



UNIVERSITY OF NAIROBI
SCHOOL OF COMPUTING AND INFORMATICS
MSC. INFORMATION SYSTEMS

**“Towards Enterprise Architecture for
Road Transport Administration in Kenya”**

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**Research project submitted in partial fulfillment of the requirements for the
award of the Degree of Master of Science in Information Systems**

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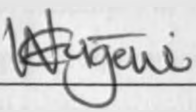
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DECLARATION

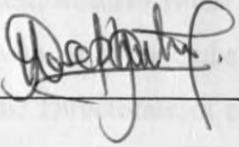
This project, as presented in this report, is my original work and has not been presented for any other University award.

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This project has been submitted as part fulfillment of requirements for the Master of Science in Information Systems of the University of Nairobi with my approval as the University supervisor.

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ABSTRACT

The purpose of this research project was to establish how Enterprise Architecture can be used to ensure that the Road Transport Department (RTD) of the Kenya Revenue Authority (KRA) derives optimal value from IT investments. As pressure mounts on the government to provide better (faster and more cost effective) public services, focus has turned to ICTs to enable the government to deliver on its mandate. Attempts at automation of government services are however fraught with failure as a result of poor requirements specifications and disjointed automation initiatives. This research project sought to determine the extent to which Enterprise Architecture can be relied upon to influence the successful automation of Road Transport Department services.

The Road Transport Department lacks an Enterprise Architecture and thus misses out on the benefits offered by Enterprise Architecture. These benefits include seamless service delivery by the department, and faster, easier and cheaper development and deployment of information systems.

Both Primary and Secondary data were used in this study. Primary data was collected using Interviews and Questionnaires while KRA surveys were the source for secondary data. Interviews were conducted with select members of staff of the Road Transport Department, KRA ICT Department, and the Directorate of e-government. Questionnaires were administered to members of the general public seeking RTD's services. KRA surveys were provided by KRA's Research and Corporate Planning Department.

A vast majority of RTD's customers (86%) rate service delivery by the department as either average or poor. This indicates failure by the department to meet customer needs. Long queues, fragmented services and poor automation were cited as the major challenges faced by customers seeking RTD services. RTD has diverse un-integrated systems with some processes partly automated. The systems are not secure, lack data integrity and are based on obsolete technology. Whereas RTD management appreciates the importance of ICTs in improving service delivery, there is a lack of understanding of what ICTs to adopt and how to do so in a systematic manner to meet the departments business objectives.

This study shows that Enterprise Architecture is required to streamline the department's operations and derive value for money from ICT investments. The methodology for developing an Enterprise Architecture is defined and a sample Enterprise Architecture for the department has been developed. The Open Group Architecture Framework (TOGAF) was the Enterprise Architecture

Framework used to develop the sample Enterprise Architecture for RTD. Enterprise Architecture should however not be regarded as a one-time event. The department needs to set up an Enterprise Architecture function to develop and update the department's Enterprise Architecture as well as sensitise staff on Enterprise Architecture.

DEDICATION

I dedicate this work to God Almighty for His grace and providence; and to my mother Meresha Achieng Waluvengo for her constant support and prayers.

ACKNOWLEDGEMENTS

I am grateful to all the people who assisted me to complete this research project. First I wish to thank my supervisor Mr. Joseph Ogutu for his dedicated effort in guiding me during the course of the study. Thanks are due also to the other panelists of the three member supervisors' panel, Dr. Peter Wagacha and Mr. Andrew Mwaura, who reviewed my work at the various stages of the study. Special thanks to the management of KRA for granting me permission to conduct the study; the staff at the KRA Road Transport Department, ICT Department, Research and Corporate Planning Department, and the KRA Library for their support in providing responses to my questions and availing scholarly resources for the project.

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LIST OF ABBREVIATIONS

CCRS	Common Cash Receipting System
DLMS	Driving Licence Management System
EA	Enterprise Architecture
EAF	Enterprise Architecture Framework
FEAR	Finnish Enterprise Architecture Research
ICT	Information and Communications Technology
IT	Information Technology
ITMS	Integrated Tax Management System
KRA	Kenya Revenue Authority
NEA	National Enterprise Architecture
OECD	Organization for Economic Co-operation and Development
RTD	Road Transport Department
TOGAF	The Open Group Architecture Framework
VMS	Vehicle Management System

DEFINITION OF KEY TERMS

Table 2 below presents definitions of terms used in this document.

Table 1: Definitions

No	Term	Definition
1.	Enterprise	An organization (or cross-organizational entity) supporting a defined mission (or set of related missions).
2.	Architecture	The structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time.
3.	Framework	A basic conceptual structure used to solve or address complex issues.
4.	Enterprise Architecture (EA)	A strategic information asset base, which defines the mission, the information necessary to perform the mission and the technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to the changing mission needs.
5.	Baseline architecture	The set of products that portray the existing enterprise, the current business practices, and technical infrastructure. Commonly referred to as the "As-Is" architecture.
6.	Target architecture	The set of products that portray the future or end-state enterprise, generally captured in the organization's strategic thinking and plans. Commonly referred to as the "To-Be" architecture.
7.	Sequencing Plan	A document that defines the strategy for changing the enterprise from the current baseline to the target architecture. It schedules multiple, concurrent, interdependent activities, and incremental builds that will evolve the enterprise.
8.	Architectural Artifact	A specific document, report, analysis, model, or other tangible that contributes to an architectural description
9.	Architectural Description	A collection of products (artifacts) to document an architecture
10.	Architectural Methodology	A generic term that can describe any structured approach to solving some or all of the problems related to architecture
11.	Architectural Process	A defined series of actions directed to the goal of producing either an architecture or an architectural description
12.	National Enterprise Architecture (NEA)	A National Enterprise Architecture (NEA) is a strategic planning framework that relates and aligns ICT with the governmental functions that it supports. Also referred to as Government Enterprise Architectures (GEAs).
13.	Enterprise Architecture Framework (EAF)	A framework for an Enterprise Architecture, which defines, how to organize the structure and views associated with an Enterprise Architecture.
14.	e-Government	Use of information and communication technology to provide and improve government services, transactions and interactions with citizens, businesses, and other arms of government.

1. INTRODUCTION

As organizations become more dependent on Information and Communication Technology (ICT) to carry out their mandates, their major concern is how to align business with ICT in order to optimize profit from ICT investments. There are several tools that have been developed to address this concern including the I.T Balanced Score Card, the I.T value chain, and Enterprise Architecture. Enterprise Architecture presents the most comprehensive tool for aligning business with ICT in order to derive maximum gains from ICT investments.

Enterprise Architecture (EA) can be defined as the “blueprint that documents all the information systems within the enterprise, their relationships, and how they interact to fulfill the enterprises mission” (Langenberg & Wegmann, 2004). Enterprise Architecture establishes the organisationwide roadmap to achieve an organisation’s mission through optimal performance of its core business processes within an efficient I.T environment. Simply stated, an Enterprise Architecture (EA) explains how the information systems, processes, organisational units and people in an organisation function as a whole.

Enterprise Architecture enables managers to make sound decisions with regard to changes to the I.T infrastructure as the interfaces between various systems are clearly understood. Without a well defined and enforced Enterprise Architecture, organizations run the risk of buying and building systems that are duplicative, incompatible and unnecessarily costly to maintain and interface.

Governments are increasingly adopting EA in their quest for more results-oriented, efficient and citizen centered government. By identifying, structuring and categorising elements, Enterprise Architecture increases the potential for cross-public sector reuse, reduced duplication, and thus leading to reduced costs (Janssen & Hjort-Madsen, 2007). Enterprise Architecture promises to fill the gap between ICT policy and implementation. Countries that have developed and implemented National Enterprise Architectures include Denmark, the Netherlands, Canada, Estonia, Finland, Hungary, Japan, Korea, New Zealand, Singapore, Sweden, Switzerland, Taiwan, the U.K, and USA (Christiansen & Gøtze, 2006)

Kenya’s Road Transport Department lacks an Enterprise Architecture. Thus decisions to acquire systems are not made in a structured manner, there are overlaps in functionalities of information systems, and deployment of systems is costly. The value of Enterprise Architecture is not clear and

there is a lack of understanding of how an Enterprise Architecture for the department can be developed. The purpose of this research project was to address these concerns.

1.1 Background

Road Transport Department (RTD) is one of the revenue departments of the Kenya Revenue Authority. The department has its headquarters in Times Tower Building, Nairobi with regional offices in 14 other locations countrywide. RTD is principally a service department handling 65% of KRA customers.

The department is charged with the responsibility of undertaking registration and licensing of drivers and all motor Vehicles and trailers in the Republic of Kenya under the following statutory provisions:

- i. Traffic Act Chapter 403
- ii. Second Hand Motor Vehicle Purchase Act Chapter 484
- iii. Transport Licensing Board Act Chapter 404

RTD Business Functions

- i. Registration of motor vehicles and Trailers
- ii. Licensing of drivers
- iii. Transfer of motor vehicle ownership
- iv. Issue of duplicate registration books and licenses
- v. Issue of motor vehicle copy of records
- vi. Keeping and maintenance of such records
- vii. Promote road safety
- viii. Collection of Traffic Revenue related to Administration of Traffic Act, Second hand MV Purchase Act and TLB Act
- ix. Licensing driving schools and instructors
- x. Licensing of motor vehicle dealers

KRA Vision

To be the leading Revenue Authority in the world respected for Professionalism, Integrity and Fairness.

KRA Mission

To promote compliance with Kenya's tax, trade and border legislation and regulation by promoting standards set out in the Taxpayer's Charter and responsible enforcement by highly motivated and professional staff thereby maximising revenue collection at the least possible cost for the socio-economic well being of all Kenyans.

Quality Policy Statement

Road Transport Department being a constituent department of Kenya Revenue Authority is committed to developing a dedicated professional team, embracing modern processes and technologies and delivering customer focused services that enhance compliance and revenue collection. The department shall endeavor to continually improve revenue collection and service delivery by meeting the requirements of ISO 9001:2008 Standard on Quality Management Systems.

Road Transport Stakeholders

Table 2: Road Transport Stakeholders

	Stakeholder	Role
1.	KRA Road Transport Department (RTD)	Registration & licensing of vehicles and drivers.
2.	Ministry of Transport	Policy formulation
3.	Ministry of Home Affairs	Production of Number plates
4.	Police	<ul style="list-style-type: none">- Enforcement- Driver testing- Driving school licensing- Motor Vehicle Inspection
5.	Customs	<ul style="list-style-type: none">- Handle Vehicle Imports, Exports, Re-exports, and transit.- Collection of motor vehicle registration fees.
6.	Association of Kenya Insurers	Insuring of vehicles
7.	Motor Vehicle Dealers	Buying and selling of motor vehicles
8.	Matatu Owners & Welfare Associations	Represent the interest of PSV owners as well as PSV drivers and conductors
9.	Driving Schools	Train individuals to be drivers
10.	The general public	Apply for the various services offered by the department.

RTD Offices Locations

1. Nairobi – Times Tower
2. Mombasa – Forodha House
3. Kisumu – Swan Centre
4. Nakuru – Standard Bank Building
5. Eldoret – Kiptagen House
6. Kericho – DC’s Compound
7. Garissa – KRA Offices
8. Machakos – Otisi Building
9. Malindi – Malindi Complex Building
10. Kisii – Family Finance Building
11. Kakamega – Ambwere Complex
12. Meru – KRA Offices
13. Embu – Wanjiku Centre
14. Nyeri – Premier Plaza
15. Thika – Thika House

1.2 Statement of the Problem

The Road Transport Department of the Kenya Revenue Authority lacks an Enterprise Architecture and thus misses out on the benefits offered by Enterprise Architecture. These benefits include seamless service delivery by the department, and faster, easier and cheaper development and deployment of information systems.

