also by empowering business users to sense and respond through a highly configurable environment, without having to engage in large scale IT projects time and again. (4) Increase visibility into operational performance and compliance: this is through a comprehensive set of processes and task-based statistics that provide insight into the already defined organizational key performance indicators. According to developers

of the iWD, the system can work in concert with existing organizational software applications such as Enterprise Resource planning (ERP), Business Project Management (BPM), Customer Relationship Management (CRM) as well as home-grown legacy systems.

The above examples (Winstantly 2004, Aldea, Lòpez, & Bañares-Alcántara 2000, Genesys 2012) have demonstrated that an organization such as KRA may effectively manage all its staff, customer services resources, business processes and service delivery across the board. However, based on this study, such intelligent agents do not specifically address the issue of optimizing the ICT staff allocation for the provision of ICT services support in organizations. In order to address these shortcomings, 1 have considered the strengths and limitations provided in the already developed systems and my research has been guided by the four objectives as stated in Chapter 1 of the study. The fourth objective specifically aims to develop an intelligent agent prototype for optimizing staff allocation in ICT services support at KRA.

In summary therefore, Intelligent agents can be applied in various platforms to help answer many questions including: administrative management, collaborative use, commerce, mobile and desktop applications, information access and management, messaging such as chat and e-mail, mobile access and management and finally, network management just to mention but a few. We can delegate intelligent agents to handle various types of problems and the outcome of this is that we get the right information at the right time, without having to do it ourselves (Hopkins, 2016). Based on this premise, the study provides the following conceptual framework used

for the development of the Intelligent Agent intended for optimizing allocation of staff to specifically support the KRA's ICT services.

2.4 The Conceptual Framework of KRA Intelligent Agent

The KRA Intelligent Agent was conceptualized using three main factors: organizational factors, competences and goals. These factors are summarized in the following conceptual framework shown in Figure 2.3.

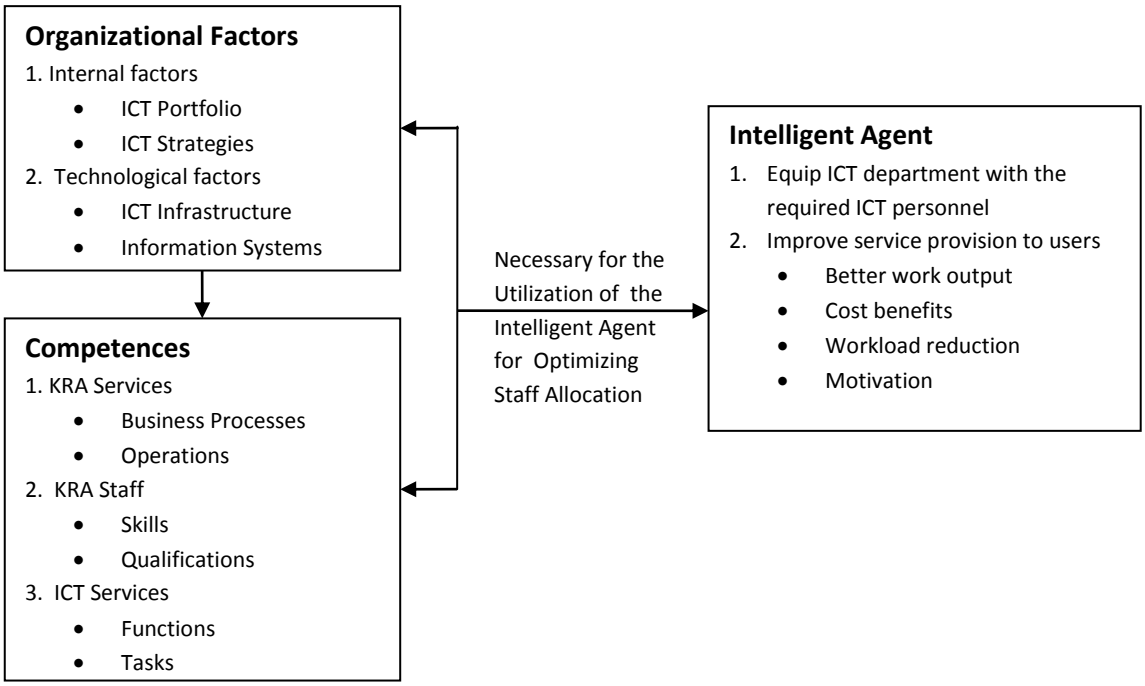

Figure 2.3: A Conceptual Framework for the Intelligent Agent

First, it was necessary to consider the organizational factors that included both internal and technological factors so as to facilitate the provision of ICT services platforms. The main components necessary for the successful utilization of intelligent agents included the current status of KRA's ICT portfolio, the extent of the ICT services required and the implementation of organizational strategies. A combination of these factors leads to evident outcomes among end users and stakeholders in the form of demonstrable competences in KRA services support and facilitation of

communication for both internal and external ICT users. Furthermore the conceptual framework espouses that the intelligent agent was used to equip the ICT department with the required ICT personnel who based on their competencies, qualifications and skills, provide the necessary support services that lead to the achievement of KRA's vision and mission in terms of better work output, cost benefits, motivation and workload optimization.

According to numerous studies (Award 2001, Bruton Consultancy 2004, Erickson 2009, Kendall & Kendall 2013) research has shown that for ICTs services to be accessible and satisfy the needs of a particular user group, they must take into account the characteristics and needs of the user group to enable them to perform efficiently. That being said, it is virtually impossible to create an effective organizational control system without the use of ICTs. The underlying phenomenon is a major concern and therefore, this study builds on and contributes to work in the application of intelligent agents in optimizing staff allocation for ICT services support.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter describes the research methodology used and the procedures for requirements elicitation based on the study objectives. It presents the research method and design used and further explains the requirements elicitation techniques and system methodology employed in the study.

According to Kumar (2011), research methodology is considered as a science of studying how research is done scientifically and is concerned with systematically solving the research problem. The study employed the qualitative approach that is great for answering the 'why' and the 'how' questions and getting to the bottom of complex issues (Denzin & Lincoln, 2008). This method involves collecting detailed information from a fairly small number of people who produce rich, insightful information by for example using open-ended questionnaires and interviews. This perspective placed more emphasis on the KRA ICT department staff to provide their own explanations of their experiences and situations.

3.1 Research Design

Research design refers to the overall strategy that you choose to integrate the different components of the study in a coherent and logical way, thereby, ensuring you will effectively address the research problem (Gorard, 2013). The study adopted qualitative case study research design for data collection and actualized through experimental prototyping for the Intelligent Agent development**.** According to

Dawson (2009), experimental prototyping is particularly suited where the problem is not well defined in terms of user requirements. This is an experiment where the researchers manipulates one variable, and control/randomizes the rest of the variables as conceptualized in Chapter 2 of this study. As presented in Figure 2.3, there are three variables: (1) Organizational factors that include KRA's internal and technological factors, (2) Competences that include KRA services, KRA Staff and ICT services and (3) Intelligent Agent variable that is used to equip the ICT department with the required ICT personnel dn. It has a control group, in this case the ICT staff; the subjects have been randomly assigned between the groups, in this case only selected ICT functions are used to represent the tasks and finally, the researcher only tests one effect at a time, for this study, one staff is allocated a particular task at a given time based on prioritization and availability of the required staff. The study sought to test an idea to determine the effect on an outcome. This meant that the researcher was generating feedback about what is good and what is bad about the idea, then the new insights were gathered from the users and the requirements later used to develop an Intelligent Agent prototype that would influence the allocation of tasks to for ICT services support.

3.1.1 Population and Sampling

As mentioned earlier in section 1.4 in Chapter 1, the study was carried at Kenya Revenue Authority headquarters in Nairobi. The population comprised of 4,500 employees of KRA whereas the sample comprised of a total of 135 staff working in KRA mainly drawn from four departments namely: ICT Department, Support Services Department, Domestic Taxes Department and Human Resource Management Department.

3.1.2 Sampling Method and Sample Size

The study used the judgment sampling or purposive method to select the sample for the study. This is a form of non-probability sampling and is more often applied in case study because it is believed to be a rich source of data of interest (Patton, 2002, Yin, 2009). The sample was drawn from a diverse category of service facilitators, providers and implementers based on the different ICT functions that facilitate the running of KRA as a whole. Nonetheless, every effort was made to ensure that a representative sample size was identified. Purposive sampling was used to get the different functional units of the ICT Department that perform distinct ICT functions and also to select eligible group of respondents from each of the departments considered to be sufficiently informed on the subject matter due to their nature of work. These were (1) Senior Deputy Commissioners in-charge of the overall running and management of departments in particular all the business and services operations. (2) Heads of ICT Divisions and Sections the facilitators of the provision and maintenance of all ICT support services in KRA. (3) Service Providers who are the actual implementers and perform the intra and inter-departmental ICT support services to customers and other KRA staff. Further, purposive sampling was employed to identify the information-rich staff recommended by the Heads of Divisions and Sections in order to enable the researcher cover sufficient areas of application and usage of ICTs. Consequently, the sample size was arrived at as shown in the following Table 3.1.

Table 3.1: Selection of Sample Size

1. ICT DEPARTMENT				
Category	**Roles**	**Accessible Sample**	**Selected Sample**	**Percentage**
Senior Deputy Commissioner	- In-Charge of the ICT department	1	1	100%
Heads of ICT Divisions 1. Service Management 2. Technical Management 3. Business Systems Operations 4. Projects Management Office	Manage staff and oversees the maintenance of all ICT resources and services	4	1	25%
Heads of ICT Sections: 1. Business Systems Development 2. Database Administration 3. Information Systems Security 4. Infrastructure Management 5. Operations 6. Projects Management 7. Quality Management 8. Regional Support 9. Service Desk 10. Service Monitoring	Facilitate provision of staff, ICT resources Provision and maintenance of ICT services	10	6	60%
Other Staff: (referred to by DC Service Management 1. Services Providers	- Offer intra and inter-departmental ICT services to customers and staff	107	10	9.3%
2. SUPPORT SERVICES DEPARTMENT				
Senior Deputy Commissioner: Marketing and Communication	- In-Charge of the department	1	1	100
Other Staff (referred to by the SDC, Marketing and Communication - Call Centre Attendants - Mobile Clinics Services - Service Desks (Huduma Centers and - County Tax Support Centers)	- Utilization of ICT-based services to taxpayers/customers and provision of customer awareness through mobile clinics, tax support centers	20	2	10%
3. DOMESTIC TAXES, OPERATIONS DEPARTMENT				
Deputy Commissioner, Head of Operations, Domestic Taxes Department	- In-Charge of all the organization's revenue collection operations	1	1	100%
4. HUMAN RESOURCE MANAGEMENT DEPARTMENT				
Senior Deputy Commissioner	In-Charge of hiring, recruitment and deployment of staff to departments	1	1	100%
TOTAL		**135**	**23**	**17%**

The three categories of KRA staff were purposively selected to focus on perspectives and were therefore deemed to be a sample of those who were known to have an experience in the phenomenon of interest. As mentioned earlier, purposive sampling was used to select the study respondents at KRA. A total sample size of 23 KRA staff

participated in the study. The DC, Service Management and the Projects Manager were the key informants selected from the sample size. They were both interviewed to get an in-depth exploration of their individual experiences. In order to build this sample, Kumar (2011) recommends the purposive sampling technique to locate subsequent participants or settings very different from the first. This was accomplished in two ways: the first was to make the initial contact with the key informants who in turn pointed to the information-rich cases. The second technique was snowballing, that is, the researcher began with initial respondents who in this case were the DC, Service Management and the Projects Manager, through the process of interview, who were asked to suggest information-rich cases as well as the characteristics and issues that needed further inquiry in ICT services. For this study, the two key informants subsequently referred the researcher to the other staff in the ICT department who were deemed to be information-rich in their departments and or sections.

3.1.3 Pilot Study

The researcher undertook a pilot study prior to the main study for the purpose of testing the research instruments. This study was conducted at the Eldoret Station based in the Rift Valley Regional Office. The researcher mainly sought to find out the structure of the ICT department, the functions of each section and the staff working in the sections. Thereafter, the researcher made the necessary amendments on both the interview schedules and the questionnaires administered during the pilot study.

3.1.4 Requirements Elicitation Techniques

The techniques used for requirements gathering consisted of interview schedules with semi-structured interview, open-ended questionnaires and documentary evidence as described here below.

3.1.4.1 Interviews

The researcher made numerous visits to KRA headquarters in order to create an opportunity for formal discussions with the key informants and other ICT Department and KRA staff. A number of staff including the Senior Deputy Commissioners of ICT, Human Resource, Domestic Taxes and Support Services together with the Project Manager and heads of ICT sections were considered to be interviewed. However, due to some organizational policies and restrictions to engage the public on organizational matters, the researcher was only allowed to interview three members of the ICT Department using semi-structured interview approach. Selection of the key informants was based on a person's role in the institution, their influence and attitude towards ICT as perceived by the ICT Manager. As much as possible interviews were planned to cover a wide range of interests: responsibilities, working experience, challenges encountered, the role played in the ICT structure and attitude towards use of application software such as intelligent agents.

The use of semi-structured interviews (*see Appendix III-IV*) provided some degree of flexibility. Interview schedule (*see Appendix III*) had already been used in the initial contact with the Eldoret Station Rift-Valley Regional offices during the pilot study to evaluate the interview protocol. Only one interview session (with the Projects Manager) was taped subject to the permission of the interviewee.

3.1.4.2 Semi-Structured Questionnaires

Semi-structured questionnaires (*Appendix V-VII*) were applied to establish the ICT personnel requirements hence aid in developing an intelligent agent for optimizing staff allocation for ICT services support at KRA. The questionnaires were administered to: (1) Senior Deputy Commissioner, Support Services, Marketing and Communication, (2) Senior Deputy Commissioner, Human Resource (3), Senior Deputy Commissioner, Domestic Taxes Department and (4) to the Heads of ICT Department Sections and other end-user staff.

3.1.4.3 Documentary Sources Review

In addition to interviews and semi-structured questionnaires, the researcher reviewed various supplemental documents provided by the key informants regarding the ICT Department in particular, KRA Corporate Plans (Kenya Revenue Authority 1st, 4th Corporate Plans), ICT Strategic Plans (Kenya Revenue Authority Strategic Plans 2008/2009, 2009/2010, 2011/2012), ICT Policy, ICT Structures and KRA Technical documentations, Revenue Administration Reforms, among others. These secondary materials were used to develop background information for the study as well as to understand the profile of KRA and the ICT Department's overall functions and services.

3.1.5 Requirements Validation Techniques

The study used various validation techniques to demonstrate that the requirements defined the system that the users really wanted. This was achieved by (1) requirements review which entailed a systematic manual analysis of the requirements through frequent communication and feedback (2) experimental prototyping which

entailed using an executable model of the system to check requirements as demonstrated in Figure 5.1 in chapter 5 and (3) test-case generation which entailed developing tests for requirements to check testability as further demonstrated using the IF THEN statements in chapter 5.

3.2 System Development Methodology

According to Dawson (2009), a system development methodology refers to a framework used to structure, plan and control the process of developing an information system. Building the Intelligent Agent entailed analyzing the ICT staff problems with existing information systems, assessing staff information needs, selecting appropriate technology and re-designing procedures and jobs. This study employed the Experimental Prototyping Methodology.

3.2.1 Experimental Prototyping Approach

Prototyping is an approach to software development that requires developers to construct a working representation of the system. Prototyping approach is based around the notion of Rapid Application Development (Valacich, George, & Hoffer, 2012). Pressman & Maxim (2015) defines prototyping as creating an initial version of a software system that is used to demonstrate concepts, try out design options and generally, used to find out more about the problem and its possible solutions. This approach was deemed relevant to the study since the system stakeholders could experiment with the prototype early in the software development process in particular, during the requirements gathering and design specifications. Some practitioners however, advocate prototyping as a complete alternative to the Systems Development Life Cycle. For example, Denham & Denham (2001) observe that prototyping

significantly reduces the time between requirements determination and delivering a system. This therefore, implies that current system requirements for the KRA Staff Allocation Intelligent Agent were more accurately reflected in the final product. The model was therefore used to explore particular system solutions and to support the users work through the user interface.

According to Sommerville (2010), this methodology is organized as a set of tools that allow data to be created, searched, displayed and presented in forms of reports. The following diagram illustrates the stages of Prototyping.

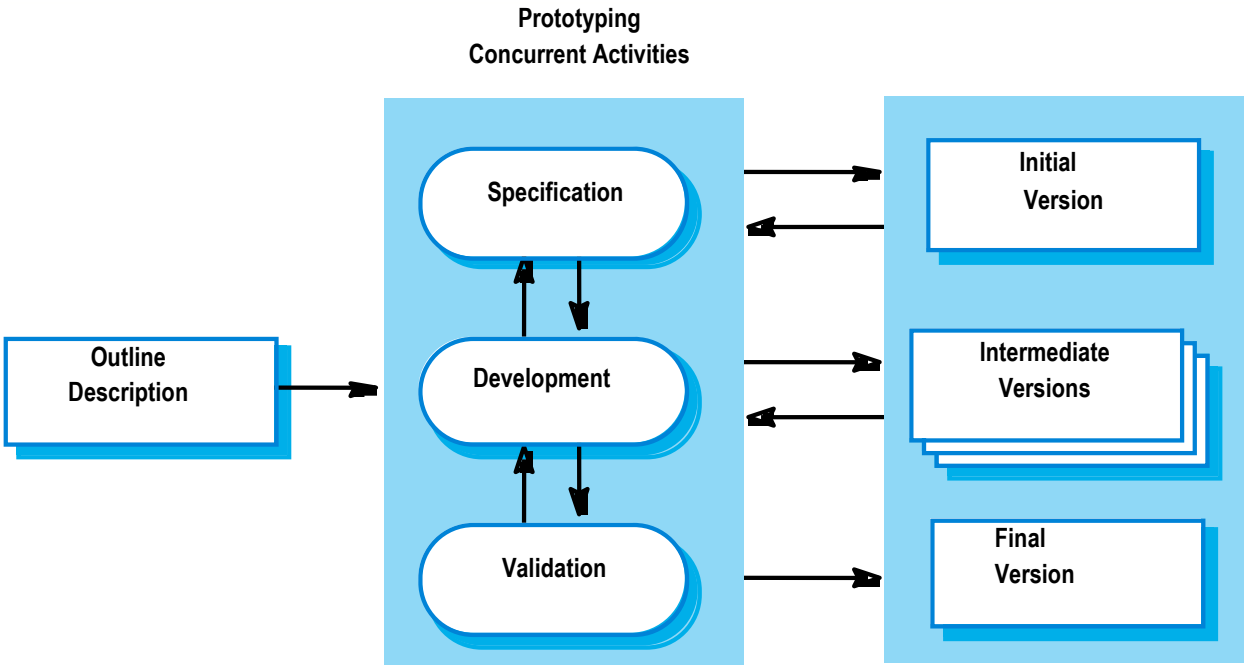

Figure 3.1: The Prototyping Process (Source: Sommerville, 2010)

The process entailed: (1) *Concurrent processes*: there was no detailed system specification, design and implementation of the system since all these activities were done concurrently. (2) *Incremental development*: the system was developed in series of increments where users were involved in specifying and evaluating each step, from

the initial to the final versions. The researcher allowed changes from time to time as suggested by the KRA staff and other new requirements to the system as perceived by the researcher from the findings. (3) *Cooperation*: customer collaboration was very important since a representative of the end-user of the system was always consulted at each stage. The ICT manager and his representative were readily available to respond to comments and provide further guidance in developing the system. (4) *Iterative development of User Interface*: the user interface design was created by placing and linking modules on the interface.

