



**UNIVERSITY OF NAIROBI
SCHOOL OF COMPUTING & INFORMATICS**

**SERVICE ORIENTED ARCHITECTURE MODEL FOR INTEGRATION
OF E-GOVERNMENT SYSTEMS IN KENYA.
A case study of the eCitizen portal in Kenya**

**By
JOSEPH KAIBIU GITAU
P54/73088/2014**

**Supervised by
Dr. Stephen N Mburu**

*A Project submitted in partial fulfilment of the requirements for the Degree of Masters of
Science (MSc) in Information Technology Management from the University of Nairobi*

NOVEMBER 2016

DECLARATION

This proposal is my original work and has not been presented for a degree in any other university.

.....

Signature

.....

Date

This proposal has been submitted for examination with my approval as University Supervisor

Dr. Stephen N Mburu

Supervisor:

.....

Signature

.....

Date

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor Dr. Stephen Mburu for the guidance towards the completion of this project. I would also like to thank my lecturers in the academic faculty of University of Nairobi who guided me through my coursework and taught me the research knowledge and skills to undertake and complete this project. The skills and knowledge I have acquired will help me in doing further research in different areas and varied topics. The assistance provided by various users and support staff, my colleagues and friends who helped in data collection which took a considerable amount of their time, is greatly appreciated.

DEDICATION

I would like to dedicate this study to my wife and son (Ruth Nyiha and Jomo Gitau), parents (Sammy and Elizabeth Gitau) and Sisters (Ruth, Rose and Joy Gitau). You all believed and invested so much in me financially, time-wise and emotionally, even when you owned so little of your own. For what I claim as my achievements, you have achieved much more through your dedication to excellence and the opportunities you provided for me. God blessed you all without measure.

ABSTRACT

During the last decade, organisations in Kenya have worked to automate processes and digitize information and services using various systems. These systems have however become diverse due to the various vendors and their use of different data formats, storage types, languages and even middleware, thus the issue of heterogeneity and interoperability of systems.

This has created a need for an integrated platforms to enhance sharing of information and services between organisations. The E-government platforms in Kenya are growing to a size that requires a framework that ensures an integrated platform for the e-government applications and services provided to citizens, business and other government agencies. Currently most e-government platforms are independent thus result to redundancy of efforts, inconsistency of data and lack of integration, while some platforms are peer-to-peer integrated resulting to tight coupled system, and tedious process of adding of new services into E-government systems.

The aim of this research was to use the eCitizen portal in Kenya as a case study, thus understand the challenges that users and support staff have with the current e-government systems by use of questionnaires, and then use Service-oriented modelling and architecture (SOMA) to come up with a SOA Model that may be used to meet most of these challenges, and also validate this model using a prototype. The post prototype questionnaire showed an improvement of the usability of the portal from 77.5 on the current eCitizen portal, to 87.5 on the System Usability Scale, thus ultimately reducing on costs, less redundancy of data and effort, shared information and services, interoperability and most importantly better service delivery using a SOA integrated eCitizen platform.

Key Words: *SOA, Services, Web Services, IPRS, eCitizen portal in Kenya.*

LIST OF FIGURES

Figure 1: SOA Architecture (Adapted from Shah and Patel).....	12
Figure 3: M-Shwari Services screenshot.....	16
Figure 2: M-Shwari's Fiorano SOA Architecture.....	15
Figure 4: Proposed MoIRP SOA Architecture Integration.....	17
Figure 5: Kenya e-Citizen Home page.....	19
Figure 6: Kenya e-Citizen Services and Information Page.....	20
Figure 7: Current e-Citizen IPRS Data request Flow.....	37
Figure 8: Proposed Kenya e-Citizen SOA Architecture.....	39
Figure 9: High Level Proposed e-Citizen SOA integration architecture.....	40
Figure 10: Low Level Proposed e-Citizen SOA levels Architecture.....	43
Figure 11: Login Page.....	45
Figure 12: IPRS Query page.....	45
Figure 13: IPRS Query page input.....	45
Figure 14: IPRS Response Page.....	46
Figure 15: Using SUS to compare websites or applications or systems.....	54
Figure 16: Comparison System Usability Scale Chart	55
Figure 17: Post Prototype validation results	50

LIST OF TABLES

Table 1 – Service and Business alignment.....	42
Table 2 – Services offered in the eCitizen portal in Kenya.....	68

ABBREVIATIONS AND ACRONYMS

SOA – Service Oriented Architecture

IPRS – Integrated Population Registration System

ICT – Information and Communications Technology

IFMIS - Integrated Financial Management Information System

CCK - Communications Authority of Kenya.