1.3 Justification of the Study

This study was aimed at giving decision makers at the Kenya Revenue Authority and the Ministry of Transport insight into what needs to be done to implement Enterprise Architecture in the Road Transport Department. An Enterprise Architecture offers tangible benefits to the enterprise and those responsible for evolving the enterprise. Below are some benefits of implementing an Enterprise Architecture:-

- i. EA promotes better planning and decision making – by capturing facts about the mission, functions, and business foundation of the enterprise in an understandable manner.

- ii. Improved communication – EA enhances communication among the business organizations and IT organizations within the enterprise through a standardized vocabulary.
- iii. Management of extensive, complex environments – EA facilitates this by providing architectural views that help communicate the complexity of large systems.
- iv. Adoption of new technology – EA helps enterprises to focus on the strategic use of emerging technologies to better manage the enterprise information and consistently insert those technologies into the enterprise.
- v. Enhanced Information systems – EA leads to improved consistency, accuracy, timeliness, integrity, quality, availability, access, and sharing of IT-managed information across the enterprise. In addition, EA facilitates faster and easier development of systems through re-use of components.
- vi. Cost effectiveness – EA highlights opportunities for building greater quality and flexibility into applications without increasing cost.
- vii. Economies of scale – EA facilitates the achievement of this by providing mechanisms for sharing services across the enterprise.
- viii. Faster systems integration – EA facilitates the expedited integration of legacy, migration, and new systems.
- ix. Enterprise Architecture facilitates legal and regulatory compliance by the enterprise.

1.4 Research Objectives

The objectives of this research project were as follows:-

- i. To illustrate the importance of Enterprise Architecture in enhancing service delivery in the Road Transport Department.
- ii. To evaluate the suitability of existing Enterprise Architecture Frameworks in defining an Enterprise Architecture for the Road Transport Department and recommend the most suitable framework.
- iii. To develop a sample Enterprise Architecture for the Road Transport Department.
- iv. To formulate an implementation strategy for Enterprise Architecture in the Road Transport Department.

1.5 Research Questions

This research project sought to answer the following questions;

- i. Does the Road Transport Department need an Enterprise Architecture?
- ii. Are existing Enterprise Architecture Frameworks suitable for developing an Enterprise Architecture for the department?
- iii. What would be a suitable approach to developing an Enterprise Architecture for the department?
- iv. What would be the appropriate implementation strategy for RTD's Enterprise Architecture?

1.6 Limitation of the Study

The lack of prior research studies in the area of Enterprise Architecture in African countries was a limitation to this study. The researcher lacked the benefit of accessing studies based in a comparable setting to Kenya. All the Enterprise Architecture Research studies consulted were based in western nations (the United States of America and Europe).

1.7 Theoretical Framework

The ICT policy making landscape in Kenya is strewn with many carcasses; of attempts, drafts, and communiqués (Etta & Elder, 2005). Policy implementation also suffers from inadequate strategies. This state of affairs has been attributed to the lack of stakeholder involvement in policy formulation and a lack of understanding of the intricacies of the components and interactions of information systems by implementers of policy. In Kenyan government agencies, ICT systems that have been installed so far remain disjointed and fragmented and the ICT solutions are generally under-utilised, thus duplication and wastage remain (Etta & Elder, 2005).

In order to enhance interoperability, to eliminate overlapping projects, and to support reuse, several governments around the world have established Enterprise Architecture programmes (Liimatainen, Hoffmann & Heikkilä, 2007). The aim of this research project is to determine how ICT policy formulation and implementation in the Road Transport Administration can benefit from Enterprise Architecture.

1.8 Conceptual Framework

From a review of literature, the researcher selected The Open Group Architecture Framework (TOGAF) as the most suitable EA Framework for defining RTD's Enterprise Architecture. This is because TOGAF is suited for developing public sector Information systems due to the fact that it is based on open standards (it may be used freely) and users are allowed to make modifications to it to suit their situation. TOGAF is also the most comprehensive and easy to understand AE Framework as it contains a detailed method and a set of supporting tools for developing an Enterprise Architecture. The diagram below illustrates the eight phases of TOGAF (The Open Group Architecture Forum, 2009).

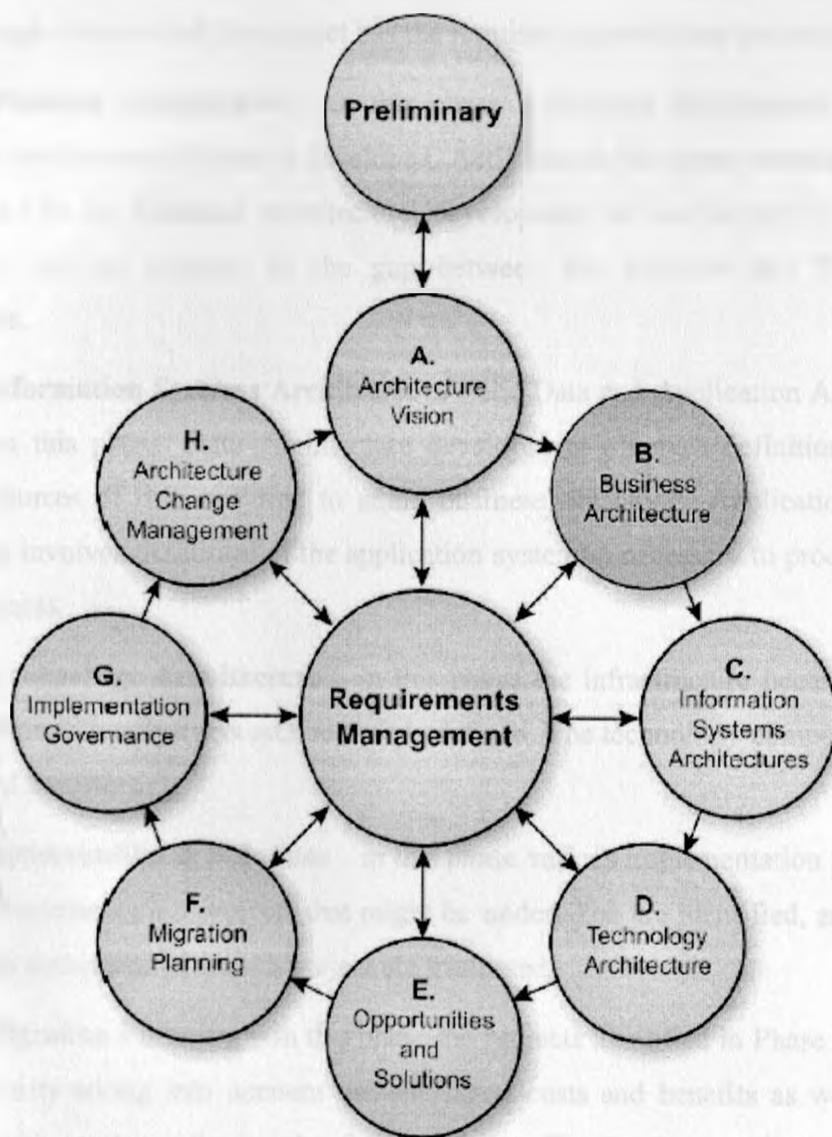


Figure 1: TOGAF Architecture Development Method Phases

The TOGAF Architecture Development Method (ADM) provides a tested and repeatable process for developing Enterprise Architectures. A description of the TOGAF ADM phases follows:

- i. The **Preliminary Phase** – in this phase the organisation makes the necessary preparations to ensure that the Enterprise Architecture programme delivers the benefits for which it is being implemented. Activities performed in this phase include set up of the EA function and staffing it appropriately, and defining the EA framework and detailed methods.
- ii. **Phase A: Architecture Vision** – this is the initial phase of an architecture development cycle. In this phase the EA project scope is defined, stakeholders and their concerns are identified, the EA vision is articulated, and a project plan is formulated. In this phase, the EA project manager ensures that the project has the requisite support from the stakeholders.
- iii. **Phase B: Business Architecture** – in this phase a Business Architecture to support the agreed upon Architecture Vision is developed. Activities in this phase include description of the Baseline (As Is) Business Architecture, development of the Target (To Be) Business Architecture and an analysis of the gap between the Baseline and Target business Architectures.
- iv. **Phase C: Information Systems Architectures** – the Data and Application Architectures are developed in this phase. Data Architecture development involves definition of the major types and sources of data required to attain business objectives. Application Architecture development involves definition of the application system(s) necessary to process data and to support business.
- v. **Phase D: Technology Architecture** – in this phase the infrastructure necessary to support the target Information Systems architecture is defined. The technology components comprise Software and hardware.
- vi. **Phase E: Opportunities & Solutions** – in this phase various implementation possibilities are evaluated, Implementation projects that might be undertaken are identified, and the business opportunities associated with each project are evaluated.
- vii. **Phase F: Migration Planning** – in this phase the projects identified in Phase E are sorted by order of priority taking into account the envisaged costs and benefits as well as the risks associated with implementing each of the projects. The implementation plan as well as resource requirements for the projects are defined in this phase.

- viii. **Phase G: Implementation Governance** – oversight of the implementation of the target architecture is provided in this phase. To facilitate this, acceptance criteria and lists of risks and issues are specified.
- ix. **Phase H: Architecture Change Management** – in this phase, procedures for managing change to the target architecture are established.
- x. **Requirements Management** – has to do with the establishment of the process of managing architecture requirements throughout the Enterprise Architecture Cycle.

2. LITERATURE REVIEW

As part of public sector modernization initiatives, governments seek to offer their citizens a seamless service delivery. “Today, public sector’s information and communication technology (ICT) initiatives can no longer be developed in silos with no regards to other parts of the government” (Liimatainen, 2008). Interoperability is required to achieve this kind of service.

In many countries including Kenya, e-Government has not been able to adequately address the concerns that stakeholders have about how to utilize ICT to its fullest strategic extent. One solution employed by governments has been to initiate Enterprise Architecture programs. Enterprise architecture (EA) is a hierarchical approach for aligning business and ICT (Langenberg & Wegmann, 2004) and it describes how the information systems, processes, organizational units and people in an organization function as a whole (Morganwalp & Sage, 2004).

EA has also been defined as “a strategic information asset base, which defines the mission, the information and technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to the changing mission needs”. An enterprise architecture “includes baseline architecture, target architecture, and a sequencing plan” (CIO Council, 2001). “In plain language, an EA documents the entire business as it exists, as well as how it is projected to be at some future date, and by analyzing the differences between the two states, defines what needs to be done to achieve the desired target state” (EA Program Support, 2007).

“The origin of Enterprise architecture like all other architectures within information technology can be traced to lessons learned from building architecture” (McGovern, 2003). In the building industry, there are specialized experts such as masons, plumbers and carpenters who have mastered a particular aspect of construction each of which is responsible for solving specialized problems. “Whereas these specialized experts are responsible for the details of construction, the role of the architect (general contractor) is primarily focused on providing the overall blueprint for the structure and managing the relationships that exist between the client and the specialists” (McGovern, 2003).

“The role of the Enterprise Architect has many parallels to the building trade. As organizations and their systems grow larger, the complexity of incorporating business specifications, use of distributed teams and integration with external parties have necessitated the creation of the role of Enterprise Architect whose primary responsibility is to ensure the integrity of information systems and the development process” (McGovern, 2003). Garlan, 1992 stated, “as the size and complexity of

software systems increases, the design problem goes beyond the algorithms and data structures of the computation: designing and specifying the overall system structure emerges as a new kind of problem. This is the software architecture level of design.” Enterprise architecture diagrams the blueprints for all of the people within an organization so they know how to build an agile enterprise. “The blueprint like that of a building is meant to provide sufficient detail to allow the idea to become a reality when put in the hands of skilled professionals” (McGovern, 2003).