The main advantages of adopting the Experimental Prototyping approach were twofold. Firstly, there was accelerated delivery of ICT staff services whereby the staff was able to see their requirements in practice and also could specify changes to be incorporated in successive increments. Secondly, there was a lot of ICT staff engagement with the intelligent agent since the staff could provide feedback for the system thus providing a commitment to the development of the intelligent agent. Later on in Chapter 5, I have demonstrated how this approach was achieved using the bottom-up software development approach.

3.3 Ethical Considerations

According to Fraenkel & Wallen (2003), ethics is all about what is right or wrong. In this regard, the researcher obtained the necessary research permit to conduct the study (*see appendix I and II*). However, prior to this, the researcher had already been given consent by the Commissioner General, KRA for the research setting. The subjects' consent was obtained both in verbal, electronic and written communication and subsequently, all notifications and appointments for interviews with the key

informants and administration of questionnaires to other participants was made in advance and scheduled at the KRA headquarters. In addition, the researcher treated all the data obtained with utmost confidentiality including keeping private the names of all the organizational subjects involved in the study as outlined in the research permit. Lastly, all the data collected was treated with utmost confidentiality and the research findings were presented honestly and objectively.

CHAPTER FOUR

DATA PRESENTATION AND REQUIREMENTS IDENTIFICATION

4.0 Introduction

This chapter gives the data presentations and requirements identification for the Intelligent Agent's prototype. I used interviews and open-ended questionnaires (*see appendices III-VII*) supplemented by documentary review to elicit requirements from the respondents. A total of 135 KRA staff members comprising: 3 Senior Deputy Commissioners, 5 Deputy Commissioners, 10 Section Managers, 117 service providers and end-users were considered as the sample population in the research (*see Table 3.1 above*).

4.1 Distribution of Respondents by Category

The researcher designed and distributed four (4) categories of open-ended questionnaires. The key informants comprised of three (3) senior managers who were successfully interviewed. The face-to-face interviews were considered most appropriate since the three senior managers were the key people who oversee the day to day operations of the ICT department. The interviewees were each approached at different times prior to booking of appointments for each and their views and contributions were considered valuable and of very much significance to the study. They shared very important information about the current situation at the ICT department and also pointed out the challenges facing the department in relation to human capacity and provision of ICT services. They further provided their opinions on how to improve the operations at the ICT department. The selection of the sample size was considered as presented in Table 3.1 in the previous chapter. The Table 3.1

indicates that out of the 135 accessible sample, a sample size of 23 respondents was selected as follows: 1 head of ICT department, 1 head of ICT division, 6 ICT Section Heads, and 10 ICT technical and support staff who were drawn from the following cadre of staff: Network Administrator, Database Manager, ICT Security Manager, Systems Administrator, Application Developers, ICT Support Staff, Data Entry Clerks, Mobile services staff and Call Centre Attendants. The other category was drawn from end-users who mainly comprised of 3 senior managers drawn from the Support Services Department, Domestic Taxes Department and Human Resource Department and 2 Clerical Staff working in the Support Services department. The selected sample size was considered either for interviews or administering of questionnaires.

4.2 Response Rate

All the key informants: SDC, ICT, the DC, Service Management division together with the Projects Manager were successfully interviewed thus providing a 100% response rate for these respondents. Out of the 20 questionnaires administered, only 16 of them were returned duly completed this representing an 80% response. This response rate is considered adequate for the study according to Cresswell (2014) as the author recommends 3-5 participants for case study research. Interview schedules for the three managers were considered most appropriate since these managers were the key informants as they were involved in managing and facilitation of the ICT staff who offer day to day operations and ICT support services to KRA in general. The interviewees were approached as individuals (at different times based on appointments) and each was assured that their views and contributions were valuable

and of significance to the study. The preliminary investigation of the study is presented in the following sections.

4.2.1 ICT Portfolio at KRA

The first research question required the respondents to describe the current situation of ICT Portfolio including the infrastructure and support tools and policy documents. This information was sought from the three key informants including the SDC, ICT, DC, Service Management and the Projects Manager who were responsible for managing and maintaining all the ICTs and their related policy documentation at KRA. The key informants mentioned a collection of various ICTs mainly drawn from five areas namely: hardware, software, information systems, and network infrastructure and policy documents. The DC, Service Management further reiterated that "*it is very important to have relevant and adequate ICT support tools and services so as to efficiently support the business, operations and all ICT projects in order to meet KRA's productivity and customer satisfaction*."

Table 4.1 provides a brief overview of the collection of different automated systems in use within the Authority that improve the overall efficiency of administration and revenue/tax collection. As shown on Table 4.1, KRA had adopted a range of information systems to support its business and operational activities.

Table 4.1: Types of KRA Business and Support Service Systems

A: Information Systems for Revenue Collection		
No.	**Name**	**Brief Overview**
1.	**TRADEX/SIMBA System**	The SIMBA system was implemented in 2005 as an online cargo clearance system aimed at improving efficiency and reducing congestion at the port.
2.	**Electronic Cargo Tracking System (ECTS)**	The ECTS project was a joint initiative between KPA (Kenya Ports Authority) and KRA. It is currently in the piloting phase. The system monitors/tracks the movement of cargo from points of entry at the Kenyan borders until the goods cross the border to their intended destination.
3.	**Integrated Tax Management System (ITMS)**	This is the electronic registration service that was officially launched on 29th January 2009.The system currently allows taxpayers to apply online for Personal Identification Numbers (PIN), register online for a variety of tax obligations i.e. VAT, PAYE, Excise duty and Corporation tax and as well as online filing of returns.
4.	**VAT System**	The VAT system has automated the following functions: tax refunds management, turn over tax management, withholding tax management, receipt and recording of tax related payments by taxpayers, processing of VAT returns, processing and management of tax waivers and ledger card management, among others.
5.	**Income Tax System**	The Income Tax system has automated the following functions: income assessment management (for both companies and individuals), receipt and recording of tax related payments by taxpayers, PAYE management, audit management, VAT remissions and exemptions management and EFT management, among others.
6.	**Common Cash Receipting System (CCRS)**	CCRS provides a common platform for payment of taxes. It enables taxpayers pay their taxes at any of the KRA offices and provide a platform for integration with bank systems.
7.	**Integration of VMS with SIMBA System**	Motor vehicle registration at the port and the Container Freight Stations (CFS) in Southern region was integrated with customs processes to speed up the clearance of imported vehicles.
8.	**iTax**	This is the implementation of ITMS re-launched and named iTax in November 2014. The portal https://itax.kra.go.ke is expected to deliver tax payment through common electronic

		cash receipting system. It is easy to navigate and addresses challenges faced by taxpayers in current systems.
B. Information Systems to support administrative and business operations		
1.	**Driving License Management System (DLMS)**	DLMS was implemented to enhance the efficiency of processing driving licenses.
2.	**Vehicle Management System (VMS)**	VMS is used in processing of log books.
3.	**KOVIS**	KOVIS is used for indexing/storage of scanned logbooks. The owner of the vehicle retains the hardcopy of the logbook, while KRA retains the soft copy.
4.	**Audit System**	This is the latest electronic audit service that was officially launched on 18th June 2015 to enhance tax auditing.
5.	**KRA Databases (web-enabled and business intelligence)**	This is a collection of related and interrelated information typically describing the activities of KRA including staff, taxpayers, procedures, information systems, business processes, operations, government agencies and other stakeholders. The web-enabled databases provide an entry practice of updating data to real time update of business data. This results to availability of information through reports to assist in timely decision making for management. This is used to guide the organization to take early remedial action before they escalate to serious issues. The business intelligence database is crucial to the Investigation and Enforcement Department.
6.	**Enterprise Resource Planning (ERP) System**	The ERP system was implemented to support administrative support functions in the Authority. The system was adopted using the Free Open Source System (FOSS).It is an integrated application with a unified database that cuts across the following support departments within the Authority: Finance, Human Resources and Procurement.
7.	**Software Systems**	System Software including: Linux, versions of Windows Operating Systems, Network Operating Systems, Android, Malware, etc. Application Software including: Lotus Notes, Office Applications, Windows Office applications, Linux Office applications, MS Visio, MS Project, Control-es, etc.
8.	**Oracle Discoverer**	This is a system mainly used in report generation of data and information from the various DTD and RTD systems. These systems enable users/managers to scrutinize and analyze tax

		related information so as to: make informed decisions, make projections on estimated revenue collection, study trends/patterns in revenue collection, analyze performance of departments and their respective stations based on their revenue collection and analyze revenue collection and tax compliance levels according to taxpayers and thus facilitate the annual taxpayer reward programmes.
9.	**Electronic Tax Registers (ETRs)**	The ETR system is used as an enhancement to other systems by interconnectivity to the KRA central server through GPRS to facilitate two-way communication between taxpayers and KRA and to facilitate faster VAT refund processing. ETR is an enforcement tool that creates a clear invoice trail, making it much easier to detect and deter tax evaluation thus aimed at addressing the perennial problem of poor record keeping for business transactions.
10.	**KRA eStamp**	This is a real-time system for monitoring of the production of excisable goods done to reduce on the counterfeiting of stamps.
C. Support Services Systems for Marketing KRA Business Processes		
1.	**KRA Contact Centre/Call Center**	The Authority has set up a state of the art Call Centre. The centre facilitates communication with customers via a multiplicity of communication avenues which include: telephone, short message service (sms), fax, e-mail and delivered physical mail services. It also provides for a system of tracking taxpayer queries to ensure that they are dealt with in a timely manner. It is a one-stop information center where customers and taxpayers obtain responses to their enquiries promptly. Callers are also able to access self service facilities through the Integrated Voice Response systems of the contact centre. The purpose of this centre is to integrate all existing service desks including all channels of communication as well as contacts onto one platform. The centre thus allows for efficient management and tighter controls on monitoring and tracking of all channels of taxpayer communication with the Authority and ensures that consistent responses are given.
2.	**Huduma Centres and County Tax Support Centres**	The purpose of these centres is to provide an extension of KRA's iTax support services presence in various counties. The centres make it easier for taxpayers to access various tax administration services. It allows one to register and file returns, make payments, apply for Tax Compliant Certificate and lodge

		a refund claim online.
3.	**KRA Website**	This is an electronic collection of KRA's information systems with the domain address (www.kra.go.ke). Also comprises of various business processes, information resources and organizational information on staff structures that conveys the information of KRA to all over the world and allows staff, taxpayers and other stakeholders to engage with the Authority. The website, a makes it easier and cheaper for customers to access vital information conveniently. Further, the website allows users to download updated legislation on revenue Acts, public notices, taxpayers' charter and corporate plans, among other documents. It also provides current information for advertised tender and job opportunities. The interactive website also allows customers and taxpayers to forward questions, which are responded to by appropriate KRA departments within the defined time limits.
4.	**E-Learning**	KRA has adopted an e-learning programme, an initiative of the World Customs Organization (WCO) that offers on-line courses and exercises available in the form of interactive multimedia training modules to selected staff members. The WCO is specialized in professional training on income tax and customs matters.
D: ICT Marketing Service		
1.	**KRA Mobile Clinics**	This is a marketing service that includes mobile clinics to reach taxpayers at the grass-root levels. Used to create awareness campaigns especially when handling the informal sector where the number of taxpayers is higher than the potential revenue.
E: ICT Technical Support Tools		
1.	**KRA ICT Infrastructure Support Services**	This include a Network Management and Monitoring Solution for: - LAN and WAN back-up links and solutions, upgrades in all identified stations - WAN equipment to minimize infrastructure downtimes - Data centre consolidation and virtualization of systems - Voice over IP (VoIP) in identified stations - CCTV in KRA operational areas - X-Ray Cargo scanners at the Kilindini Harbour - Commercial power back-up solutions in all KRA departments - Network UPSs to provide backup solutions

		- Technical support (inspection, installation and maintenance as applicable) for ETR and cargo scanners - Authority's link to the fibre installations taking place countrywide - Disaster Recovery site in various operational areas

When asked whether KRA supported a single or a multi-vendor architecture, the SDC, ICT disclosed that all the systems mentioned above ran on a multi-vendor architecture that was made up of hardware, software and networking infrastructure (including networking and internetworking devices and services such as GPRS, KRA Cloud, and the Internet). This as indicated by the SDC, Service Management implies that ICT Department must ensure that all systems are tested before deployment and changes in both hardware and software must be approved before installation. In addition, the department must at all times also ensure that all ICT related resources are available to both the internal and external stakeholders.

Further the study sought to find out whether the department had any strategy and implications for the current and future ICT service support requirements. The SDC, ICT pointed out that KRA had various ICT strategies in form of policy documents, strategic plans and government policies. The ICT Manager further revealed that KRA ICT department implemented the new ICT structure based on ITIL framework since 2005. However, it was noted that from the documentary review (Kenya Revenue Authority 4th Corporate Plan) that since then, the department had re-organized and re-

aligned business processes and also developed various Online Applications to aid inter-process dependencies. From document review analysis, the study revealed that ICT department was mandated to: (1) Review procedures in line with best practices (ITIL, COBIT, etc.); (2) Develop Key Performance Indicators (KPI) to measure and monitor performance of processes; and (3) Review the current structure to ensure more efficient service delivery. Documentary analysis further revealed that the above requirements were adequately met and currently, a number of ICT systems have been used to enhance revenue collection and facilitation of administration support services within the Authority.

4.2.3 The Current ICT Staff Allocation System at KRA

The second research question sought to establish the current ICT staff allocation system utilized in the KRA's ICT department. In order to answer this question, the study sought to find out (1) the main role and functions offered by each ICT division/unit and (2) the opinion of each respondent on how each division/unit was allocating staff for ICT services support for the business processes and operations in terms of meeting KRA's mandate. As pointed out earlier, the ICT Department structure comprises four (4) divisions namely: Service Management, Technical Management, Business Systems Development and Projects Management respectively. The four divisions are further divided into ten (10) functional units or sections. The divisions and sections are overseen by the ICT Manager. Based on this structure, responses from the DC, Service Management and the heads of sections indicated the following as the main roles of the ICT Department:

1. To identify, implement, manage and support ICT projects to deliver systems and processes to the Authority's stakeholders;

2. To ensure efficient and effective delivery of all KRA business operations;
3. To enhance information systems, business processes and ICT system availability and reliability with the Authority's stakeholders;
4. To implement policies and strategies geared towards re-aligning procedures and business processes in support of the Authority's corporate objects; and
5. To coordinate and manage quality management systems to the Authority's stakeholders.

The specific ICT processes and responsibilities of each division/unit are further summarized in the following Table 4.2.

Table 4.2: Scope of Responsibilities of ICT Functional Units

Division	**ICT Process and Responsibilities**
1. Service Management 2. Technical Management 3. Business Systems Development 4. Projects Management	The processes include: • Planning • Organizing • Staffing • Directing and Controlling The main responsibility is to over-see the overall functions, operations and services of the department
Section/Unit	**ICT Process and Responsibilities**
1.Service Desk	The processes include: • Customer Relationship Management • Business Perspective • Feedback • Performance Reporting The main responsibility is to be in-charge of all enquiries made by staff, customer and other stakeholders
2.Regional Support Teams	The processes include: • Infrastructure support • applications support The main responsibilities include: incident and problem management, training and release management, business perspective, relationship management, feedback and performance reporting
3.Business Systems Development	The main process include: • Business Applications Support The responsibilities involve: analysis (requirements), event management, incident and problem management, training and release management, application construction, application design, application development, deployment and maintenance.
4.Service Monitoring	The process involves service monitoring. The responsibilities include: ✓ Monitoring standards definition ✓ Monitoring of service components ✓ Performance monitoring, evaluation and reporting • System administration Process The responsibilities include: ✓ Installation and deployment ✓ Performance monitoring, tuning and improvement • Data centre management Process ✓ Management of data centre • Research and development
5.Infrastructure Management	• Infrastructure design and planning • Infrastructure deployment • Technical support ✓ Incident management ✓ Problem management ✓ Implement (train and release management)
6.Database Administration	• Installation • Performance monitoring, tuning and improvement

	• Back-up, archiving and restoration ✓ Database administration and maintenance
7.Quality Management	• Quality Assurance ✓ Applications and Systems Software ✓ Infrastructure components • Change control ✓ Configuration management ✓ Change management
8.Projects	• Project management ✓ Project evaluation and selection ✓ Project planning ✓ Project implementation ✓ Reporting • Strategy and performance management ✓ Strategic planning and implementation ✓ Performance monitoring, evaluation and reporting
9.Operations	• Human Resource for ICT ✓ Human Resource capital development ✓ General administration services ✓ Communications ✓ Business automation committee meetings, monitoring and reporting • Liaison ✓ Financial management ✓ Quality Management Systems ✓ Audit recommendations • Planning ✓ Strategic planning ✓ Financial management ✓ Capacity management ✓ Availability management ✓ IT service continuity management ✓ Supplier management ✓ Service level management (including service catalogue management)
10.Information Systems Security	• Security incident management • Security risk management • Integrity assurance • IT/IS security, compliance and assurance • Policy and standards • Forensic and investigation ✓ General information systems and ICTs security management

The study findings further revealed from documentary reviews (Kenya Revenue Authority Revised ICT Structures, 2009, 2010, 2011, 2012, 2013, 2014) that each of the four divisions and functional units was responsible for the overall efficient and

effective delivery of ICT services in different ways both at the headquarters level and regional level.