ITU - International Telecommunication Union.

ATM - Automated teller machine

KSh - Kenya Shillings

CBA - Commercial Bank of Africa

IFC - International Finance Corporation

KYC – Know Your Customer

WAN – Wide Area Network

WSDL – Web Service Definition language

LAN – Local Area Network

LAIFOMS - Local Authorities Integrated Financial and Operations Management System.

ESB - Enterprise Service Bus

BPEL – Business Process Execution Language

SOMA - Service-oriented modelling and architecture

SUS - System Usability Scale

DEFINITION OF TERMS

1. Service Oriented Architecture (SOA)

SOA is an architectural pattern in computer software design in which application components provide services to other components via a communications protocol, typically over a network. The principles of service-orientation are independent of any vendor, product or technology.

2. Service

A service is a discrete unit of business functionality that is made available through a service contract.

3. Web Services

Web services are the amalgamation of extensible Markup Language (XML) and Hypertext Transfer Protocol HTTP that can convert an application into a Web-application, which publish its function or message to the rest of the world.

4. Web Services Description Language (WSDL)

WSDL refers to an XML based protocol used for sending and receiving the information through decentralized and distributed environments. It defines what services are available in its Web service and also defines the methods, parameter names, parameter data types, and return data types for the Web service. The WSDL document is quite reliable and applications that use web services.

5. Simple Object Access Protocol (SOAP)

SOAP is an XML - based standard interoperability protocol that is used for exchanging of information in a distributed environment. It provides a common message format for exchanging data between clients and services.

6. Service-oriented modelling and architecture (SOMA)

SOMA is the discipline of modelling business and software systems, for the purpose of designing and specifying service-oriented business systems within a variety of architectural styles, such as enterprise architecture, application architecture, service-oriented architecture, and cloud computing.

TABLE OF CONTENTS

DECLARATION	ii
ACKNOWLEDGEMENT	iii
DEDICATION	iv
ABSTRACT	v
LIST OF TABLES AND FIGURES	vi
CHAPTER 1 : INTRODUCTION	
1.1 Background of the study.....	1
1.2 Statement of the problem.....	3
1.3 Purpose of the study.....	4
1.4 Objectives of the study.....	4
1.5 Research Questions.....	4
1.6 Significance of the study.....	5
1.7 Limitations of the study.....	5
CHAPTER 2: LITERATURE REVIEW	
2.1 Introduction.....	6
2.2 SOA application in the world.....	13
2.3 SOA application in the Africa.....	15
CHAPTER 3: METHODOLOGY	
3.1 Introduction.....	22
3.2 Research design.....	22
3.3 Service-Oriented Modelling and Architecture (SOMA).....	26
CHAPTER 4: PRE-PROTOTYPE STUDY AND SOA DESIGN	
4.1 Pre-Prototype Study and Results.....	28
4.2 SOA Design and Implementation.....	37
4.2.1 Identification Stage.....	37
4.2.2 Specification Stage.....	40
4.2.3 Realization Stage.....	43
4.2.4 Implementation Stage.....	44
CHAPTER 5: POST PROTOTYPE TESTING AND RESULTS	
5.1 Introduction.....	47
5.2 System Usability Scale.....	47
5.3 Testing.....	51
CHAPTER 6: CONCLUSION AND RECOMMENDATIONS	
6.0 Introduction.....	53
6.1 Conclusion.....	54
6.2 Recommendations.....	56
6.3 Limitations.....	57
REFERENCES	
APPENDICES	

CHAPTER 1: INTRODUCTION

The Kenyan government is moving towards becoming more efficient operationally by collaborating across traditional departments and has to become more responsive towards its citizens' needs. The government faces an increased pressure to form an effective eGovernment. The e-Government is not only meant to bring public services online, but is also focused mainly in reducing overall operational costs by transforming the eGovernment into an organization that generates both social and economic value effectively. This involves implementation of various information systems such as management support systems, operations support systems, transaction processing systems, human resources management system, electronic messaging and collaboration system, IMIS (Integrated multicultural information system), IFMIS, EMIS (Environmental management information system), Transport management system, Ledger management System and National electronic single window system for various staff distributed across different government offices in different ministries and autonomous bodies (GOK, 2013).