“Government departments usually have several independent e-government projects, which may have limited coherence and remain largely uncoordinated” (Hjort-Madsen, 2007). EA can enable decision makers to understand the relationships between IT projects and manage change. This is because EA presents a holistic view of the enterprise. “Enterprise architecture provides significant benefits to an organization that embraces it” (Emery, 2007). “An effective enterprise architecture is critical in helping organizations to provide value to their customers, optimize their internal resources and meet their business needs” (Hayes, (2003).

“Tangible benefits offered by Enterprise Architecture include: capture of facts about the organisation’s mission, functions, and business foundation in an understandable manner to promote better planning and decision making; provision of architectural views that help communicate the complexity of large systems and facilitate management of extensive, complex environments; enhancement of consistency, accuracy, timeliness, integrity, quality, availability, access, and sharing of IT-managed information across the enterprise; highlighting of opportunities for building greater quality and flexibility into applications without increasing cost; achievement of economies of scale by providing mechanisms for sharing services across the enterprise and ensuring legal and regulatory compliance. The primary purpose of an EA is to *inform*, *guide*, and *constrain* the decisions for the enterprise, especially those related to IT investments” (CIO Council, 2001).

To develop an Enterprise Architecture, an Enterprise Architecture Framework is required. “An architecture framework is a tool which can be used for developing a broad range of different architectures (architecture descriptions). It should describe a method for designing an information system in terms of a set of building blocks, and for showing how the building blocks fit together” (The Open Group Architecture Forum, 2009).

There are many Enterprise Architecture frameworks available today. The top four EA frameworks are Zachman Enterprise Architecture Framework, The Open Group Architecture Framework

(TOGAF), Federal Enterprise Architecture Framework (FEAF), and the Gartner Enterprise Architecture Framework. These EA Frameworks are different from each other, both in goals and in approach (Sessions, 2007). Thus an informed decision needs to be made on which EA Framework is most appropriate for use by an organization.

“The Zachman Framework is actually a taxonomy for organizing architectural artifacts (in other words, design documents, specifications, and models) that takes into account both who the artifact targets (for example, business owner and builder) and what particular issue (for example, data and functionality) is being addressed” (Sessions, 2007). Zachman Enterprise Architecture Framework “as it applies to Enterprises is simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise, as well as to the development of the Enterprise's systems” (Zachman).

The Federal Enterprise Architecture (FEA) is “the latest attempt by the American Federal Government to unite its myriad agencies and functions under a single, common and ubiquitous enterprise architecture. FEA is still in its infancy, as most of the major pieces have been available only since 2006” (Sessions, 2007). FEA’s objectives are to provide “a common language and framework to describe and analyze IT investments, enhance collaboration and ultimately transform the Federal government into a citizen-centered, results-oriented, and market-based organization (FEAPMO, 2006).

The Gartner EA framework “is the enterprise-architecture practice of one of the best known IT research and consulting organizations in the world: Gartner” (Sessions, 2007). Gartner EA framework is basically best practice in Enterprise Architecture. This best practice is applied depending on the needs of a client. “Enterprise Architecture, in the Gartner view, is about strategy, not about engineering. It is focused on the destination. The two things that are most important to Gartner are where an organization is going and how it will get there (Sessions, 2007).

“The Open Group Architecture Framework (TOGAF) is a detailed method and a set of supporting tools for developing an Enterprise Architecture” (Sessions, 2007). “TOGAF may be used freely by any organization wishing to develop an Enterprise Architecture for use within that organization (The Open Group Architecture Forum, 2009). TOGAF has been identified as the most suitable EA Framework for the public sector due to the fact that “it is based on open standards and users are

allowed to make modifications to it to suit their situation” (The Open Group Architecture Forum, 2009).

(Sessions, 2007) states that TOGAF divides an Enterprise Architecture into four categories, as follows:

- i. Business architecture – Describes the processes the business uses to meet its goals.
- ii. Application architecture – Describes how specific applications are designed and how they interact with each other.
- iii. Data architecture – Describes how the enterprise data-stores are organized and accessed.
- iv. Technical architecture – Describes the hardware and software infrastructure that supports applications and their interactions.

“TOGAF has been developed through the collaborative efforts of 300 Architecture Forum member companies from some of the world’s leading IT customers and vendors and represents best practice in architecture development. Using TOGAF as the architecture framework will allow architectures to be developed that are consistent, reflect the needs of stakeholders, employ best practice, and give due consideration both to current requirements and to the likely future needs of the business” (The Open Group Architecture Forum, 2009).

Due to Enterprise Architecture’s importance, most developed countries have implemented Enterprise Architecture Programmes and formulated EA legislation and regulations. In the United States of America for instance, “the Clinger-Cohen Act (CCA), formerly the Information Technology Management Reform Act of 1996 (ITMRA), was adopted by the US Congress to improve the way the federal government acquires, uses and disposes information technology. The Act guides the development and maintenance of Information Technology Architectures (ITAs) by federal agencies to maximize the benefits of IT within the Government” (US Congress, 1996). “Specifically, the CCA was enacted to facilitate better management of strategic plans, enhance IT acquisition practices, justify IT expenditures, measure IT performance, report results to Congress, integrate new technologies, and manage information resources” (EA Program Support, 2007).

Denmark is another country that is at the forefront of Enterprise Architecture implementation in the public sector and is one of the early adopters of EA. “Like a number of other countries, Denmark has now placed enterprise architecture high on its agenda because through enterprise architecture it is possible to govern the organisation and interoperability of IT systems. A coherent enterprise

architecture framework in the public sector is an important factor in enhancing E-government by enabling dispensing with 'technological islands' leading to creation of a platform for more efficient work practices. EA enables this by providing government agencies with the capability to use each other's data so that citizens, companies and case officers do not have to provide and check the same information over and over again" (Working Group on IT Architecture, 2003).

In Kenya, most of the public sector ICT projects are developed within each public organization with limited consideration of cross-organizational coherence. ICT systems that have been installed so far remain disjointed and fragmented and the ICT solutions are generally under-utilized, thus duplication and wastage remain (Etta & Elder 2005). The focus today in many countries has shifted towards coordinated services offering one-stop shops to citizens and businesses (OECD, 2007). Policymakers initiate Enterprise Architecture programs to ensure interoperability, avoid duplicating efforts and enable reuse (Janssen & Hjort-Madsen, 2007). By identifying, structuring and categorizing elements, Enterprise Architecture can reduce duplication and hence reduce costs (Liimatainen, 2008).

3. METHODOLOGY

To carry out this project effectively, the researcher relied heavily upon information from staff of the Road Transport Department. The top management of the department provided a team of seven officers (one from each of the RTD sections) to provide the requisite information to facilitate the development of a sample Enterprise Architecture for the department. The researcher first sought to understand the department and how it operates. This was done through interviews and document review. After a sufficiently good understanding of the department had been achieved, the researcher established the need for an Enterprise Architecture for the Road Transport Department. Through literature review and considering the needs of the department, the researcher selected TOGAF Architecture Development Method as the basis for formulating the sample Enterprise Architecture for RTD.

3.1 Target Population

Sources of information for this research included members of staff of the Road Transport Department, RTD Customers, members of staff of KRA's Research and Corporate Planning department, and a member of staff of the Directorate of e-Government. Table 3 below presents the numbers of people who were targeted to participate in this research in their various categories.

Table 3: Target Population Numbers and Roles

	Population	Number	Role
1.	RTD Staff	8	Provide interview questions responses and material for document review
2.	RTD Customers	50	Fill questionnaire responses
3.	Research & Corporate planning staff	1	Provide material for document review
4.	Directorate of e-Government staff	1	Provide interview questions responses and material for document review

Details of the researcher's interaction with these sources of information follow;

i) **Members of staff of the Road Transport Department**

Members of staff of RTD were an important source of information as they are the subject matter experts as far as road transport administration in Kenya is concerned. From the staff, vital information such as business processes and circumstances behind the adoption of current business processes were obtained. The researcher also obtained RTD performance statistics (for example

number of logbooks and driving licences applied for and issued within specified periods, and number of complaints received from customers) from the RTD staff. The staff also offered insight into the viability of proposed enhancements to the current business processes.

ii) Research and Corporate Planning department

Clients of the Road Transport Department are members of the general public who seek services of the department. These clients include motor vehicle owners, drivers, driving schools, motor vehicle dealers, and individuals and organizations that seek information from the department. KRA's Research and Corporate Planning department provided the researcher with vital information from the various surveys conducted to establish customer needs with regard to the services provided by RTD. This information was vital in developing a target architecture that is customer focused.

iii) The directorate of e-Government

This was an important source of information for the project as the directorate's mandate is to advise government on adoption and implementation of ICTs. From the directorate, the researcher acquired information on ICT policy formulation and implementation in Kenya. Information on how decisions to acquire major information systems are made and the rate of success of implementation of these systems was obtained from this source.

iv) RTD Customers

Members of the general public who seek various services from the department form RTD's clientele. Their input in this study was significant as the target architecture can only be successfully implemented if it is customer focused. From the customers, the researcher obtained information about challenges faced by customers in their quest to obtain services as well as their needs.

3.2 Data Collection Methods

Both Primary and Secondary data were used in this study. Primary data was collected using Interviews and Questionnaires. KRA surveys were the source for secondary data. The data collection methods employed in this research project included: -

i) Interviews

Interviews were used in collecting data from staff of the Road Transport Department and at the Directorate of e-Government. Interviews were used for these staff because the information that they provided was crucial for this project as they are involved in ICT policy formulation and

implementation of public sector information systems. Interviews were suitable here because questions could be clarified easily and important information that was not expected obtained during the course of the Interviews.

ii) Document review

This method was used to establish the Road Transport Department's performance against corporate targets over time, how decisions to acquire ICTs are made, how successful IT systems implementations have been, and levels of customer satisfaction with the services offered by the department.

iii) Questionnaires

A questionnaire (see Appendix 2) was administered to RTD customers at various service points. One sample consisting of 50 individuals was selected. Both Stratified Random Sampling and Purposive sampling were used in order for the broad spectrum of customers to be adequately represented. Five questionnaires were issued to each of the following ten service points:

- a) Motor Vehicle Registration
- b) Transfer and duplicate logbook Issuance
- c) New Driving Licence Issuance
- d) Driving Licence Renewal
- e) TLB Licence Issuance
- f) Motor Vehicle Dealers
- g) Copy of Vehicle records
- h) Motor Vehicle Inspection
- i) Foreign vehicle permit issuance
- j) Number Plates Replacement

The five respondents from each strata were then selected randomly but the researcher ensured that both genders as well as diverse age groups of respondents were represented. In cases where the first four respondents in a strata were of the same gender, the last respondent picked had to be of the opposite gender. Otherwise, where the first four respondents in the strata were representative of both genders, random sampling was applied to the entire strata.

4. PROPOSED ENTERPRISE ARCHITECTURE FOR RTD

Phases A to F of the TOGAF ADM phases described in chapter 1 above were used to develop the sample Enterprise Architecture for RTD. These phases are as follows;

- i. Phase A: Architecture Vision
- ii. Phase B: Business Architecture
- iii. Phase C: Information Systems Architectures
- iv. Phase D: Technology Architecture
- v. Phase E: Opportunities & Solutions
- vi. Phase F: Migration Planning

The Proposed Enterprise Architecture is presented in the subsequent sections of this Chapter below.