According to the ICT Manager, the process in the current ICT staff allocation system entails:

1. The SDC, HRM receives requests for ICT services support from various departments including the ICT Department.
2. The SDC, HRM authorizes and approves deployment of ICT personnel as per the departmental requests and forwards the report to the SDC, ICT department.
3. A customer/user requests for assistance through the help desk.
4. A customer/user receives an email from the ICT help desk indicating the work order number to use to make follow-ups.
5. The request is then submitted to the SDC, ICT Department to provide the necessary ICT personnel.
6. This request is then submitted to the DC, SM who is required to allocate the necessary staff to the requesting departments and users.
7. The DC, SM then scrutinizes all requests' from the service desk in reference to the ICT Structure, in particular the current estimates, then checks on the prioritization of services and deployment of ICT personnel, among others.
8. Based on the nature of a customer/user problem, the DC, SM prioritizes the task to be performed.
9. The DC, SM then authorizes and approves deployment of ICT personnel as per the departmental requests and forwards the report to the SDC, ICT department who in turn forwards the information to the SDC, HRM Department for future reference.

10. The SDC, SM then allocates the task to the next available ICT personnel who will then contact the customer/user for a resolution.
11. The SDC, SM then submits the details to the DC, ICT and keeps records of all the transactions and also makes a follow-up to get to know if a customer/user was satisfied with the support services.

It is evident from the current staff allocation system that ICT support services could be delayed, a fact alluded by the ICT Manager. When further asked to comment on how the ICT service functions for each unit was adequately supported, and whether the functions were relevant to the services provided in their respective sections, it was the opinion of the Heads of ICT Sections that it was possible to support the services as the department's functions was based on the ITIL best practices. However, all the section heads recognized that there was a lot of duplication and conflicting activities offered by the ICT department and as such some functions should be centralized whereas other functions should be dispersed over several locations.

All the respondents agreed that there was need to either centralize or decentralize the current functions in the ICT department. However, their opinions were varied as follows: the SDC, Service Management and the heads of Service Desk and Operations units suggested that the following functions should be centralized: Infrastructure management, Operations and ICT user support and maintenance. Further, all the three managers suggested that the Service Desk, Quality Management and Regional Support should remain decentralized as they provided distinct services to customers. However, it was the opinion of the DC, Service Management that Service monitoring and Service Desk units should be merged since all services requested at the service

desk required to be further monitored to ensure efficient service provision. On the other hand, the head of Regional Service Support suggested that the following functions had conflicting activities: incident management, service support for hardware equipment, troubleshooting of the routers and data centre management. His opinion was that the following functions should be centralized: Infrastructure management, ICT user support and maintenance, database administration and service monitoring units. All the respondents were in agreement that all the above mentioned service functions were key and relevant to the achievement of the departmental objectives. However, it was their view that there was need to adequately support all the functional units based on the ITIL best practices since some of the services were lacking the practices. In particular, the respondents pointed out that the staff and other stakeholders should be informed about all the services provided by each section in various ways including: conducting user awareness training, conducting sensitization, carrying out user/customer satisfaction surveys, posting issues and information on the organizational websites and lastly by responding to frequently asked questions on-line, all these geared towards efficient service provision as per the ITIL best practices.

Further, the key informants cited that it was necessary to address all the weak areas so as to ensure that the staff and customer service was timely and qualitative. In particular, respondents pointed out that the department should place emphasis and focus on areas that had greatest impact on staff and customer expectations. This, the key informants agreed could only be achieved by acquiring a team of ICT staff who possessed the required knowledge, skills and a positive attitude to effectively support delivery of the ICT services in the Authority. This too, was cited as a condition for implementation of ITIL best practices.

4.2.4 Challenges Hindering ICT Department

The third research question sought to find out the nature of problems hindering the ICT Department in the allocation of staff for the provision of ICT services support. When asked what challenges KRA ICT department was experiencing, the SDC, ICT, the DC, Service Management and the five heads of sections all revealed that generally, KRA had experienced problems that had been attributed to inadequate human resource in running and supporting the information systems, business processes and provision of ICT services. This was further observed through the documented customer engagement and feedback complaints. Documented evidence revealed that customers had from time and again complained about delayed service provision and/or expressed dissatisfaction with the Authority's business operations (Kenya Revenue Authority, 2010). Table 4.2 clearly depicts the situation of the inadequacy of human resource as one of the problems in the department.

Table 4.3: ICT Staff Structure at KRA

Staff Level	Roles	Position	Establishment	Current
1. Senior Deputy Commissioner	In-charge of Department	SDC, ICT Manager	1	1
2. Deputy Commissioners	In-charge of the various divisions in the department	DC, Projects Management Office	1	1
		DC, Service Management	1	1
		DC, Business Systems Operations	1	1
		DC, Technical Management	1	-
3. Senior Assistant Commissioners	In-charge of Sections	SAC, Service Desk	1	1
		SAC, Regional Support Teams	1	-
		SAC, Business Systems Development	1	1
		SAC, Service Monitoring	1	1
		SAC, Infrastructure Management	1	1
		SAC, Database Administration	1	1
		SAC, Quality Management	1	1
		SAC, Projects	1	-
		SAC, Operations	1	1
		SAC, Information Systems Security	1	1
4. Assistant Commissioners	In-charge of departmental technical and support services	AC, Service Delivery	14	12
		AC, Applications Development		
		AC, Projects Management		
		AC, Quality Assurance		
		AC, Liaison Service Monitoring		
5. Principal Assessors, Senior Assessors and Assessors	Provide technical and support services to staff and other users	Applications Developer Database Administrator ICT Project Support Information Systems Security IT Service Delivery Network-hardware Support Engineers Software Testing and Quality Assurance Strategy and Innovation Systems Administrator ICT User Support Business System Analyst Data Warehouse and BI Designer ICT Trainer	104	85
6. Clerical Staff	Offer clerical and support services to other staff	Data Entry Clerks Computer operators	15	13
TOTAL			**148**	**122**

From Table 4.2 above, it can be observed that the ICT Department had a total of 122 staff out of an establishment of 148 staff thus obviously confirming that the department had a deficit of 26 staff. The difference was quite substantial since the majority were lacking in the support services as per the Kenya Revenue Authority Revised ICT Structure 2011/2012 of staff requirements. This according to the DC, Service Management was attributed to among other factors: duplication of conflicting activities offered by the department, lack of skilled staff in some areas and lack of human resource strategies. The study further revealed that a number of staff did not possess the general required skills for ICT staff. This is a surprising finding considering the many ICT strategies and measures that had been put in place by the department such as: (1) use of the ITIL best practices which must consider the ICT staff skills in relation to their function areas (2) use of balanced scorecards to assess achievement and improvement of ICT services and (3) signing of performance contracts by all heads of sections to ensure effective delivery of services to the organization. The study findings therefore, indicated that the department had a human capacity challenge and therefore, this confirms the numerous complaints regularly cited by customers and staff.

4.2.5 Other Challenges Experienced

Many institutions continue to face a lot of challenges due to various factors ranging from the organizational functions carried out, to the organizational infrastructure to support such functions. Based on this observation, the researcher sought to find out whether the department experienced such shortcomings and the measures put in place to overcome the challenges. This was in relation to the fourth research question, which sought to find out how an Intelligent Agent can be used for optimizing staff

allocation to support ICT services in the department. Table 4.4 presents the respondents views on the current challenges experienced and the reasons for the same.

Table 4.4: Challenges experienced at ICT Department

Challenges	Manifestation
• Loss of faith in the service desk	✓ Manifested by reluctance to call/inform Service Desk choosing to seek other officers due to bureaucracy in work order escalation.
• Operations and administration of business/revenue systems	✓ Large number of complaints relating to business/revenue systems due to lack of maintenance of the systems.
• Delayed service provision	✓ Customers' engagement and feedback complaints which include delayed access to systems and service provision.
• Lack of /poor interventions	✓ Interventions and/or workarounds coming too late and becoming the ultimate solutions.
• Lack of proper prioritization of problems	✓ The latest problems become the hottest and complaints on the previous ones such as timeliness being static or entirely overlooked.
• Lack of monitoring	✓ Lack of efficient monitoring of critical systems and services
• Staff Rotation and Allocation of tasks to staff	✓ Lack of staff rotation based on their qualification and professional interest is an issue. Indeed this leads to difficulties in allocation of specific tasks to staff due having different working teams.

From the above challenges cited by the respondents, it was evident that the department was not an exception as per McDonnell's observations. With the current situation, the respondents agreed that it was quite difficult to decide the best person to perform a given task based on the functional units, staff profile and service requirements. However, the findings revealed that the department had come up with various strategies to address these shortcomings. For example, plans were underway to re-organize the ICT Department in order to distinctively address the pain areas with efficiency, speed and accuracy as a way forward to streamline the ICT department (Kenya Revenue Authority Strategic Plan 2011/2012).

4.3 Requirements Identification and Discovery

This process involved establishing the services that the users required from the system and the constraints under which the system should operate. This entailed frequent communication with the participants to determine ambiguity, specific feature expectations as was described by the ICT staff.

4.3.1 Analysis of the Current Staff Allocation System

The existing system was analyzed and from the investigations carried out, it was established that the current staff allocation system was based on the following main roles and functions of the ICT department:

a) To identify, implement, manage and support ICT projects to deliver systems and processes to the Authority's stakeholders;
b) To ensure efficient and effective delivery of all KRA operations;
c) To enhance information systems, business operations and ICT system availability and reliability with the Authority's stakeholders,
d) To implement policies and strategies geared towards re-aligning procedures and business processes in support of the Authority's corporate objects; and
e) To coordinate and manage quality management systems to the Authority's stakeholders.

In order to carry out the above stated functions, the ICT Department was guided by the following objectives;

1. To effectively provide timely feedback to all customers through undertaking of request and changes and producing performance reports to monitor and improve ICT service provision;

2. To manage all reported cases on all ICT services by providing immediate solutions/workarounds and proactively monitoring all incidents and ensuring timely and quality release of workarounds while ensuring feedback;
3. To provide special attention to business/revenue systems by ensuring that all cases are handled within the agreed Internal Standards with mechanism to monitor and report on performance;
4. To manage the computing infrastructure at the nerve centre (systems, applications, databases, communication);
5. To provide the essential administrative support and ensure that the information security (pro-active/reactive) while responding to any threats to provide the require confidence in the computing environment; and
6. To ensure timely delivery of planned projects in liaison with all stakeholders (ICT and business).

The staff allocation system was therefore, concerned with managing all ICT portfolio, infrastructure, staff and services in order to provide delivery of effective and essential support to both internal and external users as further presented in the following sub-sections.

4.3.1.1 Activities in ICT Services Support

Following were the activities that were a reflection of the operations held by the ICT Department staff in terms of staff allocation. They helped to conceptualize the flow of data within the system and the processing within the system. These activities include:

- ✓ Recording and tracking ICT services requests from internal and external users;

- ✓ Responding to users requests through feedback mechanism and placing special focus on Revenue Collection systems;
- ✓ Ensuring that changes are planned, recorded and executed timely;
- ✓ Providing ICT technical support to user requests to reduce complaints;
- ✓ Assess, monitor and report departmental performance to the identified stakeholders;
- ✓ Provide performance statistics to measure and monitor performance and
- ✓ Support all business processes and operations through effective ICT support services.

The main activities were captured using the following UML diagrams. The flows were first separated to get a clear view of the input, process and output cycle for each activity represented by the system.

1. The Service Desk receives enquiries from various departments and customers who require various ICT support services. This request is submitted to the DC, Service Management Division who is required to allocate the necessary staff to the requesting departments and users.

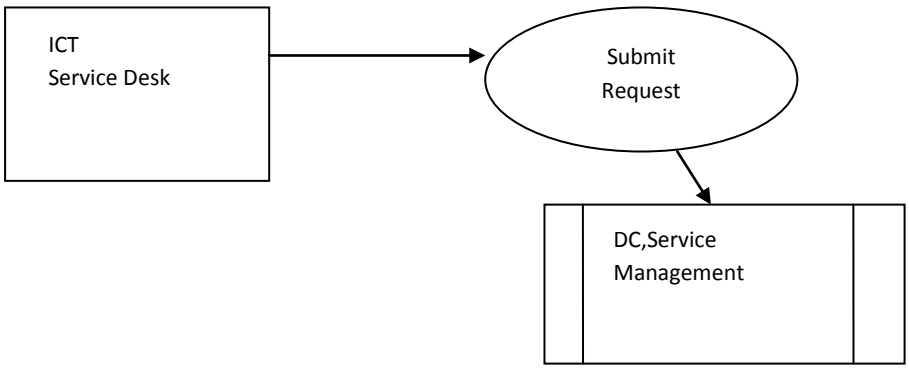

Figure 4.1: Request of ICT Personnel by Users

2. The Deputy Commissioner, Service Management Division scrutinizes the request in reference to the current ICT Departmental Estimates and approves or disapproves the same and prepares a report that is submitted to the SDC, ICT. A copy of the report is filed:

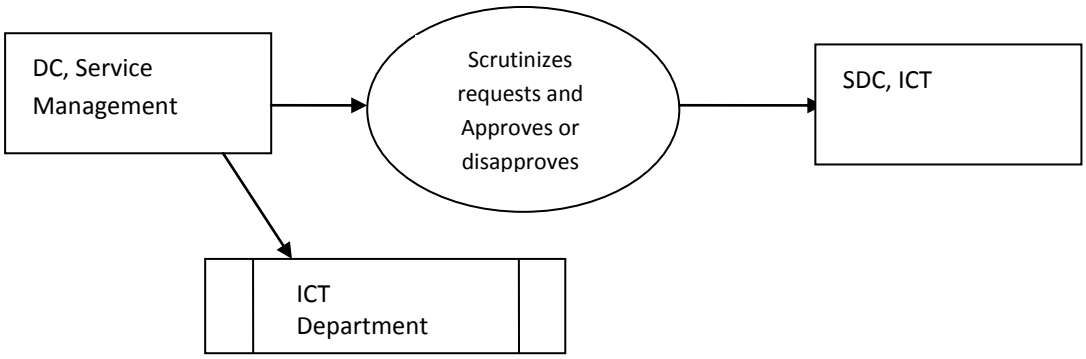

Figure 4.2: Feedback from Service Management Division

3. The DC, Service Management Division authorizes and approves deployment of ICT personnel as per the departmental requests and forwards the report to the SDC, ICT department who in turn forwards the information to the SDC, HRM Department for future reference. A copy of the report is filed:

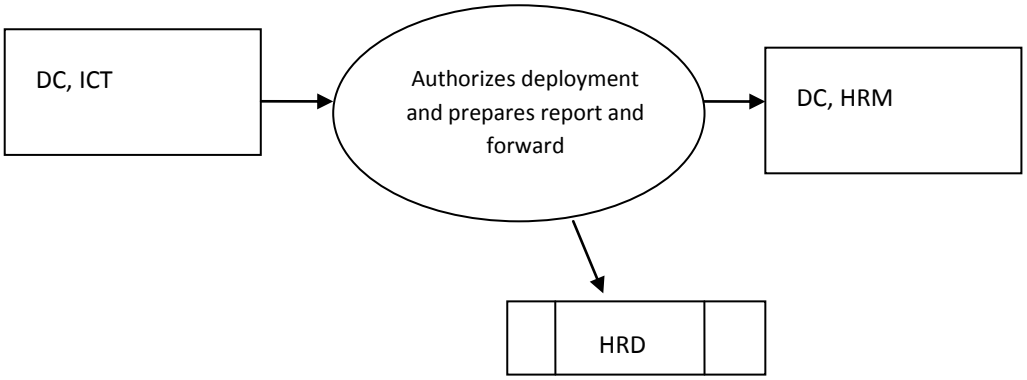

Figure 4.3: Authorization of deployment of ICT Personnel

4. The SDC, ICT allocates ICT personnel and keeps records of all the transactions.

4.3.1.2 Inputs to the System

The inputs to the current system were data pertaining to the departmental and/or user requests. These details included the department's and/or user's details, the number of staff required, date of request, tasks to be performed, duration of project/task, and the ICT support services required, among others. The request was then submitted to the SDC, ICT department.

4.3.1.3 Processing in the System

The process in the current system involved submission and scrutinizing of all requests' from the department and/or users in reference to the current ICT Structure, in particular the current estimates. The SDC, ICT Department then checks on the prioritization of the support services and either approves the deployment or disapproves the deployment of the ICT staff to honour the requests. Based on the processes outlined above, the ICT department and the HRM department decide whether there should be deployment of ICT staff, and if not so, a request may be approved to fill the vacancies based on the current year's estimates as presented in the logical dataflow diagram below:

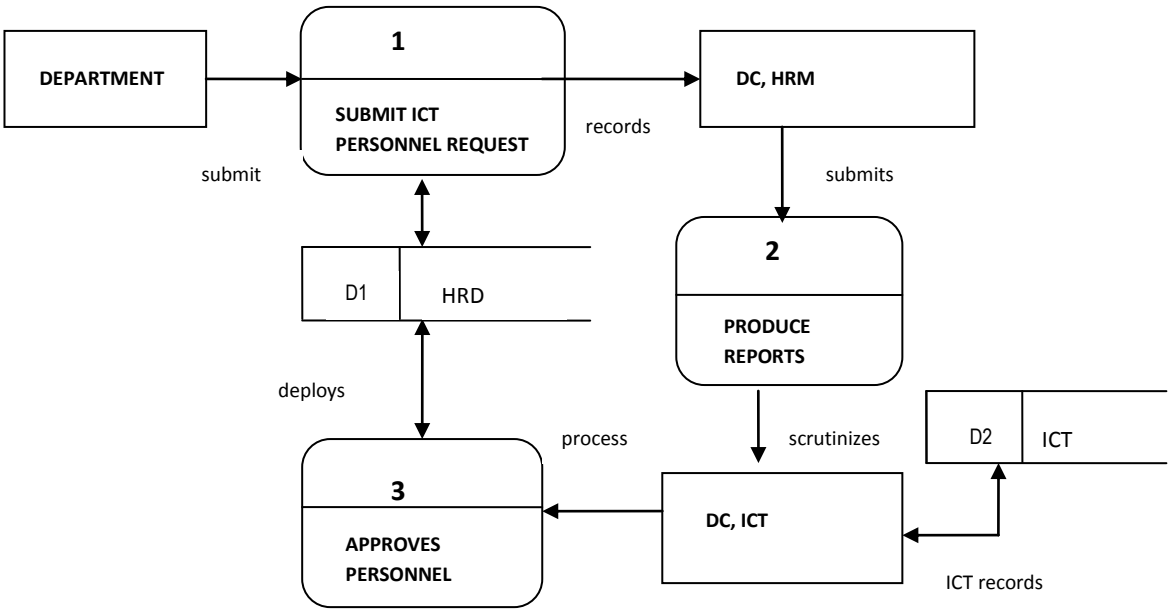

Figure 4.4: Logical Data Flow Diagram showing the major processes of KRA ICT Personnel Request

4.3.1.4 Outputs of the System

As shown in the preceding figures, the output of the current system was composed of reports pertaining to the departmental ICT staff requests, current ICT staff details, services to be provided, current ICT department estimates and ICT personnel deployment prepared by the ICT manager. The Use Case Diagram below summarizes the activities involved in the request for ICT staff.