The Kenyan government started a program of investing in ICT infrastructure with the help of foreign funding. This program was meant to address two impediments to development faced by many countries: endemic corruption and inefficiency. Unified Communication system in the E-government is intended to address the wastage in time and other resources occasioned by such meetings. By providing both voice and video conferencing services the project will increase efficiencies by allowing staff to hold such discussions from their offices or a room designated for such in a building.

The Kenya E-Government Secretariat was set up in 2004 under the Office of the President to be an oversight body to galvanize all ICT projects within government aimed at enhancing service delivery of all the ministries. The Ministry of Information and Communications was set up in 2004, for the first time in the history of Kenya, mainly to handle the wider universal access goals to enable the citizens actively participate in a global economy which is increasingly knowledge-based.

Numerous ICT projects have been undertaken all over the world most of which have been implemented successfully. However, there are issues in the methods, practices, performance and success in managing ICT projects. In the developing countries, projects that have been designed and implemented, and have the potential to bridge the digital gap, are those that were undertaken in developed countries as opposed to developing countries empirically explored the complexities of e-government implementation and diffusion challenges in a developing country that is not in an advanced state of e-government development and showed that, irrespective of strong financial support and resources, governments must be prepared to align national ICT strategies with various local level e-government projects, create legislation, implementation guidelines and standards in order to achieve e-government success.

The Government of Kenya has implemented electronic systems in various State Departments and other state-owned institutions, including national tax systems, immigration information system, legal information system, the integrated financial management system and education system. Most of these systems are to be found in various ministries and departments and information is manually exchanged by and between departments and institutions using fax, e-mail and electronic media. These systems provide partial electronic services to citizens and businesses through Government portals and websites.

But there is still a challenge in the integration of these systems due to their heterogeneity and lack of interoperability brought about by the diverse data formats, program languages, data storage methods and vendor's system access, this is closed and open systems. This has in turn resulted to data redundancy, effort duplication, lack of shared information, inconsistent information and long ineffective processes as need to verify details from other departments is basically manual. This paper proposes new integrated eCitizen portal that gets real-time data requested by users from Integrated Population Registration System (IPRS). IPRS is a central database of all Kenyan citizens and all foreign nationals resident and registered in Kenya.

1.2 Statement of the problem

The end of the first decade of the 21st Century has been described as both a historical turning point in the development of e-Government systems. Various governments have seen the launch of various systems aimed at improving the delivery of services and sharing of government information more accessible. The aim being to help public authorities use ICT to offer better services at lower cost, while making life easier and better for citizens and businesses. Most governments aim to empower citizens and businesses, reinforce mobility in the Single Market, enable efficiency and effectiveness, and create the key pre-conditions for e-Government (P. Wauters, et al., 2012).

To fully optimize its use the e-Government services need to rely on and benefit from innovative technical approaches, such as clouds of public services and service-oriented architecture (SOA) to build open, flexible and collaborative e-Government services while at the same time lowering ICT costs. Such innovative e-Government is based on developments in recent years in which ICT in government has shifted from the back office approach towards more back- and front-office integration, via a collaborative approach, third party involvement and public private complementarity.

There is a growing need to harmonise rules and procedures and to give more priority to Interoperability, exploiting the use of open environments for example open standards and source. The use of SOA architecture seeks to examine the potential for and impact of offering public services in an open and interoperable way, the reuse of public services by both different public administrations and third parties could make a significant contribution to the move towards the collaborative model of e-Government and the reorientation of online service provision towards the creation of public value shared by all actors in society and stakeholders, and significantly improve the provision of services to these stakeholders, at the same time improve data integrity, reduce redundancy and make processes efficient and timely, thus in the long-term reduce costs and improve service delivery

1.3 Purpose of the study

The purpose of this study is to develop a Service Oriented Architecture Model that can be used to improve use of the Kenyan e-Citizen portal, and validate the Model using a prototype.