4.1 Architecture Vision

To define and implement an Enterprise Architecture that shall facilitate the attainment of the Road Transport Department's mission, vision and quality objectives. The department's mission, vision and quality objectives may be found in Chapter 1 of this document.

Below is a list of challenges currently faced by the department. Implementation of Enterprise Architecture shall target the resolution of these challenges.

- i. Long queues – a taxpayer spends an average of 5 hours on a queue.
- ii. Inconvenient payment process – Tax payers queue to get invoice (e-slip), queue at the bank to make payments, then queue again to submit receipts.
- iii. Counterfeiting of documents (mainly logbooks, DLs, Inspection reports, and Certificates of Competence) leading to loss of revenue as well as unqualified individuals being allowed to drive motor vehicles resulting in increase in road accidents.
- iv. Counterfeiting of number plates.
- v. Prevalence of 'Return to Sender' cases which are costly to handle.
- vi. Rampant diversion of transit vehicles. This is done by unscrupulous individuals mainly to register vehicles older than 8 years.
- vii. System Security vulnerabilities.
- viii. Delays in procurement of products (such as Number plates, DLs and Logbooks) from suppliers

4.2 Business Architecture

In order to develop the department's business architecture, Baseline (As Is) and Target (To Be) business processes were defined. A review of the "As Is" business processes gave the researcher insight into what the department's business processes entail. Through definition of the "To Be" business processes, the researcher was able to understand the business needs of the department. Table 4 below contains the results of a gap analysis that was performed to establish the difference between the "As Is" business processes and the "To Be" business processes. The process changes presented in the table indicate RTD's business needs.

Table 4: Proposed Business Process Changes

	Baseline (AS IS) Business Process	Process Change(s)
1.	Motor Vehicle Registration & number plates issuance	<ul style="list-style-type: none"> - Process to be fully automated with all required registration data captured during the customs clearance process for imports. - Process merged with the new logbook process to facilitate issuance of the Number plates and logbook at the port for imported motor vehicles. - A validation and verification sticker to be issued to check the illegal production of number plates.
2.	Processing of replacement number plates	<ul style="list-style-type: none"> - All number plates to be issued by the number plates unit. - Vehicle owners to make online applications for number plates replacement. - Process of ordering for number plates from suppliers to be automated.
3.	New Logbook Processing	Process not to be performed after vehicle registration but as a step in the registration process. Logbook to be printed at the port for imports.
4.	Dispatch of new log book	Process eliminated
5.	Return to Sender	Process eliminated
6.	Logbook Amendment	Process eliminated
7.	Duplicate logbook Processing	Applicants to make online applications for duplicate logbook
8.	Duplicate logbook dispatch	<ul style="list-style-type: none"> - Logbooks to be picked by applicants or sent via courier services - Applicant to be notified of dispatch via sms
9.	Return to Sender	Process eliminated
10.	Transfer of ownership Processing	Applicants to make online applications for transfer of vehicle ownership
11.	Transfer logbook dispatch	<ul style="list-style-type: none"> - Logbooks to be picked by applicants or sent via courier services - Applicant to be notified of dispatch via sms
12.	Registry File Construction	<ul style="list-style-type: none"> - Files to be constructed by clearing agents for imports. - Images of records to be scanned and uploaded to the system by clearing

	Baseline (AS IS) Business Process	Process Change(s)
		agents
13.	Registry File Receiving	Manual registers to be replaced by online receiving of files.
14.	Registry File retrieval and issuance	Manual registers to be replaced by online issuance of files.
15.	Registry File updating	Scanning and uploading of additional records to be done before physical file is updated.
16.	Copy of vehicle records	<ul style="list-style-type: none"> - Process to be fully automated. Applicants shall make online application, then pay via mobile money transfer services and receive copy of records via sms and email. - Registry to issue all copy of records (vehicle and driver)
17.	Certificate of vehicle ownership	Soft copy to be in the system. Only endorsement and printing to be done.
18.	Deregistration of written-off Motor vehicles	Applicants to make online application for deregistration
19.	Court summons Information Retrieval	Process shall remain unchanged
20.	Registry Caveat lifting	Applications for caveat placement to be done online
21.	Issuance of foreign vehicle permit	Applications to be made online
22.	Provisional driving license (PDL) issuance	PDL to be applied for online and to be collected from driving schools
23.	Interim Driving Licence Issuance	Process eliminated
24.	Original Driving Licence Processing	<ul style="list-style-type: none"> - Certificate of Competence from the testing centres to be submitted electronically. - Smartcard DL to be issued. Passport photo, finger prints and signature as well as driver details to be written onto the Smartcard chip. - DL to be issued to driver after capture of biometrics.
25.	Original Driving Licence Dispatch	Process eliminated
26.	Duplicate Driving Licence Processing	<p>Applicants to make online application.</p> <p>Smart card to be issued after verification of details.</p>
27.	Duplicate Driving Licence dispatch	Dispatches to be via counter collection or courier service.

	Baseline (AS IS) Business Process	Process Change(s)
28.	Renewal of driving licence	Process to remain the same except that smartcard shall be issued.
29.	Endorsement of additional classes on driving licence	Certificate to Competence to be sent from testing centres electronically.
30.	Court Endorsements	Process to remain the same.
31.	Conversion of foreign DL to Kenyan	<ul style="list-style-type: none"> - Applicants to make online application. - Smart card DL to be issued.
32.	Processing of PSV badges (Drivers & Conductors)	Applicants to make online application. PSV badge and licence to be merged and a smartcard to be issued in their place.
33.	Processing of PSV licences (Drivers & Conductors)	PSV badge and licence to be merged and a smartcard to be issued in their place.
34.	Driving School licence Issuance	<ul style="list-style-type: none"> - Online application to be made. - Approvals from Kenya police to be granted online. - Dispatches to be via counter collection or courier service.
35.	Driving School Instructor Licence issuance	<ul style="list-style-type: none"> - Online application to be made. - Approvals from Kenya police to be granted online. - Dispatches to be via counter collection or courier service.
36.	Return to Sender	Process to be eliminated
37.	Copy of Driver's records	Process to be eliminated as all copies of records shall be issued by the registry.
38.	Issuance of TLB licences for PSVs	<ul style="list-style-type: none"> - Online application to be made - Motor vehicle Inspection units to submit electronic vehicle inspection reports - Dispatches to be via counter collection or courier service.
39.	Issuance of KG number plates	<p>Online application to be made</p> <p>Dispatches to be via counter collection or courier service.</p>

Figure 2 below is a system flowchart summarizing the envisaged automated business processes.

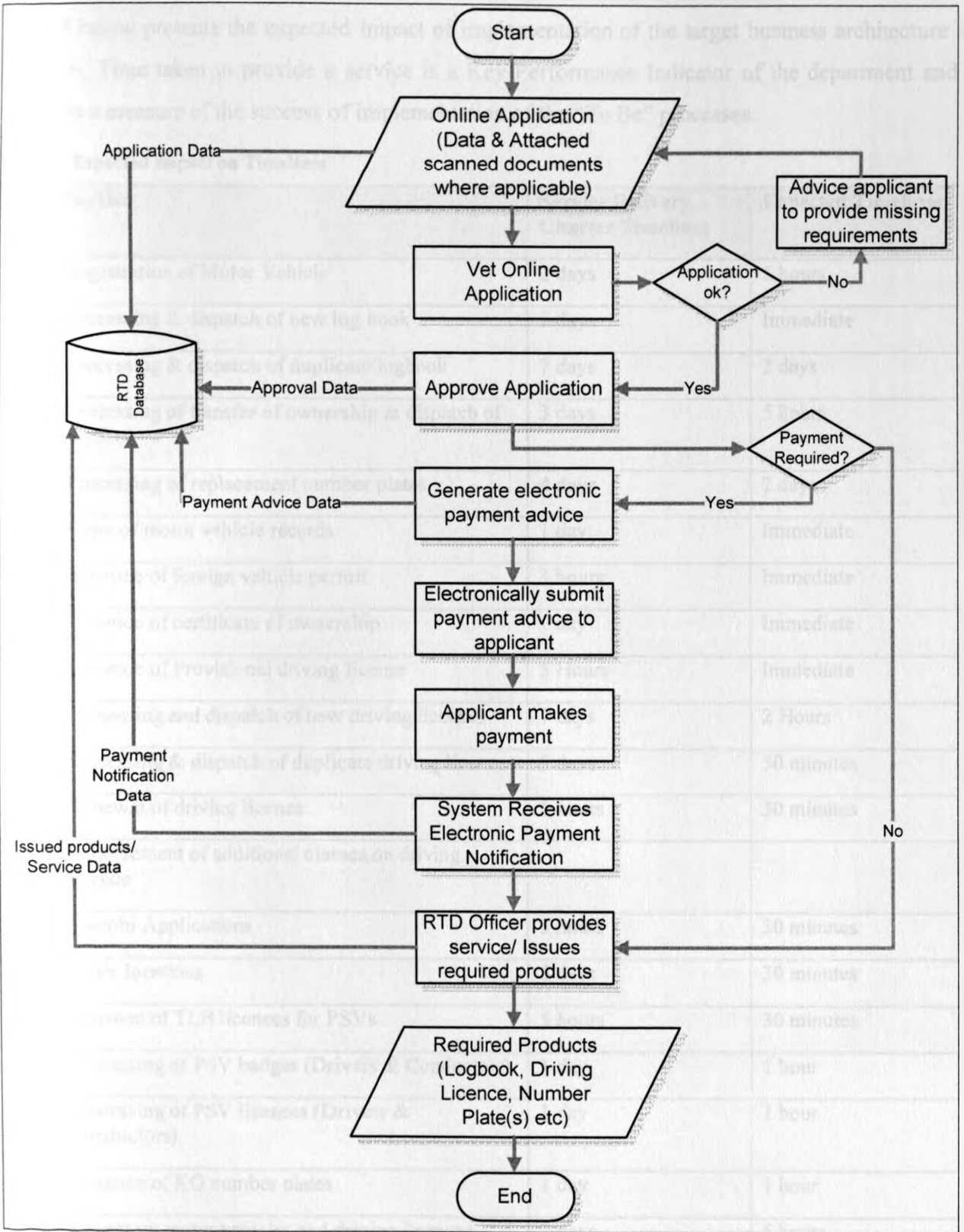


Figure 2: System Flowchart

4.3 Expected impact of implementation of the Target Business Architecture

Table 5 below presents the expected impact of implementation of the target business architecture on timelines. Time taken to provide a service is a Key Performance Indicator of the department and it would be a measure of the success of implementation of the “To Be” processes.