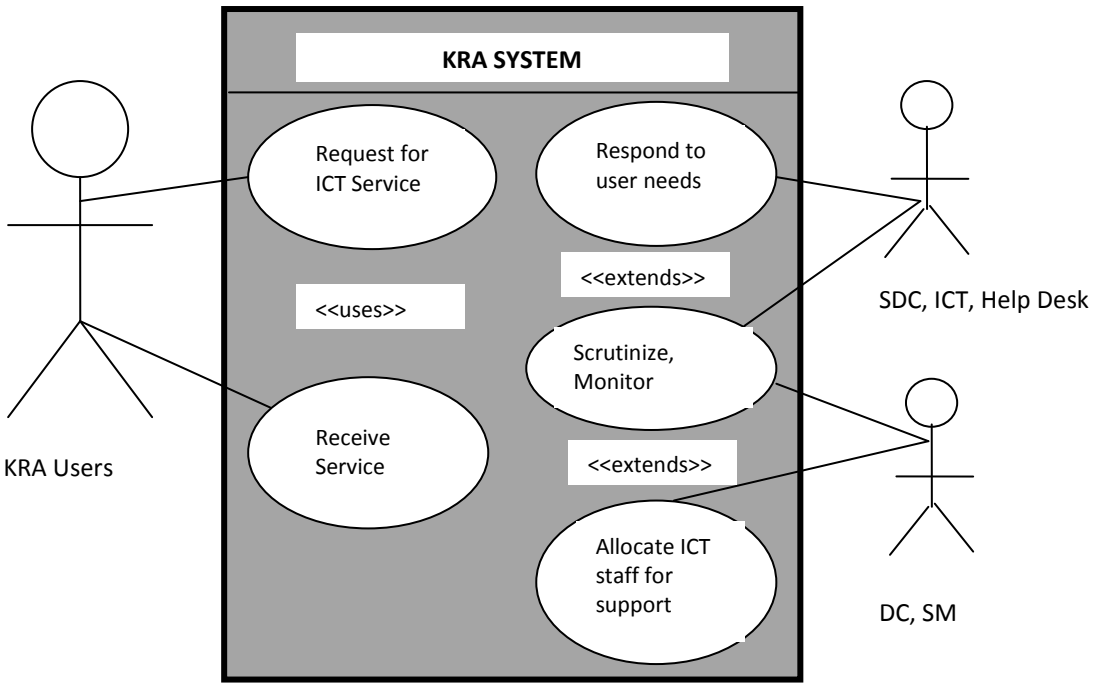

Figure 4.5: Use Case Diagram Showing Major Activities involved in requesting for personnel to support ICT services

The above Use Case diagram can further be described by using the following Case Scenario process of requesting for ICT staff to accomplish a task:

Use Case	: Request for staff
Type	: Principle
Actors	: Users, Staff, ICT Manager
Purpose	: Like to request for staff to deliver a task
Description	: A user contacts the Help Desk for a support service. The Help Desk records the requirements and notifies the DC, Service Management. The DC, Service Management then allocates the tasks to the next available staff and the records are forwarded to both the ICT and HR Managers.

4.3.1.5 Staff Organisation

The study established that the ICT staff was categorized into three groups: (i) FAST RESPONSE GROUP: the team expected to handle all existing and future services that cause user complaints. (ii) STABILIZING GROUP: the back-up team to ensure a stable computing environment and expected to stabilize the current ICT infrastructure while implementing any proposed changes appropriately. (iii) STRATEGIC GROUP:

the planning team that seeks to handle new/long term initiatives that may be cross-cutting both Intra-ICT and Inter-departmental. The three distinct groups are further re-organized into ten teams as proposed to be adopted as presented in the Process Map in Figure 6.1 in chapter 6.

4.3.1.6 Shortcomings of the Current Staff Allocation System

As pointed earlier in the chapter, the ICT department was facing a lot of challenges while using the current system. For example, it took a lot of time for the KRA users to request for staff for ICT support services. It was evident that the ICT Department could not conclusively decide who was the best person to perform a given task due to some of the following reasons: insufficient ICT personnel in the department, overwhelming feedback from customer complaints, interventions by ICT staff coming too late, prioritization of required ICT support services could be outside the control of the ICT department and more so, KRA policies could constrain the options available to the department to address problems in the requesting departments. It was now clear that staff requirement in KRA ICT department was necessary to the delivery of efficient ICT support services. Again, it was thus important to identify the sections that performed similar work by conducting meaningful comparisons so as to avoid role redundancy. This premise could be used in future to guide the ICT department into the planning and designing of a structure that would require adequate staff to accomplish various tasks.

4.4 KRA Intelligent Agent Requirements Specification

As noted above, the process of requirements discovery was able to establish the services and functionalities under which the KRA Staff Allocation Intelligent Agent

should operate. The following requirements therefore, provide the descriptions of the system services and constraints that were generated during the process.

4.4.1 Functional Requirements

- ✓ The system shall allow users to register and login.
- ✓ The user shall use valid credentials to log on, add, edit or view details.
- ✓ The system shall have provision for searching specific staff and task details.
- ✓ The system shall display the details of a given staff and or task when queried.
- ✓ The system shall generate reasons for illegality of the task.
- ✓ The system shall analyze a staff allocation request using the predetermined rules.
- ✓ The system shall not assign a task to a non-specified section or marked as illegal.
- ✓ The system shall recommend assignment of a task depending on the task priority, duration and staff with lowest time.
- ✓ The system shall generate reports on the staff and task assignments when required.

4.4.2 Non-Functional Requirements

- ✓ The system shall have a user friendly interface.
- ✓ The system shall be able to verify and validate users.
- ✓ The system shall be able to perform ATOMIC transactions.
- ✓ The system shall protect the privacy of its users
- ✓ The system shall be able to handle wrong operations and recover from failures effectively.

- ✓ The system shall allow several user requests to be made concurrently without downgrading performance.
- ✓ The system shall be able to adapt well to KRA's business and technological changes.
- ✓ The system shall be able to abide by KRA's ICT policy.
- ✓ The system shall integrate well and be able to work seamlessly with all KRA's existing systems.

4.5 Justification of the KRA Intelligent Agent

The idea of developing a system built specifically to meet specific needs of the ICT Department was therefore analyzed by the researcher. This alternative involved studying the current system, analyzing its strengths and weaknesses and determining the ICT department's needs in terms of additions, omissions and improvements in the new system. The option of designing the intelligent system was seen as a very important dimension since it would capture data and information on the current system and include more features to be used as access fields. Additionally, the system would automate most manual operations of requests, description of tasks, prioritization of tasks, estimates of duration of tasks, provide procedure for assignment of tasks and lastly assign and/or un-assign tasks to the ICT personnel to perform their departmental roles.

Further, based on the first objective of the study, investigation of the current ICT portfolio at KRA revealed that the development of the system would not demand new hardware and software resources that need to be acquired for implementation of the system. This was so since the ICT Department had all the necessary tools and

infrastructure to implement the new system. It was further observed that the department had the requisite staff to operate the system. The researcher therefore, concluded that development of an Intelligent Agent was the best solution for optimizing staff allocation to support ICT services at KRA.

CHAPTER FIVE

SYSTEMS DESIGN AND IMPLEMENTATION

5.0 Introduction

This chapter describes the approach used in building the KRA Intelligent Agent. It gives an overview of the system's design methodology employed and further recommends how the KRA Staff Allocation Intelligent Agent should be implemented.

5.1 KRA Staff Allocation Intelligent Agent System Design

Systems design is the development of an architectural model from the logical model developed during the systems analysis phase (Pankaj, 2005). This is where the analyst seeks to design a system that will fulfil the requirements of the users and one which will be user friendly presenting clear and complete specifications to both hardware and software tools (Shelly & Rosenblatt, 2011). This section will discuss the design of the agent that will meet the functional and non-functional requirements of the system users. The logical representation of the system was represented by the use of UML diagrams mapped into a relational schema that was implemented in a database management system as further guided by Connolly & Begg (2014).

5.2 KRA staff allocation Intelligent Agent Architecture

The KRA intelligent agent architecture was built based on three main subsystems as adopted from El-Nady, Nabil, Khalil & Elmahalawy (2000) as presented in Figure 2.1 and interpreted as shown in Figure 5.2:

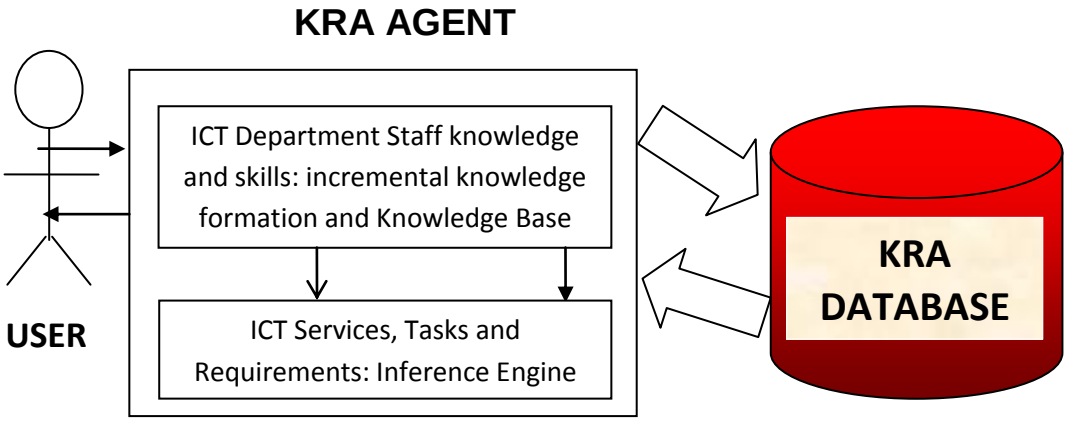

Figure 5.1: The components of the KRA Intelligent Agent System as adopted from El-Nady, Nabil, Khalil & Elmahalawy (2000)

As indicated earlier in the study, the aim of any intelligent agent is to imitate human problem-solving by referencing to a database of knowledge on a particular subject. According to the above architecture, the KRA Intelligent framework can be described in the following three areas:

a) *Incremental Knowledge Formation Process*: this entailed acquiring knowledge from the staff, updating the knowledge base and making generalization and sub-generalization concepts. This was achieved by capturing all the ICT Department's requirements and specifications of the staff profile including their professional qualifications and skills, the roles and functions of each unit and the responsibilities and activities and tasks to be performed by staff from each section in the department.

b) *The knowledge Base*: this was where all the dynamic details of all ICT departments' sections were stored in form of a database. This included all the details of the ICT staff, information pertaining to their knowledge and skills, the functions and roles of each section and the job descriptions of each cadre

of the ICT personnel and tasks to be performed. This component was therefore to form a representation of the problem in hand using IF THEN rules, it entailed data which was specific to the problem being solved. This meant that the inference engine further derived recommendations or feedback for assigning staff to perform specific tasks.

c) *The Inference Engine*: was implemented using an opportunistic search approach and was used to search for the knowledge. This was where analysis of the requirements was done by comparing the requests and mapping to the requirements. The inference engine was concerned with processing the user requests. For example, the system would check the legality or illegality of the user's request and either proceed with the request or terminate the request. The inference engine tried to derive answers from the knowledge base, for the ultimate purpose of formulating new conclusions. This component further served as a global database representing the facts or assertions about the ICT Department using a set of rules. Finally, the inference engine was used to determine which rules were relevant to a given data store configuration and choose which one(s) to apply to solve a given problem.

5.3 KRA Intelligent Agent Design Approach

According to Crespi, Galstyan & Lerman (2008), traditionally two alternative design approaches have been available for system development: top-down and bottom-up. In the top-down approach, the design process starts with specifying the global intelligent agent's state and assuming that each component has global knowledge of the intelligent agent, as in a centralized approach. The solution is then decentralized by replacing global knowledge with communication. The other option is the bottom-up

approach, a strategy that is more suitable when a system needs to be created from some existing system, where the basic primitives can be used in the newer system. Here, the design starts with specifying requirements and capabilities of individual components of the intelligent agent (Dawson, 2009). As pointed out by Crespi, Galstyan & Lerman (2008), this approach starts with the specification of the individual agent's behaviour through a set of agent capabilities or rules of engagement. The study adopted the bottom-up strategy where the global behaviour of the intelligent agent is said to emerge out of interactions among constituent components (in this case staff, their roles and tasks to be considered for optimizing staff allocation) and between these components and the environment of the intelligent agent (in this case the factors conceptualized in Chapter 2 that include KRA organizational factors and competences). As stated later in this chapter, KSAIA was built under Django web-based framework. This means that, being a web-based framework, the lower level of the system exists and this only required incremental development of additional components of KSAIA that included Accounts, Staff and Tasks modules. I began by customizing the framework's lowest levels first before bringing the three modules together to produce the fully working KSAIA system.

By adopting the bottom-up strategy to design the KRA Staff Allocation Intelligent Agent, a number of factors were taken into consideration depending on particular circumstances. For example, the process of allocation of tasks to staff was to be judged based on the following steps:

- ✓ Break down the current work;
- ✓ Group the tasks into various ICT functions and combine roles where this was feasible;

- ✓ Identify the role descriptions and transform these to job descriptions;
- ✓ Identify the necessary skills required for each function/role;
- ✓ Identify the estimated time taken to carry out each task;
- ✓ Assess the workload of each position held, it should be possible to assess how many staff (more or less than current) were required;
- ✓ Grade staff depending on levels of responsibility and the importance of each function;
- ✓ Establish existing ICT practices against which to map current and future needs of the ICT department; and
- ✓ Identify the staff required to complete the task or tasks depending on particular circumstances.

Further, the number of staff any manager and/or section head is expected to manage should be considered based on various factors such as:

- ✓ The KRA Strategic Plan to determine the ICT Departmental Structure that may reflect the corporate guidance on the maximum span of command;
- ✓ The number of staff at the managerial and operational/support levels will generally depend on particular circumstances, for instance, this will be based on career paths and succession planning and the need for such staff; and
- ✓ If the new structure requires fewer or more people, options for re-deployment or redundancy must be identified and communicated to the Human Resource Management Department and the Senior Management at the ICT Department for planning the assignment of staff.

The Use Case Diagram below summarizes the functional requirements in terms of activities that were involved in the request for ICT staff using the KRA Intelligent Agent.

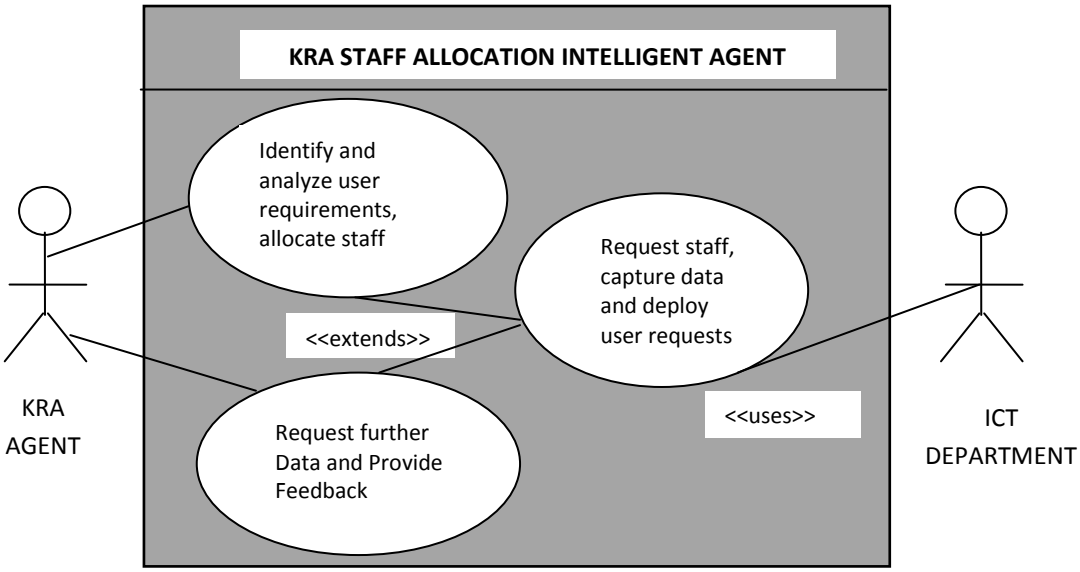

Figure 5.2: Use Case Diagram Showing Major Activities involved in staff request

The following scenario using IF THEN rules provides a sequence of events that was a representation of some of the functional and non functional requirements for the system. First, the process is initiated by the Customer/User who contacts the Service Desk. The Service Desk Personnel captures the request details and forwards the same to the DC, Service Management. Using the KSAIA, the DC, Service Management then initiates the process. Whilst the details are being validated, the requirements are elicited as demonstrated here below.

```
IF the DC, Service Management fails the validation procedure,
     THEN the request process terminates.
IF the DC, Service Management's validation is successful,
     THEN the request is recorded and mapped against the ICT
     Service Requirements and ICT Personnel Portfolio in the
     Intelligent System's Database and Inference Engine.
IF matching occurs and Agent is satisfied with the current
     contents,
     THEN Agent identifies the ICT service and personnel
     requirements profile and select the possible rule.
```

```
IF the requirements are met,
     THEN the ICT services requirement request is executed.
IF the desired ICT Service and Personnel is legal,
     THEN the entire process continues.
IF the desired request is illegal,
     THEN the entire process terminates and the user is informed.
     In this case, the Agent will request further information and
     the user must correct the data or enter new data altogether.
IF there is any uncertainty about the request legality,
     THEN the process is suspended while further information is
     obtained from the user.
```

Finally, the KRA Staff Allocation Intelligent Agent executes and displays the allocation of the ICT service requirements by providing the staff, the task to be performed, the priority of the task and finally the estimated time to complete the task. The above process is facilitated by the three main elements of the inference engine as described here under:

i) *An Interpreter*: this element executes the chosen agenda items by applying the corresponding base rules.

ii) *A Scheduler*: this element maintains control over the agenda by allocating the effects of applying inference rules in light of item priorities or other criteria on the agenda.

iii) *A Consistency Enforcer*: this element attempts to maintain a consistent representation of the emerging solution.