1.4 Objectives of the study

The general objective of the study is to develop a SOA Model that can be suitably implemented in the Kenyan e-Citizen portal to improve its usability, while the specific objectives are

1. To identify the current challenges faced by users of the e-Citizen portal in Kenya.
2. To identify the current integration methods and their challenges as implemented in the e-Citizen portal in Kenya.
3. To develop a Service Oriented Architecture Model that can be implemented in the Kenyan e-Citizen portal.
4. Validate the proposed SOA Model using a prototype.

1.5 Research Questions

1. What are the challenges of the use of the e-Citizen system in Kenya?
2. What are the current integration methods used in the e-Citizen system in Kenya?
3. What are the current integration challenges of the e-Citizen system in Kenya?
4. What are the current applications of SOA architecture Models in Kenya.
5. Will the proposed SOA Model improve the usability of the e-Citizen system in Kenya?

1.6 Significance of the study

There several challenges and issues that need to be addressed to meet the goal of effective e-governance in Kenya some of which are business challenges while others are technical challenges such as Information sharing, Insufficient infrastructure, Unaffordable internet services, data duplication, and redundancy, Integrating desperate business applications into common workflow, Security enforcement, Lack of integration between systems within and across departments, lower productivity, and potential revenue leakages and losses.

The goal of E-Governance was to enable citizens, private and public sectors to access government services and information in effective and efficient integrated services delivery to the customers anywhere, any time in a form convenient to the service recipients through the use of internet, mobile phones and other channels. The use of Service Oriented Architecture (SOA) and the web services for optimizing the performance of e-governance applications. This can be achieved by enhancing the agility and flexibility of the technologies used in e-governance applications. This research paper attempts to find an approach to the application of e-governance using SOA as the solution approach.

1.6 Assumptions of the study

Some assumptions made was that the sample population used answered the questionnaires accurately, the data collected was analysed accurately and with appropriate summaries, and research tools and techniques were accurate for the study done.

1.8 Limitations of the study

The research had various limitations that should be kept in mind. The sample that was used was relatively small in comparison to the affected population due to time and resources limitations that such a research would otherwise require, and thus was a drawback to my study. This resulted in the findings not being wholly accurate.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The evolution in the factors motivating the development of e-Government over time: Initially, the introduction of ICT in government was driven by the need for greater efficiency. Then, the effectiveness of public service provision was included as a goal. And Latter, good governance has been added as an objective in its own right. Most governments aim to empower citizens and businesses, reinforce mobility in the Single Market, enable efficiency and effectiveness, and create the key pre-conditions for e-Government (P. Wauters, et al., 2012). According to Rothenberg, J. (2009), interoperability has long been recognized as one of the major enablers for providing ‘one stop’ government services to citizens, while Gottschalk, P.(2009) stated that interoperability refers to a property of diverse systems and organizations enabling them to work together.

The Kenyan e-Citizen portal offers both citizens and non-citizens access to online services that can be paid for via mobile money, debit Cards and eCitizen agents. Some of the Government to Citizen Services offered are Business Name Registration, Notice of Marriage and Issuance of a marriage certificate, Provisional and Interim Driving License, Driving License Renewal and duplication, Land Rent Clearance Certificate, Passport application and Application for Kenyan Visas.

The traditional peer-to-peer e-government integration results in a tightly coupled e-government system which reduces agility, expansibility and interoperability. Traditional e-government systems suffer from several inefficiencies as follows: Firstly, tightly coupled applications. Secondly, in-agility and in-expansibility of the systems; the systems were developed by different developers using different programming languages in different platforms. Thirdly is unreliability in communication between government entities and agencies. SOA is considered one of the promising technologies that provide interoperability and integration between various services, different software applications, running on a variety of platforms in government and non-government organizations.