Table 5: Expected Impact on Timelines

	Service	Service Delivery Charter Timelines	Expected Timelines
1.	Registration of Motor Vehicle	2 days	5 hours
2.	Processing & dispatch of new log book	5 days	Immediate
3.	Processing & dispatch of duplicate logbook	7 days	2 days
4.	Processing of transfer of ownership & dispatch of logbook	3 days	5 hours
5.	Processing of replacement number plates	4 days	2 days
6.	Copy of motor vehicle records	1 day	Immediate
7.	Issuance of foreign vehicle permit	3 hours	Immediate
8.	Issuance of certificate of ownership	1 day	Immediate
9.	Issuance of Provisional driving license	5 Hours	Immediate
10.	Processing and dispatch of new driving licenses	7 days	2 Hours
11.	Processing & dispatch of duplicate driving licence	5 days	30 minutes
12.	Renewal of driving licence	5 hours	30 minutes
13.	Endorsement of additional classes on driving licence		
	Nairobi Applications	5 hours	30 minutes
	Other locations	5 days	30 minutes
14.	Issuance of TLB licences for PSVs	5 hours	30 minutes
15.	Processing of PSV badges (Drivers & Conductors)	1 day	1 hour
16.	Processing of PSV licences (Drivers & Conductors)	1 day	1 hour
17.	Issuance of KG number plates	1 day	1 hour
18.	Caveat on motor vehicles and driving licences	2 days	5 hours

4.4 Data architecture

4.4.1 Baseline Data Architecture

Table 6 below shows RTD's main data groups as well as the sources and forms of data

Table 6: Main Data Groups

	Data	Source	Form
1.	Vehicle	Customs and Applicant	Electronic and Hard
2.	Vehicle Owner	Customs and Applicant	Electronic and Hard
3.	Motor Vehicle Dealer	Applicant	Hard
4.	Driver	Applicant	Electronic and Hard
5.	Driving School	Applicant	Hard
6.	Instructor	Applicant	Hard
7.	PSV Conductors and Drivers	Applicant	Hard
8.	Court Endorsement	Courts	Hard
9.	Motor Vehicle dealer	Dealers	Hard

4.4.2 Target Data Architecture

In order to achieve the target business architecture, RTD requires more data and in electronic format as indicated in table 7 below.

Table 7: Required Data

	Data	Source	
1.	Vehicle	Customs and Applicant	
2.	Vehicle Owner	Customs and Applicant	Electronic
3.	Motor Vehicle Dealer	Applicant	Electronic
4.	Driver	Applicant	Electronic
5.	Driving School	Applicant	Electronic
6.	Instructor	Applicant	Electronic
7.	PSV Conductors and Drivers	Applicant	Electronic
8.	Court Endorsement	Courts	Electronic
9.	Motor Vehicle dealer	Dealers	Electronic

	Data	Source	Form
10.	Vehicle Inspection data	Police	Electronic
11.	Driver Competence data	Police	Electronic
12.	Test booking data	Applicant	Electronic
13.	Transit Vehicle data	Customs	Electronic

Figure 3 below is a context diagram illustrating the data flows in the envisaged automated business environment.

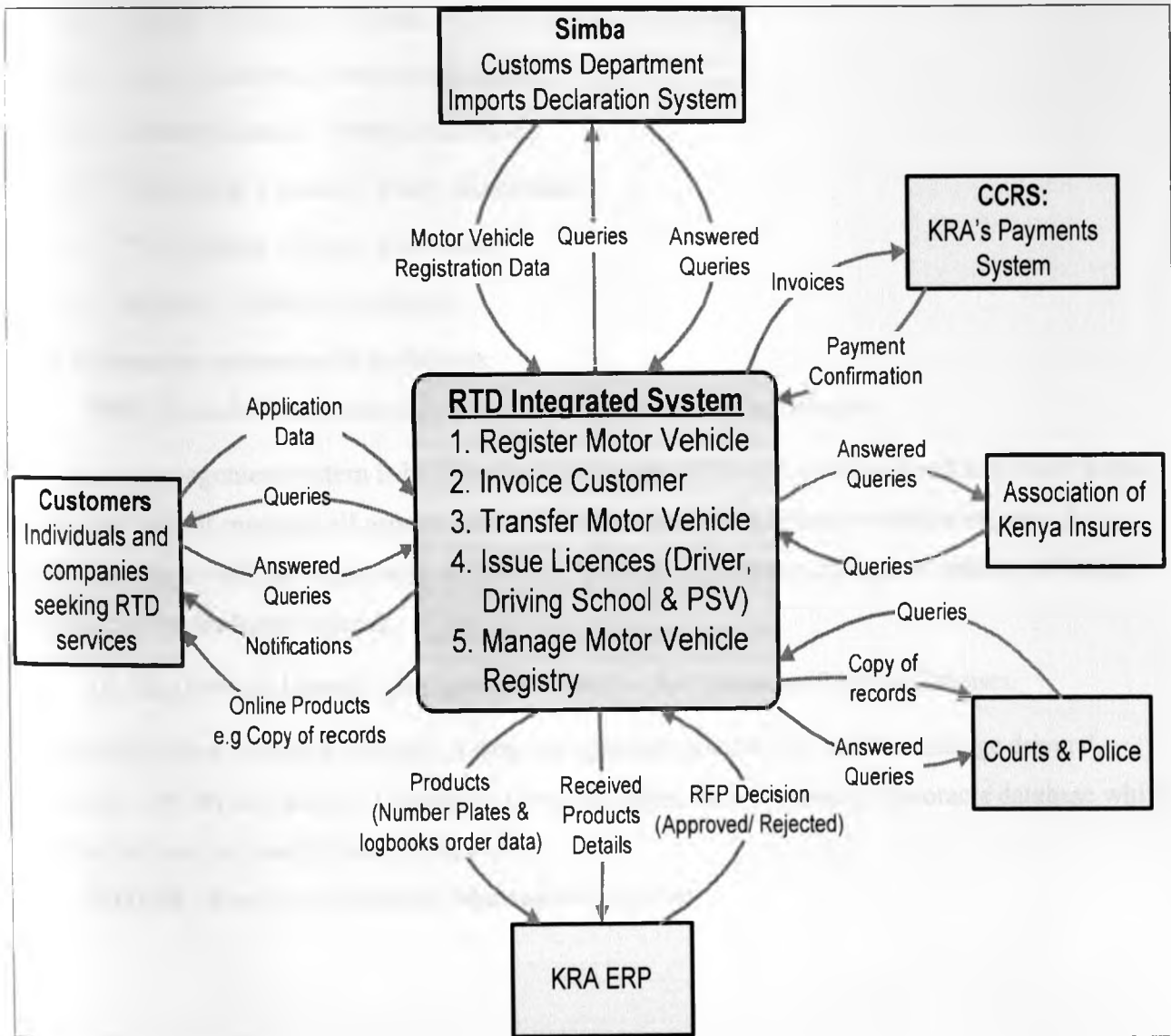


Figure 3: Context Diagram

4.5 Application Architecture

4.5.1 Baseline Application Architecture

Applications within the department can be grouped within the categories below:

- i. Registration of motor vehicles – Partly Automated
- ii. Transfer of ownership – Partly Automated
- iii. Issuance of duplicate logbook – Automated
- iv. Issuance of number plates – Manual
- v. TLB – Manual
- vi. Dealers' License – Manual
- vii. Copy of records – Partly Automated
- viii. Driving License – Partly Automated
- ix. Instructors' License – Partly Automated
- x. PSV License – Partly Automated
- xi. Registry – Partly Automated

Three information systems exist as follows:

- i. **VMS** (Vehicle Management System) – for motor vehicle registration.

The vehicle management system is built around the oracle database for the backend and oracle forms for the front end. It manages all aspects related to the management of motor vehicle records. It specifically deals with the registration of vehicles, transfer of vehicles, change of vehicle particulars and requests for duplicate logbook.

- ii. **DLMS** (Driving License Management System) – for issuance of driving licenses.

The driving licence system is basically a data management system. It is used to manage drivers', conductors' and driving school. To manage these functions, data is stored in the oracle database while the front-end runs on oracle forms version 4.5.

- iii. **KOVIS** – Electronic document Management System.

4.5.2 Target Application Architecture

In order for RTD to meet its business objectives, the department requires an integrated application (defined in detail in Chapter 5) that shall facilitate efficient data exchange with other KRA systems as well as external stakeholder systems. The department also requires greater efficiency for business processes by having data capture delegated to applicants as much as possible. The target application architecture is as a result of the following objectives:-

- i. Achievement of faster service timelines.
- ii. Increase of revenue collection.
- iii. Lowering of the cost of collection.
- iv. Enhancement of system security.
- v. Reduction of corruption by reducing physical contact between staff and clients.
- vi. Reduction of customer complaints
- vii. Attainment of a Single view of the taxpayer.
- viii. Improve quality of service to stakeholders.
- ix. Quality /timely production of statistical data

4.6 Technology Architecture

4.6.1 Baseline Technology Architecture

The current data centre infrastructure setup is a mixed environment of IBM P-570 series, HP and DELL entry and mid range servers. The servers are mostly based on Linux and Windows platforms. Most of the business critical applications are hosted on the IBM P-570 series. The storage requirements for the existing setup are based on IBM DS-4500 and IBM DS-4800.

Currently, the Authority's storage needs are addressed through the use of IBM DS-4500 and IBM DS-4800. Due to the envisaged automation of business processes, the demand for high availability and reliability in storage resources is expected to grow dramatically. The IBM DS -4500 has a capacity of 3 TB with a 70% utilization rate, while the IBM DS-4800 has a capacity of 6 TB with a utilization rate of around 60%. Of concern is the fact that support from the provider for the IBM DS-4500 is no longer guaranteed.

Technology challenges being faced currently include the following;

- i. Limited skills for managing specialized equipment like P-570 IBM servers and DS 4800 Storage among others.
- ii. Inefficient utilization of the storage infrastructure due to the rigid allocation of storage resources. The current deployment scenario cannot meet the ever growing storage demands in a timely, reliable , and effective manner since fixed storage space needs to be pre- allocated to servers and in the event the resources are under or over utilized resources cannot be re-allocated to where their needed most.
- iii. Inefficient backup methodology typically based on tape technology thus leading to long recovery times in the event of failure or data corruption.
- iv. Server sprawl due to each system or application being hosted on its own individual box thus leading to inefficient utilization of critical and much needed resources.
- v. High power and cooling requirements due to numerous individual servers each hosting its own application/databases.
- vi. Inadequate cooling capacity.

4.6.2 Target Technology Architecture

In order to effectively serve the interests of RTD, an infrastructure set up with the following characteristics is desired:

- i. A set up that enables KRA to optimize on the existing storage and enable it to resume operations from an alternate site with minimal service disruptions when required.
- ii. An infrastructure that offers a unified storage pool that provides flexibility and scalability to store different types of data over various protocols without requirements for purchasing new hardware and software.
- iii. A set up that shall reduce data redundancy, increase data availability, ease and enhance the scalability of data storage, while improving serviceability and reducing overall costs by simplifying data management and enabling faster data backup and recovery processes.
- iv. To implement a solution that offers simplified data management, improved storage resilience, instantaneous restores and a comprehensive portfolio of disaster recovery options.
- v. A set up that is able to offer a resilient and high availability configuration that addresses the issue of redundancy and robustness.
- vi. A storage architecture that allows KRA to scale in multiple dimensions with respect to upgrades of software, controllers and disks.

It is envisaged that upon implementation of the target technology architecture the following benefits will be realised:

- i. **Regulatory Compliance** – KRA shall create an environment that adheres to corporate and government regulations to improve data access and retention.
- ii. **Storage Consolidation** – Storage consolidation which will streamline growth, simplify data sharing, and reduce management tasks and costs. Backup, disaster recovery, and archiving will be simpler to manage, more reliable, and non-disruptive.
- iii. **Efficient Alternate site Backup** – consolidated primary and alternate site leading to reliable and instantaneous backup and rapid restore mechanisms.
- iv. **Effective Disaster Recovery (DR) and Business Continuity (BC)** – Effective disaster recovery and Business continuity that delivers complete data protection and fast access to the alternate site. The Authority shall be able to meet recovery point and recovery time objectives, keep information secure, and achieve compliance as per government regulations.
- v. **Improved Server Infrastructure** - Reduced infrastructure costs as well as eliminating information silos, easing server management, and improving utilization rates of shared resources.
- vi. **Efficient Archiving** - Archiving data in storage tiers will help protect structured and unstructured data, keep it quickly accessible, and reduce costs and backup times.