The Inference Engine facilitates the above execution in a cycle consisting of three action states namely: (1) match rules - while performing the matching rules, the inference engine finds all of the rules that are satisfied by the current contents of the data store and which must be candidates for execution known as a conflict set. (2) select rule - here the inference engine applies some selection strategy to determine which rules will actually be executed otherwise known as heuristics. (3) execution

rules – this is where firing or processing of the selected strategy occurs to solve the problem at hand. The above sequence of actions can further be summarized using the following Sequence Diagram.

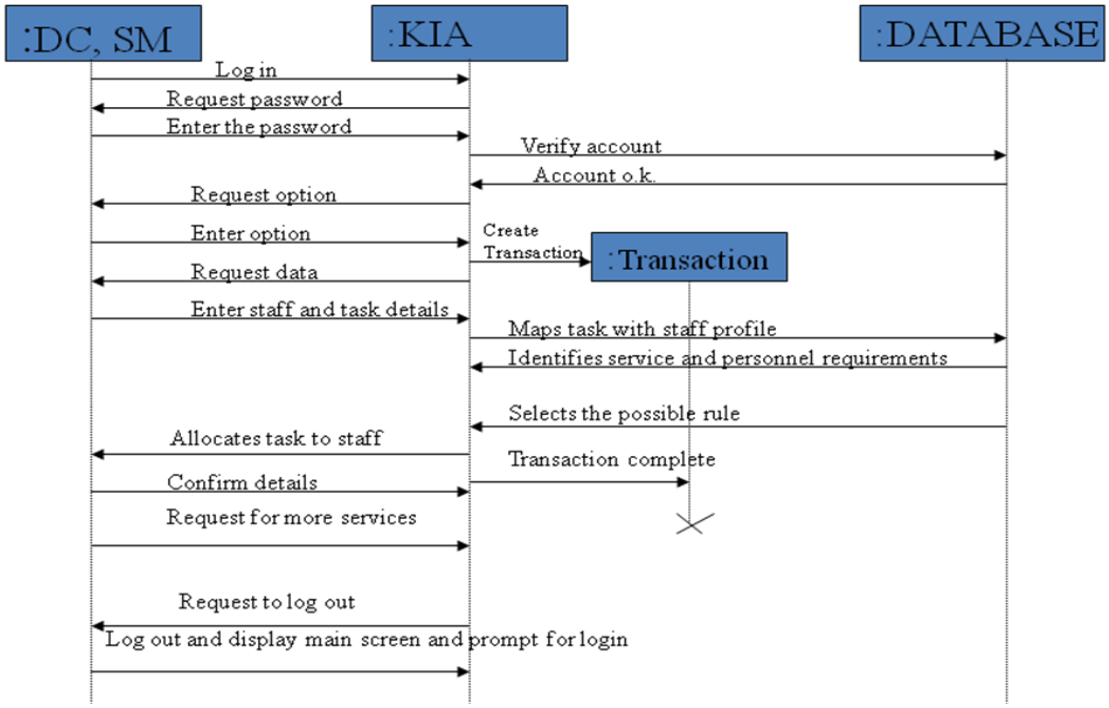

Figure 5.3: Sequence Diagram for Allocation of tasks to staff

The Intelligent Agent planning and design is performed as a centralised system. This means that when a task needs to be assigned, the ICT manager only assigns tasks to individuals and not groups of people working in a section. Then when starting a new task, the agent checks if the preconditions of the task are satisfied which includes, the job to be done, the section responsible for the service and the availability of the qualified staff to perform the task. If the conditions are satisfied, the agent will proceed with the allocation and inform the individual selected about the expected situation. The agent then informs about the current status, so that the ICT manager can decide what to do in case of additional tasks. However, if the preconditions of the task are not satisfied, the agent displays information about the unexpected situation.

From the foregoing, it is evident that KSAIA needs a general knowledge of how its environment works, and what actions are available to it. As earlier discussed in Chapter 2, for an intelligent agent to be autonomous, the agent can learn and modify itself and its data based on its current world experiences.

5.3.1 KRA Staff Allocation Intelligent Agent System Requirements

To appropriately run the new system, the minimum requirements and specifications for the KRA Staff Allocation Intelligent System were identified as presented in Table 5.1 below:

Table 5.1: KRA Staff Allocation Intelligent Agent System Requirements Platform

1.	**Hardware Requirements**	
No.	**Type**	**Specifications**
i.	Server	IBM, HP or Dell Server Quad core 3.0 GHZ RAM at least 4GB Hardisk 500GB or above Backup Drive eg. Tape, Disk NIC: at least 10/100/1000 mbps
ii.	Computer HP, Compaq, Dell, Intel, IBM (branded)	Processor: Intel Pentium IV 3Ghz Speed: 3.0 GHz Memory: 2GB RAM and Cache Memory Hard Disk: 160 GB Monitor: 15" TFT Other Drives: Removable CD-RW/DVD, USB NIC: at least 10/100 mbps Full multimedia: audio card, inbuilt speakers
iii.	Uninterruptible Power Supply (UPS)	APC 600 VA or above
2.	**Software Requirements**	
i.	Operating System	Unix/Linux or Windows 7 or higher versions
ii.	Application Program Platform	Django 1.8 and Python 3.2 or higher versions
iii.	Database Management System	SQLite, MySQL or Oracle
3.	**Staff Requirements**	
i.	ICT Manager or Manager, Service Management	Administrator of the System
ii.	Section Heads and their staff	Main users of the system
iii.	Database Administrator	Control and manage usage of system

Both the hardware and software requirements were readily available in the ICT Department as revealed from the findings of the study (*see Table 4.2 and Table 4.4 above*). However, the operational staff for this system will require to under-go an in-house training to operate the system. These include the ICT Manager, division and section heads. It will also be advisable to involve the organization's database administrator to control the usage and maintenance of the system in the long run.

5.3.2 Database Requirements Review

The entities and the attributes for the KRA Staff Allocation Intelligent System are presented in the KRA System's data model in form of a UML Class Hierarchy diagram below. The entities will be further described in the data dictionary in the subsequent sections.

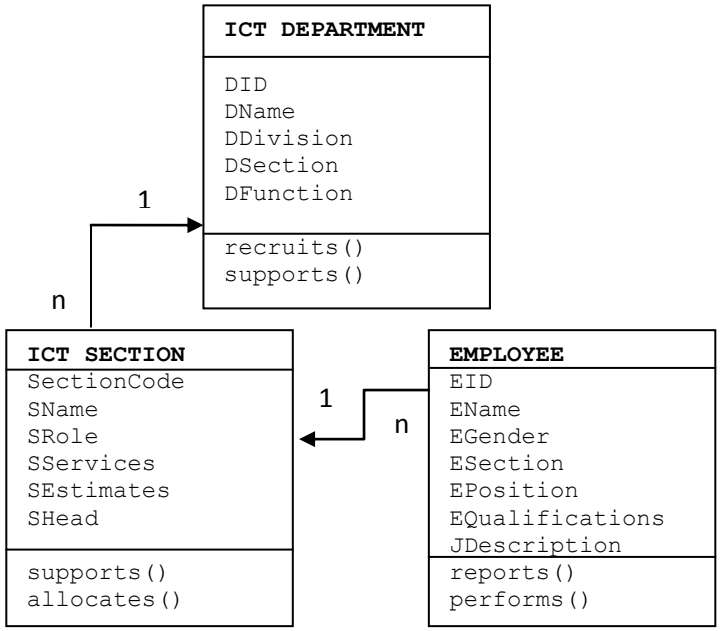

Figure 5.4: Class Diagram for the KRA Staff Allocation Intelligent Agent

5.3.2.1 Relational Schema of some selected Tables

This provides a holistic view of the KRA Staff Allocation Intelligent Agent's database. The database schema view is represented as follows:

```
Section:    [SCode, SName, SRole, SServices, SEstimates, SHead]
Employee:   [EID, EName, EGender, ESection, EPosition, EDoA,
            ETerms, EQualifications, JDescription, ETask]
Department: [DID, DName, DDivision, DSection, DFunction]
```

5.3.2.2 Data Dictionary

The purpose of the data dictionary as highlighted by Rajaraman (2000) is to offer documentation for the database and to ensure that consistency is maintained whenever changes are made to the database as part of maintenance activities or upgrading. The following Tables 5.1, 5.2 and 5.3 depict part of the data dictionary for the KRA Intelligent system.

Table 5.2: Data Specifications for the Department Relation

Department

Field Name	Data Type	Field Size	Description
DID	Number	Short Integer	Unique Department No. (Primary Key)
DName	Text	20	Name of Department
DDivision	Text	50	Name of Division
DSection	Text	50	Name of Section
DFunctions	Text	>50	Roles of Department

Table 5.3: Data Specifications for the Section Relation

Section

Field Name	Data Type	Field Size	Description
SCode	Number	Short Integer	Unique section Identity No. (Primary Key)
SName	Text	50	Name of the Section
SRole	Text	50	Role of the Section
SServices	Text	50	Services provided by Section
SEstimates	Number	Short Integer	The current estimates for the department
SHead	Text	50	Designation of the head

Table 5.4: Data Specifications for the Employee Relation

Employee

Field Name	Data Type	Field Size	Description
EID	Number	Short Integer	Unique Employment No. (Primary Key)
ETitle	Text	20	Title of employee
EName	Text	50	Name of employee
EGender	Text	1	Whether M or F
ESection	Text	50	Name of section
EPosition	Text	50	Current position
DoA	Date	Short date	Date of first appointment
ETerms	Text	50	Terms of employment
EQualifications	Text	20	Employee professional qualifications
JDescription	Text	>50	Employee job description qualifications
Task	Text	>50	Employee task allocated

5.3.3 User-Interface Design

According to Elmasri, Navathe & Ramez (2015), the primary purpose of human computer interface is to enable communication to and from and between the user and the computer system. Pressman & Maxim (2015) points out that careful user interface design is an essential part of the overall software design process. The user-interface will facilitate the dialog between the user and the KRA Staff Allocation Intelligent Agent as shown in the presented in Figure 5.2. The main features of the KRA Staff Allocation Intelligent Agent is its user-friendliness that entails: how helpful the system is to the user, the ease to learn, use, recognize and recall, it is self-contained and lastly, that the system can adjust to different levels that would make the user feel in control. This therefore, means that with a good user interface designed to match the KRA anticipated users skills, experience and expectations KSAIA will function properly to achieve its full potential. The study was further guided by the following six user interface design principles as presented by (Pankaj 2005, Pressman & Maxim 2015 & Sommerville 2010):

i) *User familiarity*: the user interface entails terms and concepts drawn from the experience of KRA users for example use of familiar terms used in the departmental structure.

ii) *Consistency*: to allow comparable operations to be activated in the same way by the users, for example, similar problems are addressed using the same descriptions familiar to each section.

iii) *Minimal surprise*: the system should not surprise the users at any one time, this means that KSAIA should consistently perform as expected.

iv) *Recoverability*: the system includes mechanisms to allow users to recover from errors, this includes having backups at all stages of the user interaction.

v) *User guidance*: the interface provides meaningful feedback when errors occur.

vi) *User diversity*: the system provides appropriate interaction facilities for different types of users, this means that for example, the ICT Manager who is the System Administrator must have unique privileges to either register or de-register a user. On the other hand, the database administrator must also have adequate privileges to conduct database maintenance.

The prototype was constructed using Django, a free and open-source high-level Python web-based framework that encourages rapid application development and was achieved using program codes as presented in Appendix X. According to Greenfeld & Greenfeld (2017), Django was built by experienced developers to take care of much of the hassle of Web development. Roy & Roy (2015) further assert that, developers can focus on writing their applications without needing to reinvent the wheel every time they undertake an application development project. Finally, as well as supporting the KSAIA's process activities, the experimental prototyping was used to

reduce the time required to develop user documentation and training of users since a working system was available to demonstrate the feasibility and usefulness of the application to the KRA ICT staff.

Prototyping approach was considered because of availability of the following tools in the rapid application development environment that include: (1) *A database programming language* that was used to embed KRA knowledge of the database structures, basically the researcher used SQLite database management system. (2) *An interface generator* that was used to create windows for data input and display. (3) *A report generator* which was subsequently used to define and create reports from information derived from the KRA database and inference engine.

Following are some selected screen shots and the general user interface for the KRA Staff Allocation Intelligent Agent.

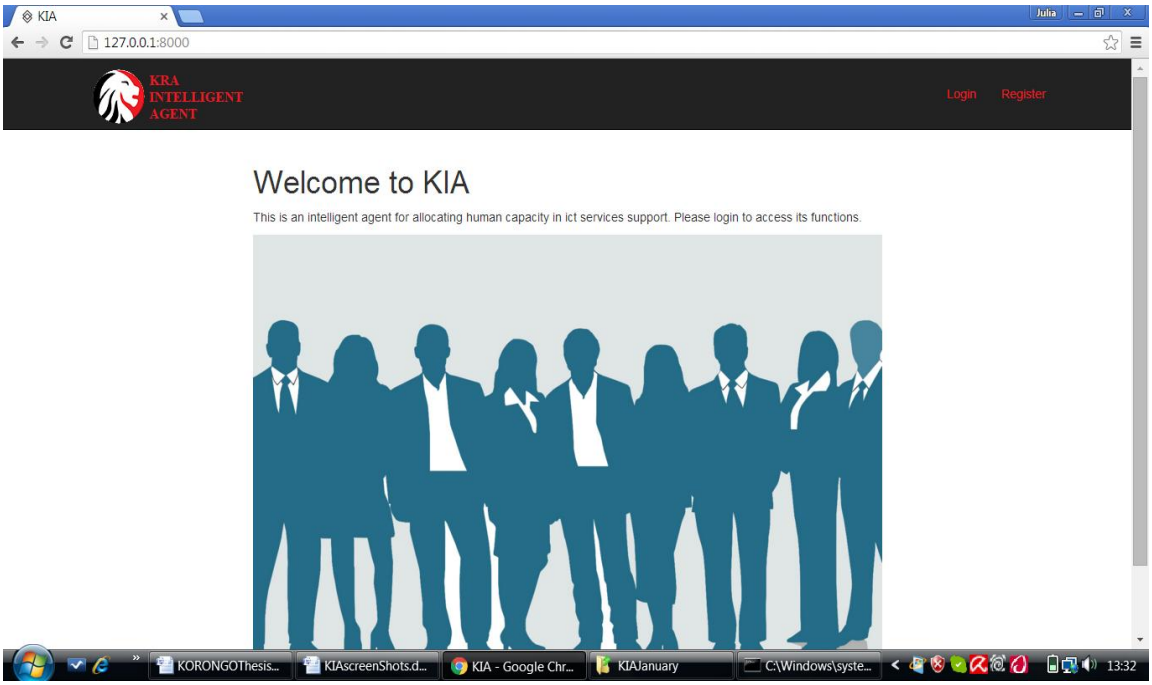

Figure 5.5: Screen Shot of KSAIA's Home Page

The homepage screen shown in Figure 5.6 tells the users they are now welcome to interact with the system by either registering as a new user or login if already registered.

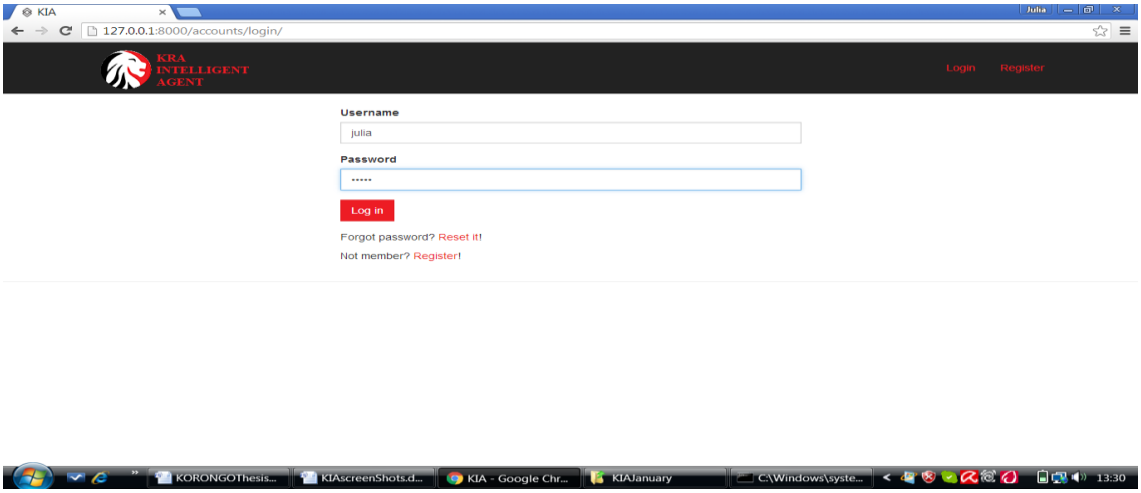

Figure 5.6: Screen Shot of KSAIA's Login Interface

After registering into the system, the system will prompt the user for a username and password as shown in Figure 5.7 and upon correct login credentials, the system provides a user interface profile for both staff and task modules.

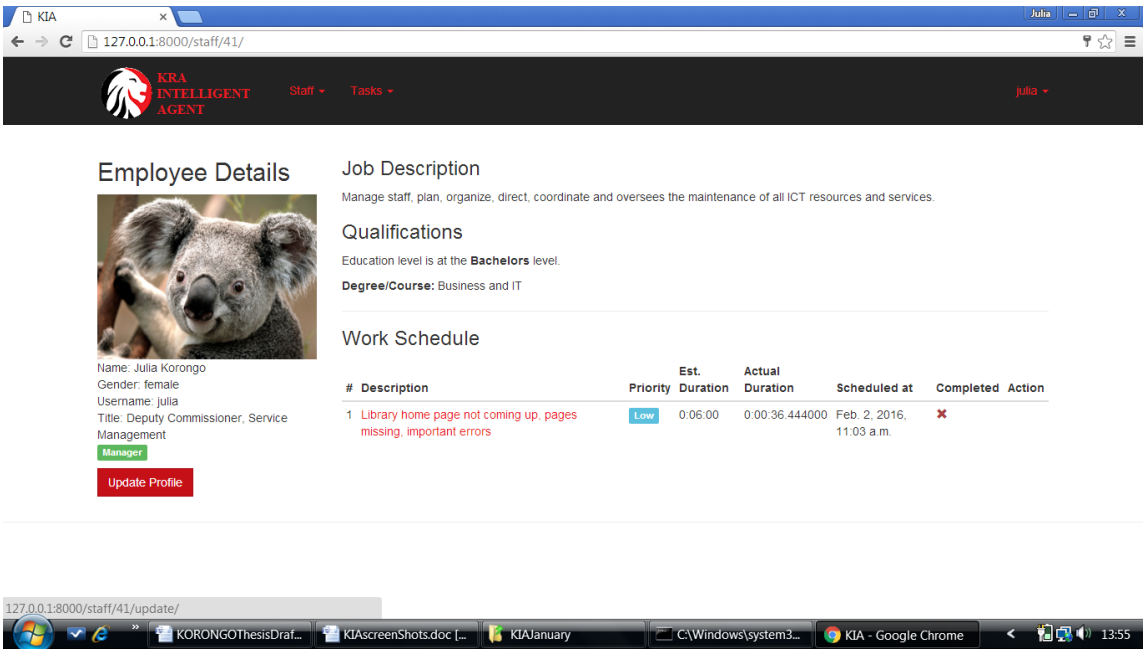

Figure 5.7: Screen Shot of KSAIA's User Profile

The user profile shown in Figure 5.8 allows the DC, Service Management to select either the staff or the task menus and further update the employee details and add new tasks to the system. *Appendix X* provides further details on installation and use of the system.

5.3.4 Training the KRA Staff Allocation Intelligent Agent

The Intelligent Agent was build under the four components as shown in Figure 5.2 and the training process was accomplished using different training cases. The training procedure entailed periodically enhancing the agent intelligence. The agent is connected to a knowledge base from which it can extract values and transfer data from the database which acts as the agent's repository. First, the system requires the

user to register before using the agent and subsequently, when logged-in to the system, the user must enter a password before accessing the system. Secondly, the user is required to input (both real data and false data) into the system to see if the KSAIA could function properly.

Further, the training cases provided for facilities to ensure the security of data and to enable users to access only that data in the system that they are authorized to access. The system incorporated user rights and privileges that varied with authority at work place. For example, the ICT Manager had all the rights to change any part of the data related to employee details, departmental services and transactions. Other users are restricted to only viewing task assignments. There were also integrity constraints, such as legality and illegality of tasks, for the database so as to ensure that the data entered to build the knowledge base had minimal errors. The aforementioned characteristics translate to two roles of the intelligent agent: (1) delegation – the agent is assigned a particular activity and is entirely responsible for carrying it out and (2) decision support functionality - the agent acts autonomously and proactively to gather information and make recommendations. The agent's decision making can further be characterized in terms of belief, desire and intention constructs as earlier presented in chapter 2. By training the KSAIA, the agent will be able to react on the predefined states of its environment as shown in Figure 5.2. First is for its acquired information (its incremental knowledge formation), second, its own built-in preferences (the KRA Database) and lastly from its knowledge (its knowledge base).

5.3.5 Testing of KRA Staff Allocation Intelligent Agent

Two fundamental testing activities namely: component testing – testing parts of the KRA Intelligent Agent and system testing – testing the KRA Intelligent system as a whole were considered for the KSAIA. The aim of the component testing as highlighted by Pankaj (2005) was to discover defects from each module, including the Login, Staff and Tasks modules. On the other hand, system testing required integrating all the modules of the KSAIA and establishing that the system met its functional and non-functional requirements. The researcher developed some test scenarios using test case design to determine the suitability of the KRA Intelligent Agent. The goal of the test case design process was to create a set of test cases that were effective in discovering program defects and showing that the system met its requirements.

5.3.6 Status of the KRA Staff Allocation Intelligent Agent

Following is the status of the KRA Intelligent Agent.

i) *Accelerate allocation of staff*: the ICT manager can accelerate the process of allocation of staff to perform a task.

ii) *Flexibility*: additional staff details and task details can be added to cater for changes in the ICT department.

iii) *Modification of records*: if some information is no longer required, the ICT manager can easily modify and or remove such data in regards to staff and their profile as well as the task assignment details.

5.4 Implementation of KRA Staff Allocation Intelligent Agent

Implementation of the KRA Staff Allocation Intelligent Agent should involve the coordination of the efforts of the users in getting the new system into operation. Additionally, this will involve controlling the activities necessary to put the new system into use. It will also involve the migration of the data from the manual system to the new system. The organization's choice of hardware and software will also be determined by the operating system's platform. For example, incorrect configurations of computer hardware for the system could cause data loss and damage. The ICT manager was therefore, advised to avoid obsolete device drivers, outdated departmental staff profile and functional roles and lastly, always maintain correct computer configurations when installing the intelligent agent. Implementation of KSAIA entails the following activities:

i) *Master File Conversion*: where it will be necessary to capture all the data relevant to the system from the ICT Department. This includes: details of ICT staff, the functions and roles of each section, support services requirements, the responsibilities of each section and finally the details of the current ICT Structure.

ii) *Changeover Procedures*: this entails conversion of old system to new system and the researcher suggests using the pilot changeover method. This method will allow the ICT department to initially introduce the system in one section, preferably, the Service Management Desk before rolling it out to other sections once it has been thoroughly tested further with the KRA infrastructure. In addition, the piloting will make room for evaluation of performance of the Intelligent Agent.

iii) *Training of Users*: it is highly recommended that the ICT manager make the necessary arrangements to train the users of the new system so as to acquire the knowledge and skills on how to operate the system. This will further be achieved by providing the user manual to guide the ICT manager and the entire department.

iv) *Maintenance and Support*: The ICT Manager should ensure the technical support of the KRA Intelligent Agent. Firstly, the database administrator will be in charge of making all the necessary capturing, modification and overall maintenance of the system's database. Secondly, the ICT Manager must ensure that the technical manager facilitates accessibility and operational needs of the system such as provision of the necessary hardware and software and also creating additional permissions to new users of the system.

(v) *System Security and Backup Procedures*: The system should be to prevent its data or program against accidental or intentional destruction or disclosure to unauthorized persons. The ICT Manager should ensure the security of both the information and the programs is maintained including: protection from theft, fire, disk corruption and other types of physical destruction, frequently updated anti-virus, ensure regular backups and to prevent unauthorized access to users.

v) *KRA Intelligent Agent Evaluation and Review*: it is highly recommended that the KRA system be evaluated and reviewed from time to time to provide the necessary measures in terms of corrective, preventive, perfective and adaptive maintenance support.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This final chapter presents a summary of the major findings, conclusions and recommendations of the study. The conclusion of the study is drawn from the summary of the findings based on requirements gathering discussions presented in chapter 4. The study also gives recommendations that attempt to address the current situation in the ICT department and provides suggestions for further research in the area of Intelligent Agents.

6.1 Summary of the Major Findings of the Study

The study was undertaken to investigate the process of ICT staff allocation at KRA head office and develop a model intelligent agent for optimizing staff allocation for ICT services. The study had four objectives and was guided by four research questions as outlined in chapter 1 of the study. Following is the summary of the major findings of the study.

6.1.1 The ICT Portfolio at KRA

The study found out that KRA had invested in multiple information systems used to both enhance revenue collection and to support administrative and business operations in the Authority. Additionally, KRA had invested in diverse mechanisms to market its business processes and operations such as the KRA Website, a state-of-the-art Call-Centre. In regards to infrastructure, KRA had invested in a robust ICT infrastructure including hardware, software and networking technologies to allow for access, use,

dissemination and maintenance of all the above stated information systems. That notwithstanding, KRA had also invested in a number of policies and guidelines to allow implementation of the above mentioned resources all integral to effective and essential service delivery of KRA's business processes.

6.1.2 ICT Staff Allocation System at KRA

The study established that the ICT department comprised of four divisions extended further into ten functional units with a total of 122 out of a required establishment of 148 staff thus confirming that the department was understaffed. The main functions of the department include: customer relationship management, infrastructure management, business applications support, service management, systems administration and security and lastly the provision of human resource for ICT support services. However, as the study found out, there were a lot of duplication and conflicting activities offered in these units that further results to unclear and uncoordinated services.

6.1.3 Challenges of Current Staff Allocation System at KRA

The study established that KRA ICT Department is understaffed having a deficit of 26 staff, a majority of whom were lacking in the support services. This has hindered the department from providing support services. Further, there was no clear policy indicating on-the-job training which would equip the department with the necessary knowledge and skills to embrace the ever changing ICTs. This finding is supported by past studies including (Gichoya 2005, ICT Authority 2015, Ndemo, 2016) that +propose the need to address the mismatch between the Information Systems being developed and the required personnel to manage these systems hence it is important to

address the shortage of skilled manpower required to operate and support information systems.

6.1.4 Development of KRA Staff Allocation Intelligent Agent Prototype

The fourth study objective required finding out how an Intelligent Agent can be used for optimizing staff allocation to support ICT services at KRA. The study analyzed the existing KRA system and from the investigations, the study identified both the functional and non functional requirements. From the requirements description, a specification was formulated that was used for designing and developing the KRA Staff Allocation Intelligent Agent prototype as further demonstrated in Appendix IX.

6.2 Conclusion

The study has drawn the following conclusions based on the four study objectives as outlined in Chapter 1:

6.2.1 Situation of the ICT Portfolio at KRA

As espoused in KRA's 4th Corporate plan (2009/10-2010-/14)), the situation of the ICT Portfolio KRA is very clear based on the extent to which KRA had embraced ICT as a platform for enhanced service delivery which further necessitated heavy investments in IT infrastructure. It is evident that at KRA, use of ICT is crucial in routine data processing, provision of business operations and routine correspondence with customers. Revolutionary advances in ICT have presented opportunities to reinvent service provision within KRA.

6.2.2 ICT Staff Allocation at KRA

The study concludes that it is necessary not only to decide who is the best person to perform a task but also to foresee how the ICT department will coordinate its functions and provide staff that will work together and fulfil the final goal. There is need for KRA ICT department to use such communications as feedback to learn, take advantage of opportunities, and change the service delivery approach appropriately.

6.2.3 Challenges hindering ICT Services Support at KRA

The study concludes that the changing demands from customers, the need to contain costs and to improve services in business processes requires the application of ICTs which require to be supported by adequate human capacity. So, if well managed, coordinated and well streamlined, ICT staff and functions will clearly align the initiatives in the provision of better ICT services to enhance the business objectives they support.

6.2.4 Development of an Intelligent Agent Prototype

The study concludes that the impact of intelligent agents has created great changes in large institutions that are now reshaping the way they manage and organise work in order to be more competitive. Finally, it is evident from the above findings that the study achieved its aim and objectives. The findings indicate that mere introduction of ICTs will not help KRA ICT department achieve its goals and objectives. It is also important to consider the alignment of the ICT portfolio along with the staff profile in the following ways: to support the key business capabilities required to achieve the department's goals and objectives, to maintain the necessary ICT capabilities available or needed to support the delivery of key business processes, for developing

and retaining the necessary skilled manpower and lastly for streamlining the activities of the ICT department. All these are critical to the successful optimum allocation of human capacity for ICT services support at KRA in order to help achieve the department's mission, strategic goals and objectives.

6.3 Recommendations

The study recommends the following to KRA:

6.3.1 Effective Automation and Creative use of ICTs

- That the ICT Manager at KRA should explore the possibilities on how to improve the level and range of its ICT investments and infrastructure. This is because it is impossible sensibly to consider the provision of ICT services without making references also to the equipment, functions and human resources available.
- That KRA ICT Department should consider improving the internet infrastructure especially by increasing bandwidth immediately so as to ensure adequate and sustainable connectivity and also facilitate the uptake of remote technologies.

6.3.2 Investing in Human Resource Development

- That KRA should emphasize change and promote ICT literacy and enlightenment through human capacity building. This should be through the use of ICT resources and other areas to improve the knowledge and skills of ICT personnel.

6.3.3 Re-organization of ICT Staff Allocation

- That KRA management should effect changes in the structure and functions of the ICT department before any ICT solutions are rolled out.
- Further with the considered opinion of the ICT Manager, the study proposes that KRA implements the following ICT Staff re-alignment process map.

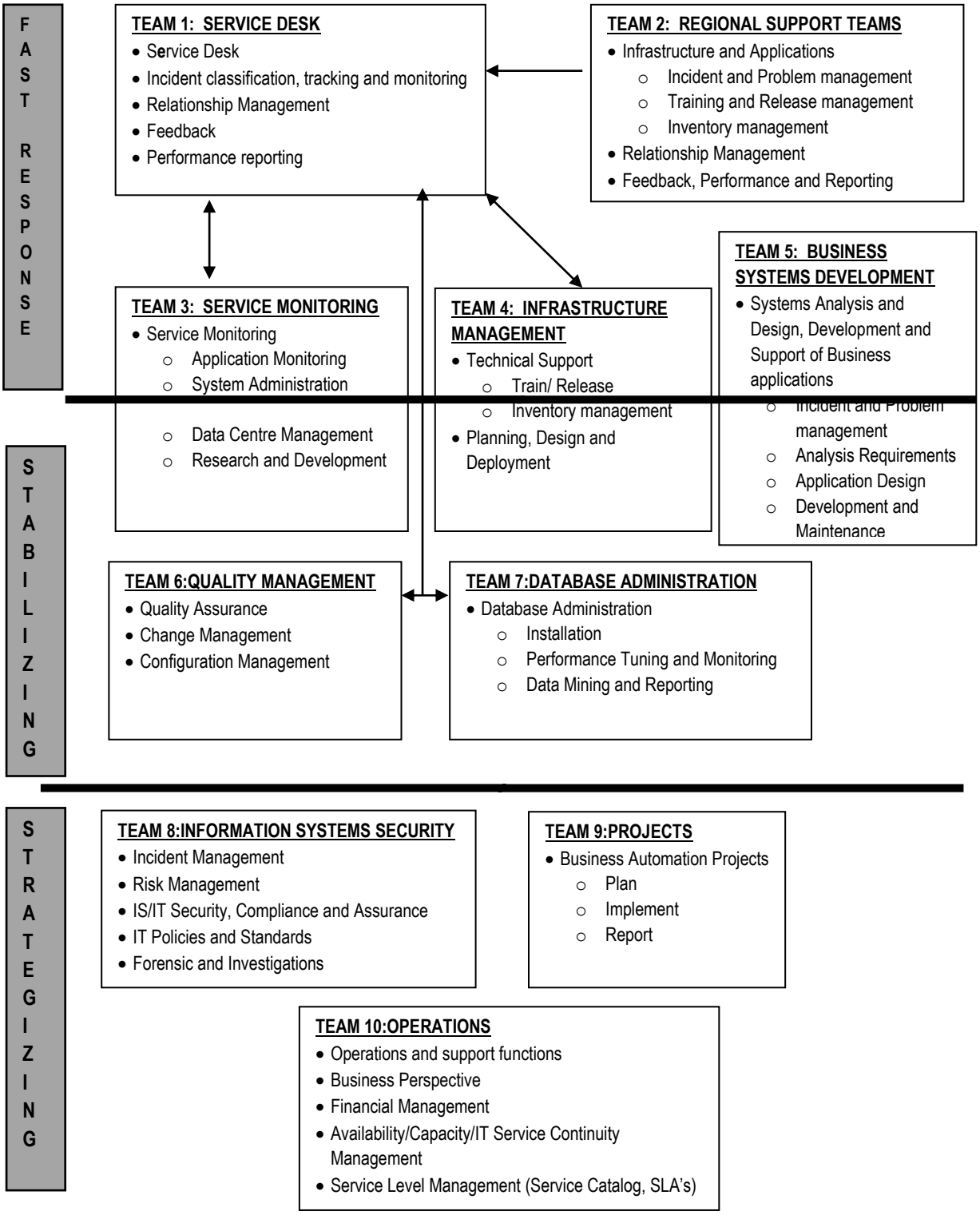

Figure 6.1: The Proposed KRA ICT Department Service Delivery Process Map

The above process map formed the basis of the development of the Intelligent Agent for optimizing staff allocation for ICT Services support at KRA. This is envisioned to provide an essential framework that will enable KRA's ICT department to provide clear definition and delineation of ICT services and thus maintain stakeholders' confidence. The Intelligent Agent should therefore, evolve in tandem with KRA changes in operations, processes and technology.

6.3.4 Adoption of the KRA Staff Allocation Intelligent Agent

It is suggested that KRA ICT Department should consider the adoption of the Intelligent Agent Prototype with or without modifications depending on the integration with its existing systems and to:

- Maintain proper configurations of computer hardware for the Intelligent Agent system installation.
- Modify the staff profile and functional roles in relation to the current ICT structure.
- Include the intelligent agent system implementation measures into the ICT department disaster preparedness plan and contingency measures to ensure business continuity of KRA.

6.3 Suggestions for Further Research

This study on an Intelligent Agent for optimizing staff allocation for ICT services support was mainly confined to KRA, ICT Department. There is need to study the design and implementation of a hybrid approach to develop multi-agents for the provision of distributed services in organizations, thus this is a direction that is worth pursuing in further research.

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APPENDIX I: LETTER OF INTRODUCTION

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ELDORET.
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Dear Sir/Madam,

RE: AN INTELLIGENT AGENT FOR OPTIMIZING STAFF ALLOCATION FOR ICT SERVICES SUPPORT

I am a student in the School of Information Sciences, Moi University pursuing an MSc. in Information Sciences (Information Technology). The research that I am undertaking will result in thesis for submission for Master of Science degree at Moi University.

The research will be carried out among members of staff at KRA in order to develop a clear picture of developing an intelligent agent for optimizing staff allocation in ICT service support.

The study is envisaged to provide a basis for considering the actions that can be taken to effectively offer ICT service support and thus add value to KRA in working to achieve its mission and vision.

Your participation in this research is greatly appreciated. In order to maintain confidentiality and anonymity for all the participants, no names will be required. Please also note that the information provided will be treated with utmost confidentiality and will only be used for the purpose of the said study.

If there are any questions or concerns following your participation, please do not hesitate to contact me. I can be reached on the contacts or address provided on top of this page.

Once again, thank you for your assistance and co-operation.

Yours sincerely,

Julia N. Korongo
IS/MPHIL/059/08

APPENDIX II: PERMIT FROM KENYA REVENUE AUTHORITY

KENYA REVENUE AUTHORITY

Ref: KRA/5/1003/26

8th March, 2011

Julia N. Korongo
Moi University
Department of Information Technology
P.O Box 3900- 3011
ELDORET

Dear Madam,

RE: REQUEST TO UNDERTAKE ACADEMIC RESEARCH

We refer to your letter dated 2nd March, 2011 seeking to undertake academic research in KRA.