4.7 Opportunities and Solutions

In this section, the opportunities available as well as possible solutions to the challenges presented under section 4.1 are presented.

Table 8: Proposed Solutions

	Challenge	Opportunity	Solution
1.	Long queues – a taxpayer spends an average of 5 hours on a queue.	Availability of mature technologies for development of online applications	Online transactions (application for and issuance of products & provision of services) The challenge of Limited service time where currently customers can only be served during official working hours shall also be solved by introducing online transactions
2.	Inconvenient payment process – Tax payers queue to get invoice (e-slip), queue at the bank to make payments, then queue again to submit receipts.	Availability of mobile money transfer as well as Debit and Credit card services.	Use of debit and credit cards as well as mobile money transfer services such as M-Pesa and ZAP
3.	Counterfeiting of documents (mainly logbooks, DLs, Inspection reports, and Certificates of Competence) leading to loss of revenue as well as unqualified individuals being allowed to drive motor vehicles resulting in increase in road accidents.	<ul style="list-style-type: none"> – Availability of secure document technologies for instance Smartcard – Availability of electronic data transfer technologies 	<ul style="list-style-type: none"> – Use of smart card technology for driving licences – Electronic data exchange with other government agencies involved in Road Transport
4.	Counterfeiting of number plates	Validation and verification stickers	Issuance of validation and verification sticker in addition to number plates upon motor vehicle registration
5.	Prevalence of 'Return to Sender'	– Availability of courier	– Use of courier service

	Challenge	Opportunity	Solution
	cases which are costly to handle	services – Availability of SMS technology	to deliver documents. – Improved communication with applicants through SMS notification of dispatches
6.	Rampant diversion of transit vehicles. This is done by unscrupulous individuals mainly to register vehicles older than 8 years	Availability of RFID technology Availability of Validation & Verification stickers	Use of Validation & Verification stickers embedded with RFID chips to track transit vehicles.
7.	System Security vulnerabilities	Availability of mature Information security technologies	Adoption of 2-factor authentication
8.	Delays in procurement of products (such as Number plates, DLs and Logbooks) from suppliers	Availability of the KRA ERP	Extend capability of the KRA ERP system to enable automated stock management and online ordering for products

4.8 Identified Initiatives

Table 9 below contains initiatives whose implementation shall enable the attainment of the Target Enterprise Architecture. These initiatives were arrived at after the business needs of the department were defined and opportunities for resolution of challenges explored.

Table 9: Proposed Initiatives

	Initiative	Priority	Business Benefits (addressed challenges)
1.	Implementation of an Integrated RTD system	High	<ul style="list-style-type: none"> - To enable online transactions. - To ensure that the reengineered business processes are automated end-to-end. - To facilitate easier integration with both internal (other KRA departments) and external stakeholder systems. - To enhance system security as some of the system security challenges being faced by the department are as a result of poor system design and obsolete technology.
2.	Registration of transit motor vehicles	High	<ul style="list-style-type: none"> - To address the challenge of diversion of transit vehicles by having the vehicles' data in the RTD system and issuance of a Transit Validation & Verification sticker embedded with an RFID chip to monitor movement of the vehicles.
3.	Introduction of Mobile payment options	High	<ul style="list-style-type: none"> - To address the inconvenience experienced by taxpayers in making payments.
4.	Introduction of the Smart Card Driving Licence	Medium	<ul style="list-style-type: none"> - To address the challenge of counterfeiting of Driving Licences. - To modernize the driving licence and thus facilitate enforcement (police can be able to record offences on the smart card) and management of information (as the smart card contains electronic data).
5.	Interfacing of RTD system with stakeholder systems	High	<p>To facilitate transfer of electronic data efficiently between RTD and both Internal and external stakeholder systems. Internal (KRA) systems to be interfaced with include:</p> <ol style="list-style-type: none"> i. Simba (the Customs Declaration System) ii. Integrated Tax Management System (the Domestic Taxes System) iii. The KRA ERP iv. Common Cash Receipting System (for bank payments) <p>Systems of the following external stakeholders shall be interfaced: Police, Judiciary, Association of Kenya Insurers, and Ministry of Transport.</p>

	Initiative	Priority	Business Benefits (addressed challenges)
6.	Consolidation and virtualization of data centre resources	High	<ul style="list-style-type: none"> - To enhance cost effective usage of data centre resources such as storage and processing capacity. - To enhance system availability and performance.
7.	Implementation of an SMS solution	Medium	<ul style="list-style-type: none"> - To enhance customer service by providing information (such as copy of records) to customers via SMS.
8.	Introduction of new generation Number plates	Medium	<ul style="list-style-type: none"> - To address the challenge of counterfeiting of Number Plates by introducing number plates with security features.
9.	Introduction of the third plate for all vehicles	Medium	<ul style="list-style-type: none"> - To address the challenge of counterfeiting of Number Plates by having a tamper proof (self destructs when tampered with) Verification and Validation sticker matching the number plate, mounted on the vehicle's windscreen.

N/B – High priority initiatives are those that have a significant impact on meeting the department's objectives of enhanced customer service (faster, less costly and convenient), higher revenue yields and better administration of road transport by minimizing counterfeiting of products.

4.9 Proposed System Architecture

The system architecture defined here below is an abstraction of the proposed Integrated RTD system. It constitutes a model for how the proposed system shall be structured and how its elements shall work together.

4.9.1 Global Architecture

The Application architecture of the proposed Integrated RTD system is composed of a front end and a back end. Three servers (Web, application and Database) shall be used and these shall support both the front and back end applications. The servers shall in turn be supported by the base platform composed of server hardware and the Operating System. Figure 4 below illustrates the global architecture.

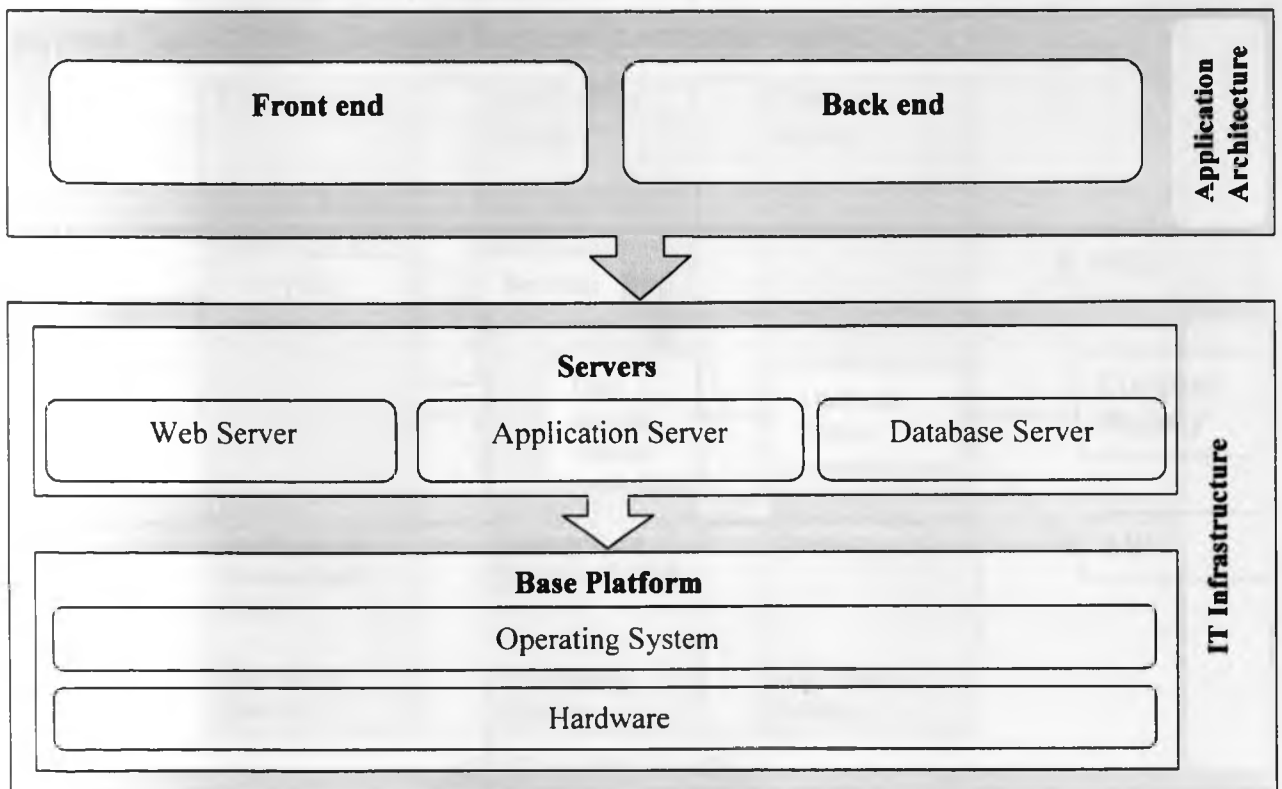


Figure 4: Integrated RTD System Global Architecture

4.9.2 Conceptual Model

System implementation shall consist of three layers as follows:

- i. Presentation Layer – enables the user to interact with the system through a web interface.
- ii. Business Layer – contains the system's business logic (business rules)
- iii. Database Layer – for storage of data as well as management of access to the data.

4.9.3 System Architecture Model

Users of the Integrated RTD system shall interact with the system via a web based interface. The system's back end shall contain services enabling interfacing with other KRA systems as well as the application containing business rules. The application shall receive, process, and submit data for storage in the database tables via a Data Access Object (DAO). The DAO shall be an important component of the system implementation as it shall hide all details of data storage from the rest of the application and ensure that the database is not adversely affected by changes to either the application or the database.

Apart from the application, the system's database tables shall be populated by data from the National Registration Bureau, the Company Registry and the Association of Kenya Insurers for validation purposes. Figure 5 below illustrates the system's architecture model.

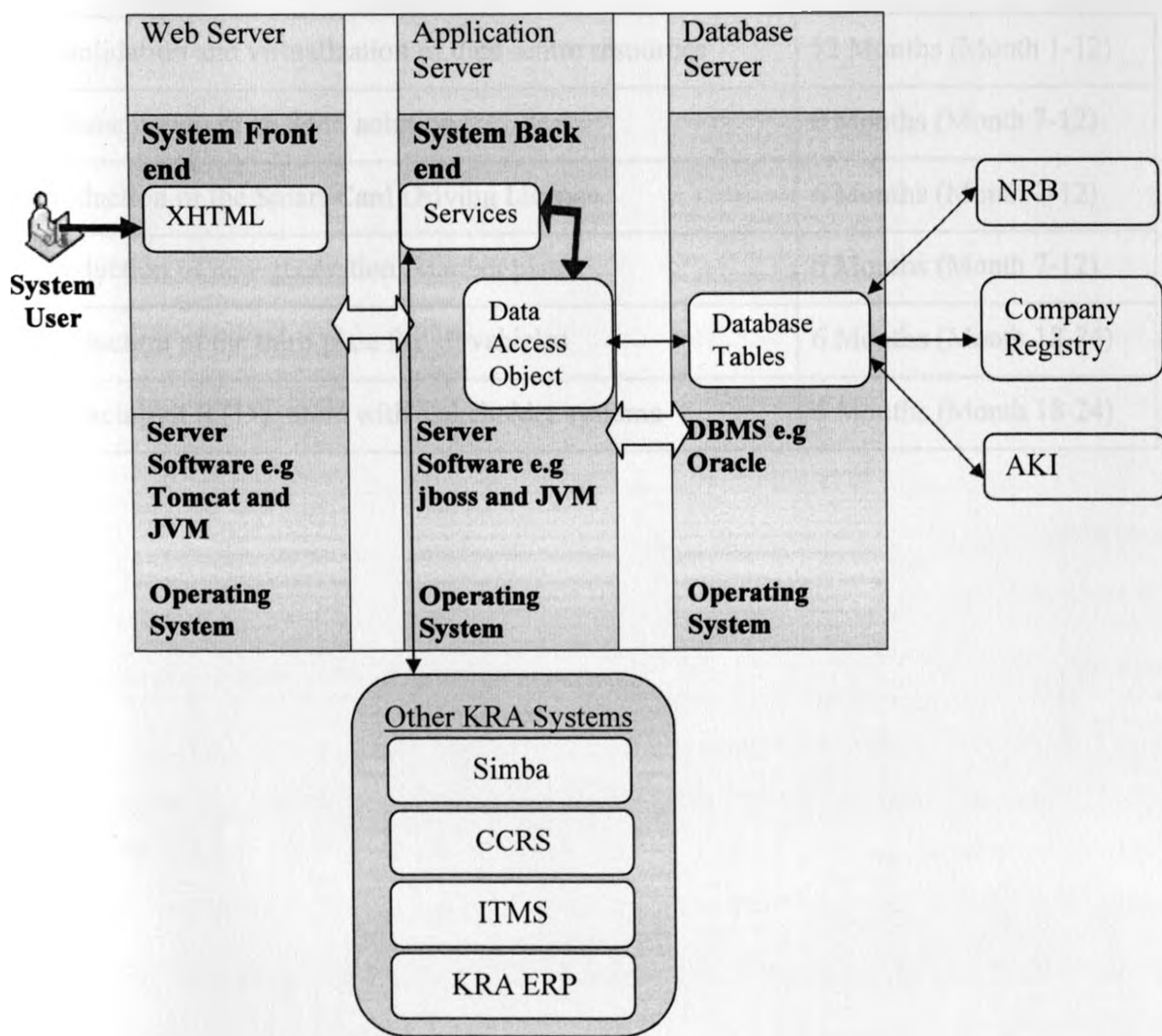


Figure 5: Integrated RTD System Architecture Model

5. IMPLEMENTATION

5.1 Reforms Implementation Road map

In this section an implementation plan showing order of priority of implementation of the various proposed initiatives and indicating timelines is presented.

Table 10: High level Implementation Plan

	Initiative	Duration
1.	Implementation of an Integrated RTD system	18 Months (Month 1-18)
2.	Registration of transit motor vehicles	6 Months (Month 1-6)
3.	Introduction of Mobile payment options	6 Months (Month 1-6)
4.	Consolidation and virtualization of data centre resources	12 Months (Month 1-12)
5.	Implementation of an SMS solution	6 Months (Month 7-12)
6.	Introduction of the Smart Card Driving Licence	6 Months (Month 7-12)
7.	Introduction of new generation Number plates	6 Months (Month 7-12)
8.	Introduction of the third plate for all vehicles	6 Months (Month 18-24)
9.	Interfacing of RTD system with stakeholder systems	6 Months (Month 18-24)

5.2 Implementation Budget for the proposed Integrated RTD system

Implementation of the Integrated RTD system is the most significant initiative proposed as all the other initiatives are dependent on it. In this section, the resource requirements for the system are stated.

5.2.1 Required Resources

Table 11: Summary Project Budget

No	Project Component	Cost (Kshs)
1	Project Management Office Equipment	2,972,400.00
2	Project Management	11,239,000.00
3	ICT Infrastructure	129,150,000.00
4	3 rd Party Software Tools	600,000.00
5	Consultancy (Business and System Reqs & Development/ Customisation)	286,000,000.00
6	Change Management	1,500,000.00
7	Data Capture	7,710,000.00
9	Training	2,660,000.00
10	Sensitization	1,521,000.00
11	Communication & Publicity	5,300,500.00
	Total	448,652,900.00
	15% Contingency	67,297,935.00
	Grand Total (Inclusive of 15% Contingency)	515,950,835.00

Analogy costing was used to estimate the cost of the various project components. This method entailed deriving estimates by comparing the proposed project with several completed projects. Three key completed projects that were used are the Simba 2005 Customs Services Department system, the Integrated Tax Management System used by Domestic Taxes Department and the KRA ERP System.

Table 11 below contains requirements for ICT Infrastructure. Breakdowns of the other Components are included as appendices to this document.

5.2.2 ICT Infrastructure Requirements

Table 12: ICT Infrastructure Budget

Cost Item Description	Quantity	Unit Cost (KShs)	Estimated Budget (KShs)
Power Distribution and Cabling for Data Centre			
Electrical Cables and Insulating Conduits	20	1,000.00	20,000.00
Data cables	20	500.00	10,000.00
Ethernet Cable CAT 6	5	16,000.00	80,000.00
Industrial Sockets	20	2,000.00	40,000.00
Cable organisers and Other fastening material	100	500.00	50,000.00
Labour, including reinstallation of existing outlets, separation of Power and Data Cabling	30	2,000.00	60,000.00
SUB - TOTAL			260,000.00
Blade Servers for Applications			
Blade Chassis including integrated power, Racks for housing server blades, cooling system, networking and management components of blades)	4	8,000,000.00	32,000,000.00
Server Blades	64	200,000.00	12,800,000.00
Server Racks to host blade Servers and other Management accessories	4	500,000.00	2,000,000.00
SUB - TOTAL			46,800,000.00
System Monitoring & Management System			
KVM Consoles	6	50,000.00	300,000.00
Service Monitoring TFT Screens 52 inch Operator / Administrator Terminals TFT 21 Inch	3	250,000.00	750,000.00
	6	30,000.00	180,000.00
SUB - TOTAL			1,230,000.00
Enterprise Storage Area Network (SAN)			
Disc Array Controllers	2	10,000,000.00	20,000,000.00
Disc Array	12	500,000.00	6,000,000.00
SAN Switches - 32 port (all activated with Fibre Modules)	4	500,000.00	2,000,000.00
Fibre Optic Modules and Cabling	100	8,000.00	800,000.00

Cost Item Description	Quantity	Unit Cost (KShs)	Estimated Budget (KShs)
Fibre Cables and Organisers/Patch Pannel	100	1,000.00	100,000.00
Server Racks to host blade Servers and other Management accessories	2	500,000.00	1,000,000.00
SATA Storage for Backups	2	2,000,000.00	4,000,000.00
Fibre Channels and Interface Cards	100	2,000.00	200,000.00
SUB - TOTAL			34,100,000.00
Virtualisation and Consolidation			
Virtualisation and Consolidation (Software Suite)	1	3,000,000.00	3,000,000.00
SUB - TOTAL			3,000,000.00
Consultancy and Technical Implentation			
Training on Storage and Virtualisation/Consolidation	10	300,000.00	3,000,000.00
Data Centre Improvement	1	1,000,000.00	1,000,000.00
SUB-TOTAL			4,000,000.00
Smart Card Driving Licence equipment			
Biometric Readers	22	30,000.00	660,000.00
Intelligent Card Management System	1	15,000,000.00	15,000,000.00
Mobile Handheld RFID Readers	200	25,000.00	5,000,000.00
Mobile Unit: Contains (Camera, Signature Pad, Laptop, RFID Reader, Finger Prints Sensor)	10	1,000,000.00	10,000,000.00
RFID based Intelligent ID cards (For Secure Access of the system)	500	200.00	100,000.00
PC attached (USB/Serial) RFID Readers (Facilitate Secure Access to the system)	300	10,000.00	3,000,000.00
RFID Card Printers	20	300,000.00	6,000,000.00
SUB-TOTAL			39,760,000.00
GRAND TOTAL			129,150,000.00

6. FINDINGS AND DISCUSSION

6.1 Response Rate

45 of the 50 questionnaires given out were returned although three were not fully completed. This constitutes a response rate of 84%. Data analysis was based on the 42 fully completed questionnaires.

6.2 Data Analysis

Both qualitative and quantitative data analysis were used in this study. Content analysis was the method employed to perform qualitative analysis. Microsoft Excel was used to perform calculations required for analysis. Calculations involved determining the proportion (in terms of numbers and percentages) of respondents who provided specific responses to questions on the questionnaire.

6.3 Findings

- i. Only 14% (6 out of 42) of respondents rate service delivery by RTD as good. 62% (26 out of 42) rate service delivery by RTD as average while 24% (10 out of 42) rate service delivery as poor. None of the respondents rated service delivery as either very good or excellent.
- ii. The key reasons cited by the respondents for the largely unfavorable ratings were as follows:
 - a. Long queues – All respondents
 - b. Fragmented services (taxpayers expressed a desire to be served from one point rather than moving from one counter to another) – 60% of respondents
 - c. Poor automation – 80% of the respondents.
- iii. 90.5% (38 out of 42) of the respondents are registered with a mobile money transfer service.
- iv. 95.2% of respondents have either a debit or credit card or both.
- v. 21% (9 out of 42) of the respondents indicated that they were not computer literate.
- vi. The department lacks standards for acquisition and implementation of ICTs.
- vii. The following weaknesses of current systems RTD systems were noted;
 - a. The RTD systems are not integrated and thus the department does not benefit from advantages of an integrated system such as non-duplication of activities for example data capture.

- b. Poor integration of the systems with other KRA systems for instance CCRS (for receipt of payment) and Simba (the customs declaration submission and processing system). There is a lack of integration between VMS (the vehicle registration system) and ITMS (the domestic taxes system). This hampers the Authority's objective of having a single view of a taxpayer across all revenue departments.
- c. Lack of referential integrity in the current systems for instance, on changing the particulars e.g. the registration number for a motor vehicle record, VMS allows the parent record to be deleted while the changes relating to the child record remain.
- d. The systems are based on obsolete technology that hinders provision of online services.
- e. Numerous control weaknesses in the systems for instance weak password management.
- f. There are no roles in the systems for instance VMS.

6.4 Discussion

From the findings of this study, it is clear that customer needs are not being met with regard to service provision by RTD. The following key areas are good candidates for automation;

Payment – this study shows that electronic payment instruments are a viable option to make the payment process faster and more convenient for customers. A large percentage of customers have credit and debit cards and are also registered with mobile money transfer services.

Online Transactions – availability of mature ICTs to facilitate online transactions make online applications, processing and service provision a viable option. This will have the effect of reducing queues at service points as only those customers who must come to KRA shall do so. Another potential benefit of online transactions is reduction in the cost of operation for the department as for instance less paper is used.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Enterprise Architecture offers a practical means by which RTD can be defined via the various architectural artifacts thereby facilitating the alignment of Business and Information Technology leading to efficient utilization of ICTs to achieve business objectives. Implementation of Enterprise Architecture should however not be a one off event. Most organizations that have successfully implemented EA do so in cycles of 5-10 years to take into account the major technological changes expected within such timeframes.

Although Enterprise Architecture is a complex discipline, selection of the appropriate framework goes a long way in facilitating understanding. TOGAF is appropriate for EA use by RTD as it contains a detailed Architecture Development Method that shows how to define an Enterprise Architecture. TOGAF also allows for tailoring of the Framework to suit the needs of any given organization.

7.2 Recommendations

In order to actualize EA adoption, it is recommended that RTD sets up an Enterprise Architecture function to spearhead the development, implementation and management of the department's Enterprise Architecture. It is also recommended that RTD adopts a five year EA cycle, adopts the usage of TOGAF as the Enterprise Architecture Framework for developing the department's EA and builds capacity in Enterprise Architecture through training of relevant staff.