We are pleased to inform you that the Authority is willing to offer you an opportunity to undertake the research on ***"An intelligent agent for estimating human capacity for ICT support services"***, a case study in KRA. However this can only be done through distribution of questionnaires.

The research you will undertake should only be for academic purposes only and any data or information given to you should be treated with utmost confidentiality.

Yours faithfully,

V. W. Ndu (Mrs.)
For: Senior Deputy Commissioner- Human Resources

Tulipe Ushuru Tujitegemee!

Times Tower Building
Haile Selassie Avenue, P.O. Box 48240-00100 Tel: 310900 Fax: 316872

APPENDIX III: INTERVIEW GUIDE FOR SENIOR DEPUTY COMMISSIONER, INFORMATION AND COMMUNICATION TECHNOLOGY

Interview Date: ..... Interview Time:.....

1. When did you join the department?
2. What are the aims and objectives including any available mission or goal of the ICT department?
3. i) What is the current ICT infrastructure at KRA?
   ii) Does the organization support a single or a multi-vendor architecture?
   iii) What is the current ICT Portfolio at KRA?
4. i) What are the various ICT services that your department supports to KRA staff and other stakeholders?
   ii) Do you have any strategy and implications for current and future ICT service support requirements?
5. i) What are the generally required roles and skills for ICT staff?
   ii) How many staff do you currently have?
   iii) In your opinion, is this number adequate and do you experience any shortfalls in the existing skills for your staff?
   iv) Do you have any strategies in place for addressing shortfalls if any, eg. requirement for hiring short term staff, contractors or consultants, training staff or recruitment of staff?
6. In your role as the ICT manager and a decision maker, at KRA, do you think adequate ICT human resource is key to successful implementation of ICT service support?
7. What are some of the problems and challenges that you experience in your effort to manage the ICT department? Are any of these problems human resource related?
8. What recommendations would you propose to optimize human capacity in ICT service provision?
9. One of the objectives of this study is to develop an Intelligent Agent for optimizing staff allocation for ICT services support. What is your opinion on this?

APPENDIX IV: INTERVIEW GUIDE FOR THE PROJECTS MANAGER IN THE ICT DEPARTMENT

Interview Date: ..... Interview Time:.....

1. Are there any duplicated, overlapping or conflicting activities offered by the ICT department?
2. What are the current and upcoming projects in the ICT department?
3. In your opinion, are there activities not required in future (such as support of obsolete systems)?
4. Do you anticipate any changes through upcoming and future projects that will affect the ICT services provided by the department and what trends can be seen? If so, what new demands and constraints will be placed as the projects manager?
5. Do you have any measures to assess achievement and implementation of ICT projects?
6. What are your requirements for project management support tools in your section?
7. Do you have any requirements for short term staff, contractors or consultants in ICT projects?
8. Do you experience any shortfalls in the existing skills for ICT staff?
9. What are the strengths and weaknesses perceived by management, staff and other stakeholders regarding delivery of services for the current, upcoming and future ICT projects?
10. What is the cost of project management? In your opinion, are these costs seen to provide value for money for KRA's mission and vision?
11. In your role as the Projects manager and a decision maker, at KRA, do you think adequate ICT human resource is key to successful project management and implementation at KRA?
12. What are some of the problems and challenges that you experience in project management? Are any of these problems human resource related?
13. One of the objectives of this study is to develop an Intelligent Agent for allocating staff for ICT services support. What is your opinion on this?

APPENDIX V: QUESTIONNAIRE FOR SENIOR DEPUTY COMMISSIONER, HUMAN RESOURCE

1. In your role as the human resource manager and a decision maker, at KRA, do you think adequate ICT human resource is key to successful implementation of ICT service support?
2. What are some of the problems and challenges that you experience in your effort to hire, recruit and deploy staff in the ICT department?
3. What is the recurrent human capacity estimates at KRA ICT Department? In your opinion, is this number adequate to support ICT services?
4. What are the job descriptions and required skills for ICT staff?
5. How have you ensured that the ICT department is adequately staffed?
6. Do you have any strategy to retain current and future ICT staff?
7. What recommendations would you propose to improve and enhance the provision of adequate ICT staff at KRA?
8. One of the objectives of this study is to develop an Intelligent Agent for optimizing staff allocation in ICT services support. What is your opinion on this?

APPENDIX VI: QUESTIONNAIRE FOR SENIOR DEPUTY COMMISSIONER, SUPPORT SERVICES (MARKETING AND COMMUNICATION) AND DEPUTY COMMISSIONER, DOMESTIC TAXES DEPARTMENT

Interview Date: ..... Interview Time:.....

1. What are the various support services offered by your department?
2. What are the various activities conducted by the ICT staff in your department?
3. How many ICT staff do you currently have? In your opinion, is this number adequate and do you experience any shortfalls in the existing skills for your staff?
4. How have you ensured that your department has access to and provide adequate ICT staff to offer support services to customers?
5. Do you have any strategies in place for addressing shortfalls if any, eg. requirement for hiring short term staff, outsourcing, training staff and addressing overstaffing?
6. In your role as the Support Services Manager and a decision maker, at KRA, do you think adequate ICT human resource is key to successful implementation of ICT service support to customers?
7. What recommendations would you propose to improve and enhance provision of ICT support services at KRA?
8. One of the objectives of this study is to develop an Intelligent Agent for optimizing staff allocation in ICT services support. What is your opinion on this?

APPENDIX VII: QUESTIONNAIRE FOR HEAD OF SECTIONS IN THE ICT DEPARTMENT

1. What is the main role offered by your section?
2. In your opinion, how efficiently is your section seen to support the business and operations in terms of meeting KRA's productivity and customer satisfaction?
3. Do you have any measures to assess achievement and improvement of ICT services in your section?
4. What are your requirements for service management support tools in your section?
5. What are the roles and required skills for your staff?
6. How many staff do you require/have and what are their skills and experiences?
7. Do you have any requirements for short term staff, contractors or consultants?
8. In your opinion, which functions in the ICT department should be centralized? Which functions should be dispersed over several locations?
9. Can all ICT service functions be adequately supported, and are they all relevant to the services provided in your section?
10. How do you ensure that your staff/customers/stakeholders are informed about all services provided by your section?
11. Are there any duplicated, overlapping or conflicting activities offered by your section staff in the department?
12. Do you anticipate any changes that will affect the ICT services provided by your section and what trends can be seen? If so, what new demands and constraints will be placed on your ICT section?
13. What are the strengths and weaknesses perceived by management, staff and other stakeholders regarding delivery of services by your section?
14. What recommendations would you propose to improve and enhance provision of adequate ICT staff at KRA?
15. One of the objectives of this study is to develop an Intelligent Agent for optimizing staff allocation in ICT services support. What is your opinion on this?

APPENDIX VIII: THE DOCUMENTARY REVIEW GUIDE (for the researcher)

OBJECTIVE: To examine and analyze the available KRA documents in respect to meeting the aim of the study which is to investigate the ICT Portfolio and staffing capacity at KRA head office.

Date: ..... Time:.....

Location: ICT Department
Human Resource Management Department
Support Services Department
Domestic Taxes Department

Documents to be examined and analyzed:

a) KRA Strategic Plans
b) KRA Corporate Plans
c) ICT Department Structure
d) Sample of Customer requests and or complaints

APPENDIX IX: KRA STAFF ALLOCATION INTELLIGENT AGENT USER MANUAL

INTRODUCTION

SYSTEM OVERVIEW

The KRA Staff Allocation Intelligent Agent is an application for allocation of tasks to staff in the ICT Department. The system is designed to handle issues related to capturing, processing, storing, retrieval, dissemination and displaying information. In order to use the system, you must register to use the system either as an Administrator or a User. The system has three modules namely: Accounts, Staff and Tasks. The system is user friendly and is easy to navigate through using both the menu-driven and graphical user interface.

BEFORE YOU START

1.1 INSTALLATION REQUIREMENTS

KSAIA is built under Django, a free open-source Python Web-Based framework
and part of it is distributed on DVD. For the program to run and operate well on a personal computer, refer to the minimum and recommended system requirements as presented in Table 5.1 in chapter 5 for proper installation.

1.2 INSTALLATION PROCEDURE

a) Insert the DVD enclosed and open the folder called KSAIA.
b) Copy all the files to a location in your desktop computer.
c) Click on Setup file to install the KSAIA Program.
d) Run the installer when prompted by clicking on ‘RUN’ and follow instructions as prompted.
e) After the installation, you are required to initialize the system from the ‘Start Button’ and enter cmd.pip.

1.3 STARTING THE KSAIA PROGRAM

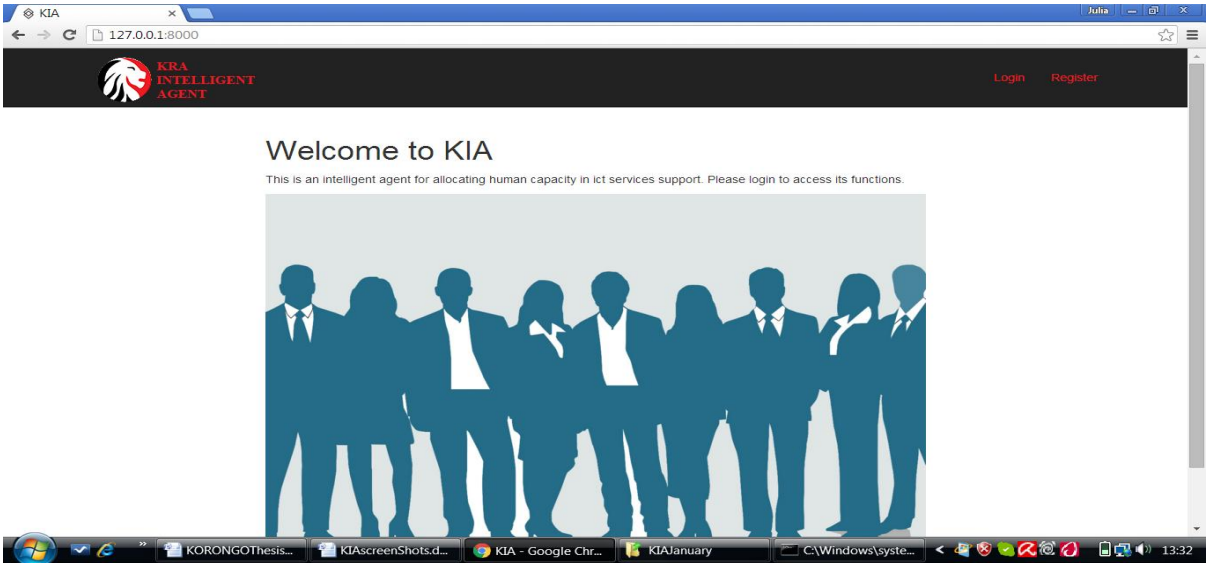
In order to start using KSAIA, first of all open a browser and enter the URL: http://127.0.0.1:8000/.

a) As a new user, you will be required to register so go to installation files and click on start.cmd.

b) Then click on run_once.cmd. The system will prompt for registration details as follows: Enter Username , Lastname, Othernames, Gender, Password , Verify Password.

c) Confirm that the file is running by clicking on the task bar on the desktop.

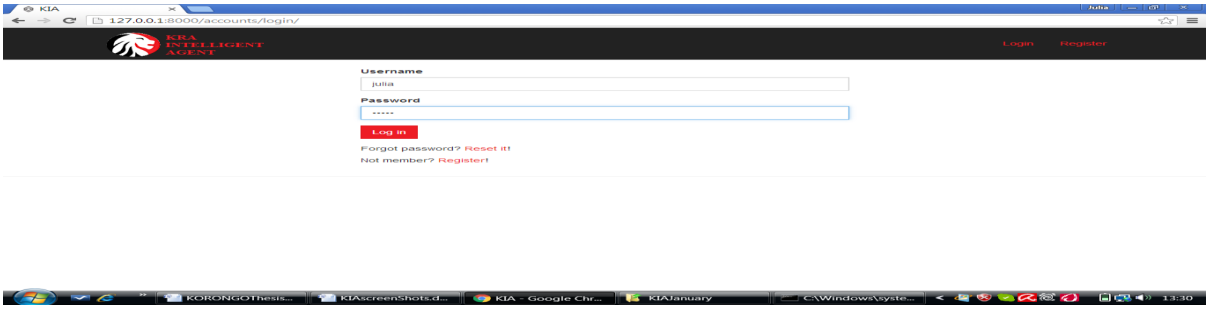
d) The system launches on a Graphical User Interface as shown in screen shot 1 below and displays the home page.



Screen Shot for KSAI's Home Page

1.3.1 Login Module

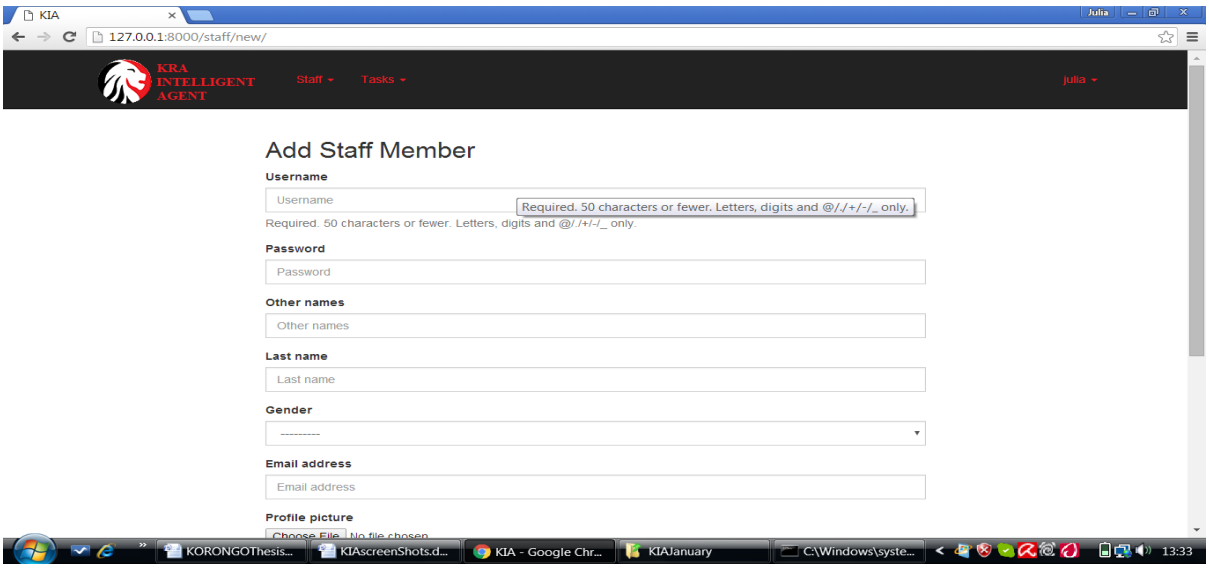
The KSAIA Home Page appears displaying login and register tabs. The login tab allows the user to get access to the system prompting the user's identity at either Administrator or New User account. For new users, use the register tab and provide your details as prompted. Enter username, password and then click login. Use the following login interface to login to the system.



Screen Shot of KSAI's Login Interface

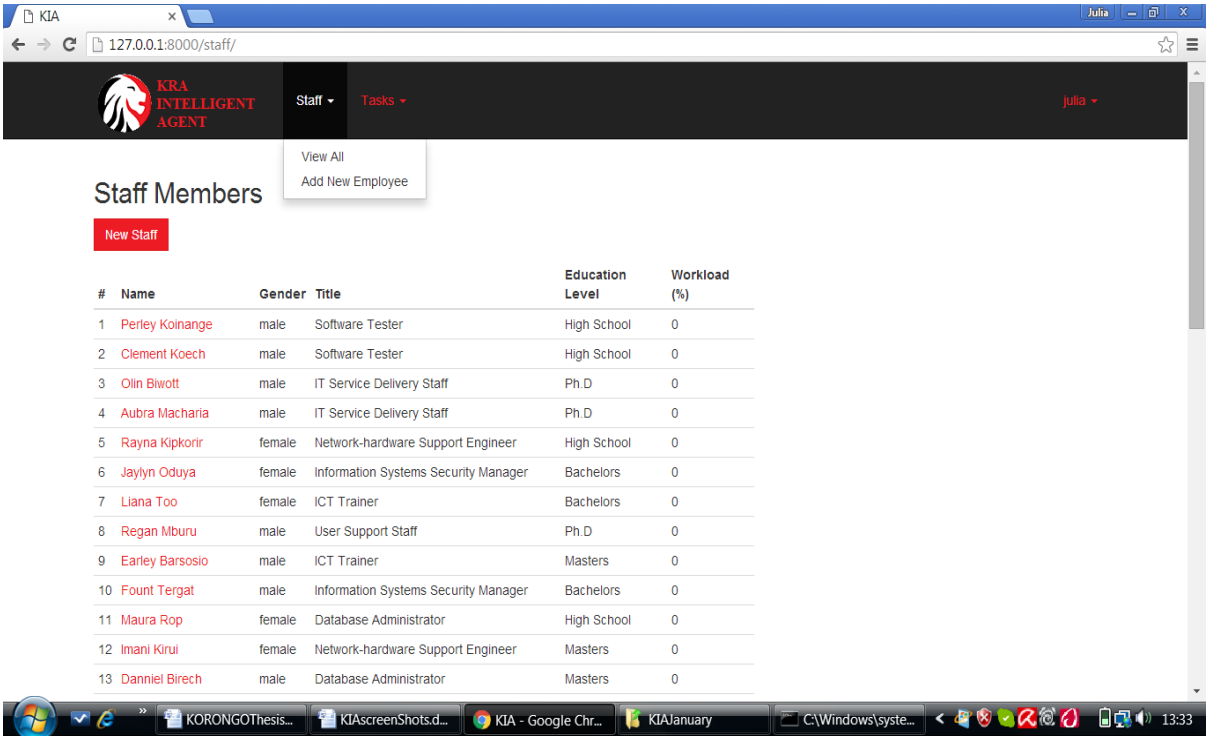
In order to proceed further, select either staff menu or tasks menu.

1.3.2 Staff Module



Screen Shot of KSAIA's New Staff Interface

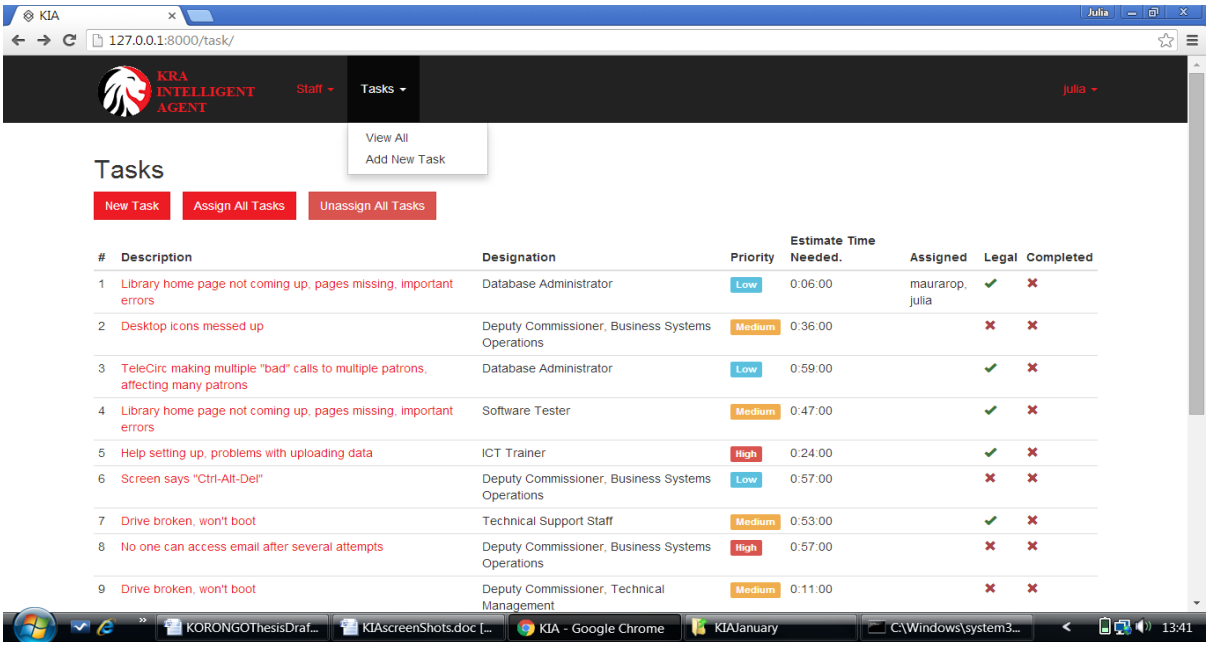
Upon selection of the staff menu as shown above, the user can add new members of staff, update and view all the employees profiles and shown in the figure.



Screen Shot of KSAIA's Staff Module Interface

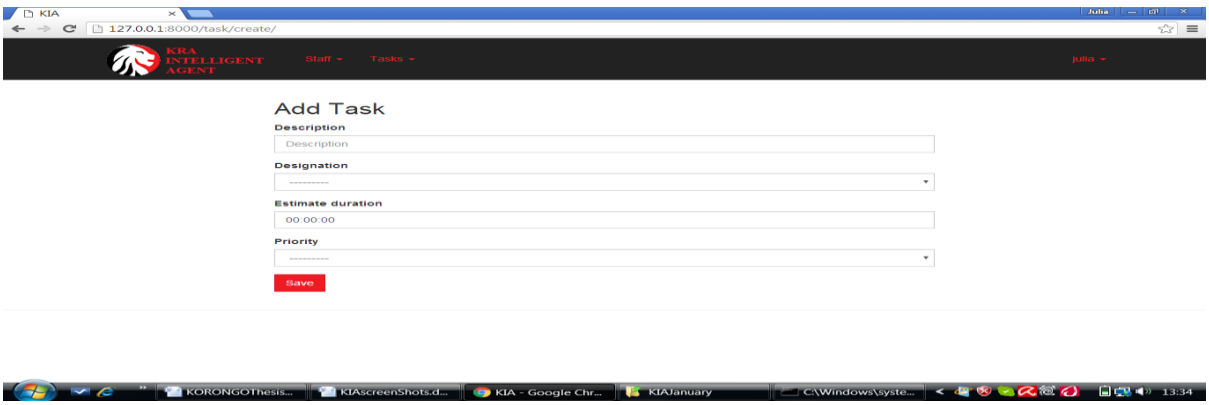
1.3.3 Task Module

Upon selection of the Tasks menu, the user is provided with three tabs: New Task to add a new task, Assign Tasks to assign a task to an employee and Unassign Tasks to deallocate or cancel an already assigned task. The user can further view all the tasks so far assigned with the description of the task, the staff assigned the task, the task priority, the estimated time to accomplish the task, the assignment, the legality and status of completion as shown in the screen shot below.



Screen Shot of KSAIA Tasks Module Interface

The add a new task tab allows a user to add a new task and all the related information as shown in the screen shot below.



Screen Shot of KSAIA's New Task Interface

1.4 QUITTING THE KSAIA PROGRAM

The program should be exited periodically as promoted by the dialog boxes. You can use the following ways to exit the system:

- At the top right, click the name of the user and select logout.
- Select the run_once.cmd on the task bar and press CTRL+FN+BREAK to exit the system.

NB: DO NOT SHUT DOWN YOUR SYSTEM ABRUPTILY.

APPENDIX XI: KSAIA'S SELECTED CODES

INDEX

```
{% extends "base.html" %}
{% load staticfiles %}
{% block content %}
 <div class="container">
  <div class="row">
   <div class="col-md-8 col-md-offset-2
text-justify">
{% if not user.is_authenticated %}
      <h1>Welcome to KSAIA</h1>
      <p>This is an intelligent agent for
allocating human capacity in ict services
support. Please login to access its
       functions.</p>
      <img src="{% static
"img/entrepreneurs.jpg" %}" class="img-
responsive">
{% endif %}
{% if user.is_authenticated %}
{# Display staff depending on permissions
#}
<h1>KSAIA INTELLIGENT AGENT</h1>
      <p class="text-muted">Use the
navigation menu above to access
functions</p>
{# <p>#}
{# An intelligent agent is software that
assists people and act#}
{# on their behalf by allowing people to
delegate work that#}
{# they could have done. This means that
agent software can#}
{#perform repetitive tasks, remember
things that people forgot,#}
{# intelligently coordinate, analyse and
summarize complex data,#}
{#filter important information and even
make recommendations#}
{# to the end-users.#}
{#</p>#}
{# <img src="{% static
"img/entrepreneurs.jpg" %}" class="img-
responsive">#}
{# <p>#}
{# The intelligent agent will therefore,
help to allocate and#}
{# maintain the required ICT human
capacity in the organization.#}
{# The system will be able to assess,
organize,#}
{#predict and accelerate recruitment and
retention of ICT personnel.#}
{#Also to identify any shortages and
surpluses so as to#}
{# maintain the right human capacity to
do the right job at the#}
{# right time for optimizing ICT services
provision in the#}
{# organization.#}
{# </p>#}
      <h3>Department Info</h3>
      <table class="table table-
condensed">
      <thead>
      <tr>
       <th>#</th>
       <th>Designation</th>
       <th>Total Employees</th>
       <th>Total Tasks Recorded</th>
       <th>Pending Tasks</th>
       <th>Unassigned Tasks</th>
      </tr>
      </thead>
      <tbody>
      {% for des in designations %}
       <tr class="{{
des.unassigned_task_count|yesno:"dange
r,default" }}">
       <td>{{ forloop.counter }}</td>
       <td>{{ des.title }}</td>
       <td>{{ des.employee_count }}</td>
       <td>{{ des.task_count }}</td>
       <td>{{ des.pending_task_count
}}</td>
       <td>{{ des.unassigned_task_count
}}</td>
       </tr>
      {% empty %}
       <tr><td colspan="6">No
departments recorded yet!</td></tr>
      {% endfor %}
      </tbody>
```

```
    </table>
    {% endif %}
    </div>
   </div>
  </div>
{% endblock %}
```

BASE DETAILS

```
{% load i18n %}
{% load staticfiles %}
<!DOCTYPE html>
<html lang="en">
<head>
 <meta charset="UTF-8">
 <meta name="viewport"
content="width=device-width, initial-
scale=1.0">
 <link rel="shortcut icon"
href="favicon.png">
 <link
href='https://fonts.googleapis.com/css?fa
mily=.|Open+Sans+Condensed:light,norm
al,bold|Open+Sans+Condensed:light,nor
mal,bold|Open+Sans+Condensed:light,no
rmal,bold|Open+Sans:light,normal,bold'
rel='stylesheet' type='text/css'>
 <link rel="stylesheet" href="{% static
"bootstrap-
3.3.5/dist/css/bootstrap.min.css" %}"/>
 <link rel="stylesheet" href="{% static
"style.css" %}"/>
 <title>{% block title %}KSAIA{% endblock
%}</title>
</head>
<body>
<nav class="navbar navbar-inverse
navbar-static-top">
 <div class="container">
  <div class="navbar-header">
   <button type="button" class="navbar-
toggle collapsed" data-toggle="collapse"
data-target="#bs-example-navbar-
collapse-1" aria-expanded="false">
    <span class="sr-only">Toggle
navigation</span>
    <span class="icon-bar"></span>
    <span class="icon-bar"></span>
    <span class="icon-bar"></span>
   </button>
   <a class="navbar-brand" href="{% url
'index' %}"><img src="{% static
"img/brand-red.png" %}"></a>
  </div>
  <div class="collapse navbar-collapse"
id="bs-example-navbar-collapse-1">
   <ul class="nav navbar-nav">
    {% if user.is_authenticated %}
    {% if user.is_manager %}
     <li class="dropdown">
      <a href="#" class="dropdown-toggle"
data-toggle="dropdown" role="button"
aria-haspopup="true" aria-
expanded="false">Staff <span
class="caret"></span></a>
       <ul class="dropdown-menu">
        <li><a href="{% url 'staff_list'
%}">View All</a></li>
        <li><a href="{% url 'staff_create'
%}">Add New Employee</a></li>
       </ul>
      </li>
    {% endif %}
{# {% if user.designation.name == "Deputy
Commissioner, Service Management"
%}#}
    {% if user.designation.id == 3 %}
     <li class="dropdown">
      <a href="#" class="dropdown-toggle"
data-toggle="dropdown" role="button"
aria-haspopup="true" aria-
expanded="false">Tasks <span
class="caret"></span></a>
       <ul class="dropdown-menu">
        <li><a href="{% url 'task_list'
%}">View All</a></li>
        <li><a href="{% url 'task_create'
%}">Add New Task</a></li>
       </ul>
      </li>
    {% else %}
     <li><a href="{% url 'task_list'
%}">Tasks</a></li>
    {% endif %}
     {% if user.is_staff %}
      <li><a
href="/admin/">Admin</a></li>
     {% endif %}
    {% endif %}
   </ul>
```

```
  <ul class="nav navbar-nav navbar-
right">
    {% if user.is_authenticated %}
     <li class="dropdown">
      <a href="#" class="dropdown-toggle"
data-toggle="dropdown" role="button"
aria-haspopup="true" aria-
expanded="false">{{ user.username }}
<span class="caret"></span></a>
       <ul class="dropdown-menu">
        <li><a href="{% url 'staff' user.pk
%}">Profile</a></li>
        <li><a href="{% url
'auth_password_change' %}">{% trans
"Change password" %}</a></li>
        <li><a href="{% url 'auth_logout'
%}">{% trans "Log out" %}</a></li>
       </ul>
     </li>
    {% else %}
     <li><a href="{% url 'auth_login'
%}">Login</a></li>
     <li><a href="{% url 'register'
%}">Register</a></li>
    {% endif %}
  </ul>
 </div><!-- /.navbar-collapse -->
</div><!-- /.container-fluid -->
</nav>
<div id="content">
 {% block content %}{% endblock %}
</div>
<div id="footer">
 {% block footer %}
  <hr/>
 {% endblock %}
</div>
<script src="{% static "jquery-
1.11.3.min.js" %}"></script>
<script src="{% static "bootstrap-
3.3.5/dist/js/bootstrap.min.js"
%}"></script>
</body>
</html>
```

REGISTRATION

```
{% extends "base.html" %}
{% load i18n %}
{% load bootstrap3 %}
{% block content %}
 <div class="container">
 <div class="row">
  <div class="col-md-8 col-md-offset-2">
     <form method="post" action=".">
      {% csrf_token %}
      {% bootstrap_form form %}
      {% buttons %}
<button type="submit" class="btn btn-
primary">Register</button>
      {% endbuttons %}
{#{{ form.as_p }}#}
{# <input type="submit" value="{% trans
'Submit' %}"/>#}
     </form>
    </div>
   </div>
  </div>
{% endblock %}
```

TASK DETAILS

```
{% extends "base.html" %}
{% block content %}
 <div class="container">
  <div class="row">
   <div class="col-md-6 col-md-offset-3">
    <h2>Task Details</h2>
    <hr>
    <ul class="list-inline">
     <li><a href="{% url 'task_update'
task.pk %}" class="btn btn-
primary">Update Details</a></li>
     <li><a href="{% url 'task_assign' task.pk
%}" class="btn btn-primary">Agent
Assign</a></li>
    </ul>
    <ul class="list-inline">
     <li><strong>Priority:</strong> <span
class="label label-{{ task.priority_class
}}">{{ task.priority_text }}</span></li>
     <li><strong>Legal:</strong> <span
class="glyphicon glyphicon-{{
task.is_legal|yesno:"ok text-
success,remove text-danger,question-
sign" }}"></span></li>
     <li><strong>Completed:</strong>
<span class="glyphicon glyphicon-{{
task.is_completed|yesno:"ok text-
success,remove text-danger"
}}"></span></li>
    </ul>
```

```
   <hr>
   <h4>Description</h4>
   <p>- {{ task.description }}</p>
   <p>- <strong>Designation:</strong> {{
task.designation }}</p>
   <p>- <strong>Estimated Time
Needed:</strong> {{
task.estimate_duration }}</p>
   {% if task.check_in_time %}
    <p>- <strong>Check in Time:</strong>
{{ task.check_in_time }}</p>
   {% endif %}
   {% if task.check_out_time %}
    <p>- <strong>Check Out
Time:</strong> {{ task.check_out_time
}}</p>
   {% endif %}
   <p>- <strong>Actual Time
Used:</strong> {{ task.task_duration
}}</p>
   {% if task.illegal_reasons %}
    <h4>Reasons Illegal</h4>
    <p>{{ task.illegal_reasons|linebreaksbr
}}</p>
   {% endif %}
   <hr>
   <h4>Assigned to</h4>
   -
   {% for u in task.users.all %}
    <a href="{% url "staff" u.pk %}">{{
u.get_full_name }}</a>,
   {% empty %}
    <p>Not assigned to any one yet</p>
   {% endfor %}
  </div>
 </div>
</div>
{% endblock %}
```

TASK FORM

```
{% extends "base.html" %}
{% load bootstrap3 %}
{% block content %}
 <div class="container">
  <div class="row">
  <div class="col-md-8 col-md-offset-2">
      {% if task %}
        <h2>Edit Task</h2>
      {% else %}
        <h2>Add Task</h2>
      {% endif %}
      <form method="post"
enctype="multipart/form-data">
        {% csrf_token %}
        {% bootstrap_form form %}
        {% buttons %}
          <button type="submit" class="btn
btn-primary">Save</button>
        {% endbuttons %}
      </form>
    </div>
   </div>
 </div>
{% endblock %}
```

USER DETAILS

```
{% extends "base.html" %}
{% block content %}
 <div class="container">
  <div class="row">
    <div class="col-md-3">
    <h2>Employee Details</h2>
      <div>
        {% if u.profile_picture %}
<img src="{{ u.profile_picture.url }}"
class="img-responsive">
        {% else %}
 <img src="http://placehold.it/200x200"
class="img-responsive">
        {% endif %}
      </div>
      <ul class="list-unstyled">
        <li>Name: {{ u.get_full_name }}</li>
        <li>Gender: {{ u.gender }}</li>
        <li>Username: {{ u.username }}</li>
        <li>Title: {{ u.designation.title }}</li>
        {% if u.is_manager %}
          <li><p><span class="label label-
success">Manager</span></p></li>
        {% endif %}
    <li><a href="{% url 'staff_update' u.pk
%}" class="btn btn-primary">Update
Profile</a></li>
      </ul>
    </div>
    <div class="col-md-9">
      <h3>Job Description</h3>
      <p>{{ u.designation.job_description
}}</p>
      <h3>Qualifications</h3>
```

```
      <p>Education level is at the
       <strong>{{ u.education_level
}}</strong> level.</p>
      <p>
<strong>Degree/Course:</strong> {{
u.qualifications.all|join:', ' }}
      </p>
      <hr>
      <h3>Work Schedule</h3>
{# {{ u.next_available_time }}#}
     <table class="table table-condensed">
      <thead>
      <tr>
       <th>#</th>
       <th>Description</th>
       <th>Priority</th>
       <th>Est. Duration</th>
       <th>Actual Duration</th>
       <th>Scheduled at</th>
       <th>Completed</th>
       <th>Action</th>
      </tr>
      </thead>
      <tbody>
      {% for task in tasks %}
       <tr>
       <td>{{ forloop.counter }}</td>
       <td><a href="{% url 'task' task.pk
%}">{{ task.description }}</a></td>
       <td><span class="label label-{{
task.priority_class }}">{{ task.priority_text
}}</span></td>
       <td>{{ task.estimate_duration
}}</td>
       <td>{{ task.task_duration }}</td>
       <td>{{ task.start_time }}</td>
    <td><span class="glyphicon glyphicon-{{
task.is_completed|yesno:"ok text-
success,remove text-danger"
}}"></span></td>
    <td>
    {% if not task.check_in_time and not
task.check_out_time %}
    <a href="{% url 'task_check_in' task.pk
%}" class="btn btn-info">Check in</a>
         {% elif task.check_in_time and not
task.check_out_time %}
  <a href="{% url 'task_check_out' task.pk
%}" class="btn btn-info">Check out</a>
         {% endif %}
       </tr>
      {% empty %}
       <tr><td colspan="4">No tasks
assigned yet!</td></tr>
      {% endfor %}
      </tbody>
     </table>
     </div>
    </div>
   </div>
{% endblock %}
```

USER FORM

```
{% extends "base.html" %}
{% load bootstrap3 %}
{% block content %}
 <div class="container">
 <div class="row">
  <div class="col-md-8 col-md-offset-2">
      {% if u %}
  <h2>Edit {{ u.get_full_name }}</h2>
      {% else %}
       <h2>Add Staff Member</h2>
      {% endif %}
      <form method="post"
enctype="multipart/form-data">
       {% csrf_token %}
       {% bootstrap_form form %}
       {% buttons %}
        <button type="submit" class="btn
btn-primary">Save</button>
       {% endbuttons %}
{# {{ form.as_p }}#}
{# <input type="submit"/>#}
      </form>
     </div>
    </div>
   </div>
{% endblock %}
```