7.3 Suggestions for Further Research

The suggestions presented here pertain to implementation of Enterprise Architecture in government institutions. An important aspect of this is the development of a suitable Enterprise Architecture maturity assessment framework. Such a framework would guide the implementation and evolution of Enterprise Architecture programmes and enhance successful implementation. Research is required to gain insight into the most appropriate method to determine whether the Enterprise Architecture programme continues to effectively align an organization's IT with the business.

Enterprise Architecture Programme's governance structure also needs to be studied with the aim of establishing the most appropriate structure for implementation of EA in the public sector. This study would be significant as the success of EA implementation is primarily determined by the EA programme governance structure comprising of relevant staff cadres, resource allocation as well as standards and procedures.

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APPENDICES

Appendix 1: Interview Guides

Interview Guide 1: Deputy Registrar of Motor Vehicles

1. What are the functions of the Road Transport Department?
2. How is RTD organized (in terms of sections, organogram and business locations)?
3. Which stakeholders does the department interact with?
4. What is the relationship between the Ministry of Transport and KRA's Road Transport Department?
5. What challenges does the department face in fulfilling its mandate?
6. What measures are being put in place to address the challenges faced by the department?
7. How is the department's performance (in terms of meeting revenue targets and customer satisfaction)?
8. Have the department's business processes been defined? If yes, when was this done and are they updated and kept current?
9. What information systems are used by the department?
10. What system challenges are experienced by the departments?
11. Please describe the kind of information system that in your opinion would fulfil the department's business needs.

Interview guide 2: RTD Sections Representatives

1. Please explain the function(s) of your section.
2. What information systems are used by your section?
3. How is your section organized (in terms of units, staffing and business locations)?
4. What challenges does your section face in fulfilling its mandate?
5. Please describe your section's business processes
6. What suggestions do you give for improvement of your section's business processes?

Interview guide 3: Head of Technology Management Division, ICT Department, KRA

1. What data storage technology is in place for the Road Transport Department?
2. What telecommunication technologies are used by the RTD?
3. What challenges are experienced by ICT department in maintaining RTD systems?
4. Are there any plans to enhance the IT Infrastructure to better meet RTD's business needs?
5. What suggestions would you give in terms of upgrade of ICTs for the benefit of RTD's business?
6. How are information systems in KRA acquired and implemented? Is there a procedure in place and is the procedure followed?
7. What is the rate of success of implementation of ICTs in KRA?

Interview guide 4: Directorate of e-government

1. Are there standards for adoption of public sector information systems?
2. How are public sector information systems acquired and implemented?
3. What is the role of the directorate of e-government with regard to integration and interfacing of public sector information systems?



UNIVERSITY OF NAIROBI
SCHOOL OF COMPUTING AND INFORMATICS

MSC INFORMATION SYSTEMS RESEARCH PROJECT

Data collection questionnaire for the general public

Dear sir/ madam

I am a postgraduate student at the school of Computing and Informatics, University of Nairobi pursuing an MSc degree in Information Systems. As part of the course requirements, I am undertaking a research project to determine how Enterprise Architecture can be applied to effectively use Information and Communication Technologies in service provision by RTD. I request you to provide responses to the questions below.

Please answer all questions. Findings will be treated confidentially and shall be used for academic purposes only. Please do not write your name on the questionnaire.

1. How old are you?

- | | |
|-----------------------------|-----|
| 20 years and below | [] |
| Between 21 and 30 years old | [] |
| Between 31 and 40 years old | [] |
| Between 41 and 50 years old | [] |
| Over 50 years old | [] |

2. What is your gender?

Male []

Female []

3. **How do you rate service delivery by the Road Transport Department?**

- Excellent []
- Very Good []
- Good []
- Average []
- Poor []

4. **What are the reasons for the rating you have given in 3 above?**

- i. _____
- ii. _____
- iii. _____
- iv. _____
- v. _____

5. **Are you registered with a mobile money transfer service for example M-Pesa and ZAP?**

- Yes [] No []

6. **Do you have a credit or debit card?**

- Yes, I have a Credit Card only []
- Yes, I have a Debit Card only []
- Yes, I have both a Debit and credit card []
- No, I have neither []

7. **What is your level of IT literacy?**

- No computer knowledge []
- Computer packages []
- Diploma in I.T []
- Undergraduate degree in IT []
- Post graduate degree in IT []

8. **Do you have regular access to the Internet?**

- Yes [] No []

What suggestions would you give for improvement of service delivery by RTD?

Thank you for taking time to fill this questionnaire

Appendix 3: Project Components Breakdowns

Table 13: Project Management Office (PMO) Equipment Budget

No	Item	Number	Unit Cost (Kshs)	Total Cost (Kshs)
1	Personal Computers	7	120,000.00	840,000.00
2	Laptops	7	150,000.00	1,050,000.00
3	Printers	2	120,000.00	240,000.00
4	Scanners	2	30,000.00	60,000.00
5	LCD Projector	1	200,000.00	200,000.00
6	Flip Chart Stand	2	10,000.00	20,000.00
7	Flash Disks	7	2,000.00	14,000.00
8	IP Phones	7	45,200.00	316,400.00
9	Mobile Phone	1	5,000.00	5,000.00
10	Water Dispenser	1	15,000.00	15,000.00
11	Desks	7	15,000.00	105,000.00
12	Chairs	7	6,000.00	42,000.00
13	Lockers	7	5,000.00	35,000.00
14	File Cabinet	1	30,000.00	30,000.00
Grand Total				2,972,400.00

Table 14: Project Management Budget

Item	Number of Officers	Number of Days	Cost Per Person Per Day (Kshs)	Total Cost (Kshs)
Project Team Retreats				
Project Team Retreat1 (Review of Business Requirements)	20	5	8,000	800,000.00
Project Team Retreat2 (Review of System Requirements)	20	5	8,000	800,000.00
Total Project Team Retreats				1,600,000.00
Project Team Training				
Project Management Training (Prince2)	20	5	8,000	800,000.00
Project Management Training (Monitoring & Evaluation)	20	5	8,000	800,000.00
Total Project Team Training				1,600,000.00
Best Practice Benchmarking				
Visits to at least 3 countries by 7 officers/country	20	5	62,500	6,250,000.00
Other Expenses				
User Acceptance Testing Training	48	1	500	24,000.00
User Acceptance Testing	23	10	500	115,000.00
Meals	20	150	550	1,650,000.00
Total Other Expenses				1,789,000.00
Grand Total				11,239,000.00

N/B - Project Management costs are those directly associated with the Project Implementation Team.

Table 15: Consultancy Budget

No	Item	Number	Cost (Kshs)
1	Review of BPR	1	4,000,000.00
2	Development of BUCs	1	5,000,000.00
3	Review of SRS	1	4,000,000.00
4	Software Development	Lot	250,000,000.00
5	End User Training	Lot	15,000,000.00
6	Go live	Lot	8,000,000.00
Grand Total			286,000,000.00

Table 16: Change Management Survey Budget

Group	Number	Days	Cost per person per day	Total Cost
Change Management Survey				
Change Management Survey	20	10	7,500	1,500,000.00
Sub-total Change Management Survey				1,500,000.00
Grand Total Training Cost				1,500,000.00

Table 17: Data Capture Budget

No	Item	Number	Unit Cost (Kshs)	Total Cost (Kshs)	Comments
1	Temporary Staff	60	67,500.00	4,050,000.00	
2	Computers	30	120,000.00	3,600,000.00	
3	Heavy duty scanners	2	30,000.00	60,000.00	60 Temporary staff paid Kshs 750/- per day for 90 days
Grand Total				7,710,000.00	

Table 18: 3rd Party Software Budget

No	Item	Cost (Kshs)
1	DBMS Software (Oracle)	300,000.00
2	Operating Systems	250,000.00
3	Web Server (Apache Tomcat)	50,000.00
Grand Total (Kshs)		600,000.00

Table 19: User Acceptance Testing (UAT) Budget

Group	Number	Days	Cost per person per day	Total Cost
Training of Regional Officers & External Stakeholders				
Trainers	4	1	500	2,000.00
Regional Officers	24	1	500	12,000.00
Association of Kenya Insurers	4	1	500	2,000.00
Kenya Police	4	1	500	2,000.00
Ministry of Transport	4	1	500	2,000.00
Ministry of Home Affairs	4	1	500	2,000.00
Motor Vehicle Inspection Unit	4	1	500	2,000.00
sub-total KRA Team	48			24,000.00
UAT at Head Office				
RTD Users (7 Sections)	14	10	500	70,000.00
Customs Services Dept - Vehicle Imports/Exports/Re-exports	2	10	500	10,000.00
Quality Management Team	2	10	500	10,000.00
Project Management Team	5	10	500	25,000.00
sub-total	23			115,000.00
Grand Total UAT Cost				139,000.00

Table 20: Training Budget

	Group	Number	Days	Cost per person per day	Total Cost
	KRA Team				
1	RTD Team (TOT)	20	5	500	50,000.00
2	KRATI Trainers	2	5	500	5,000.00
3	RTD Staff Training	20	15	7,500	2,250,000.00
	Sub-total KRA Team				2,305,000.00
	External Stakeholders				
1	Association of Kenya Insurers (AKI)	10	5	500	25,000.00
2	Kenya Auto Bazaar Association (KABA)	10	5	500	25,000.00
3	Judiciary	10	5	500	25,000.00
4	Police (CID, Traffic & Inspection Unit)	50	5	500	125,000.00
5	Min. of Home affairs - Kamiti prison	10	5	500	25,000.00
6	Min. of Transport	6	5	500	15,000.00
7	Kenya Bureau of Standards (KEBS)	6	5	500	15,000.00
8	New motor vehicle dealers	20	5	500	50,000.00
9	Driving schools association	20	5	500	50,000.00
	Sub-total External Stakeholders				355,000.00
Grand Total Training Cost					2,660,000.00

Table 21: Sensitisation Budget

Group	Number	Days	Cost per person per day	Total Cost
Kick off meeting				
All Stakeholders	35	1	200	7,000.00
sub-total Kick-off meeting				7,000.00
KRA Officers Sensitisation				
Project Implementation team	20	10	7500	1,500,000.00
Sub-total KRA sensitisation				1,500,000.00
External Stakeholders Sensitisation				
Police	3	2	200	1,200.00
Association of Kenya Insurers (AKI)	4	2	200	1,600.00
Kenya Auto Bazaar Association	4	2	200	1,600.00
Driving Schools	3	2	200	1,200.00
Ministry of Transport (MoT)	2	2	200	800.00
Kenya ICT board	2	2	200	800.00
Clearing Agents	2	2	200	800.00
Postal Service	3	2	200	1,200.00
Ministry of Home Affairs	2	2	200	800.00
Kenya Bureau of Standards (KEBS)	2	2	200	800.00
Motor Vehicle Dealers	2	2	200	800.00
Matatu owners and Welfare Association	3	2	200	1,200.00
Ministry of Foreign Affairs	1	2	200	400.00
Kenya bankers Association	2	2	200	800.00
Sub-total Stakeholder sensitisation	35	2	200	14,000.00
Grand Total Sensitisation Cost				1,521,000.00

Table 22: Communication & Publicity Budget

No	Item	Number	Unit Cost (Kshs)	Total Cost (Kshs)
1	Brochures	100,000	12.00	1,200,000.00
2	Press Supplements	4	800,000.00	3,200,000.00
3	Banners	30	13,350.00	400,500.00
4	Digital Advertising	N/A	N/A	500,000.00
Grand Total				5,300,500.00