2.1.1 SYSTEM INTEGRATION

System integration is defined as putting diverse hardware and/or software components together to work as a system. Integration is a complex task, especially when the applications involved reside on older legacy systems or utilize different hardware or software platforms. From a historical perspective, the earliest computer systems were large stand-alone computers known as mainframes that ran only one computer program at a time. Multiprocessing, the ability to run several programs, each in a distinct partition of the mainframe's memory, was a technical breakthrough that arrived in the 1960s. Since then, businesses have continued to require ever more computing power and flexibility, and the level of complexity of software solutions has increased significantly. Each decade since the 1960s has seen advances in computer technology, with each generation of hardware and software solutions standing on the shoulders of prior developments. This constantly changing environment creates a continuing dilemma for businesses of all sizes in all areas. This article traces the evolution of integrated computer systems.

Computer and information technology remains a major organizational expenditure in terms of initial investment and continuing maintenance costs. Integration bridges the gap between older legacy systems that continue to function and newer technologies that have been developed along the way. Organization leaders must therefore continually evaluate the pros and cons of when to adopt the latest technologies. Organizations use integration technology to pull together applications and extract greater benefits from their computer systems. Integration can result in cost savings, additional revenue, and competitive advantage when techniques such as process automation and business monitoring are utilized. Organizations may additionally reap benefits from rationalizing applications following an acquisition or merger, where each of the combined businesses has been using proprietary solutions.

2.1.2 SYSTEM INTEGRATION LEVELS

There are four common system integration levels

- Data-level integration
- User interface (UI)-level integration
- Application-level integration
- Method-level integration

2.1.2.1 Data-Level Integration

The backend data stores of the relevant application are integrated, and can be either push or pull based. When using push based, one application makes SQL calls on another application's database tables. This is through database links or stored procedures, and data is pushed into another application's database. However, pull based integration uses triggers and polling. The triggers capture changes to data and write the identifying information to interface tables. It is then possible for adaptors to poll the application's interface tables and retrieve the pertinent data. This pull based integration is used when an application requires passive notification of changes within another application's data. When the application that needs to be integrated does not provide any APIs or client interfaces, you would use data-level integration.

2.1.2.2 User Interface-Level Integration

This ties integration logic to user interface code, and can be either scripting or proxy based. When using scripting based, the integration code is embedded into the user interface component events, common with client/server applications such as PowerBuilder. In cases where direct access to the database is not easy or possible, or when the business logic is embedded in the user interface, this is the correct integration method to use. However, user interface level integration is generally used as a last resort. If you add scripting logic to catch events with client/server applications they become very difficult to maintain, as integration levels increase and more changes occur. User interface changes can break integration triggers and logic anyway. This tight coupling creates a permanent link between the maintenance of the user interface and the integration code.

2.1.2.3 Application-Level Integration

This is considered the best way forward for application integration, and it uses the integrated application's integration frameworks and APIs. It is good to use, since it is transparent to the integrated application and it preserves the application's data integrity. The application interface allows you to invoke business logic to preserve data integrity.

2.1.2.4 Method-Level Integration

This is less frequently used specialization of the application level integration method shown above. Here, we aggregate common operations on multiple applications into a single application that fronts the integrated applications. It is generally used when each integrated application has a similar set of API or functional methods. The integrated applications must support a Remote Procedure Call (RPC) or distributed component technology. The main disadvantage to this approach is again the tight application coupling in front components. They will break when changes are made to the integrated application API, and these problems will propagate down to the other applications that rely on them. This is used when we have distributed component or CORBA technology.

2.1.3 SYSTEMS INTEGRATION ARCHITECTURES

In a well-designed building, the electricians and plumbers usually keep working no matter how many appliances are switched on. Such a building is also capable of extension without having to tear up the blueprints and start again because of its good architectural design. The same applies to software systems. Software architecture is the backbone of any complex computer system. The architecture encompasses all of the software elements, the relationships between the elements and the user interfaces to those elements. The performance and reliability of a software system are highly dependent upon the software architecture. Well-designed software architecture can be extended with relative ease to accommodate new applications without requiring extensive infrastructure development. Described herein are the most common "**Integration**" Software Architectures.

2.1.3.1 Point-To-Point Integration Architecture

The original architecture used to support systems integration was called Point-to-Point. It derives its name from the direct, tightly bound connections that are made between applications and is the simplest of the integration architectures.

2.1.3.2 Hub and Spoke Integration Architecture

The earliest formal integration technologies worked on the principle that all information coming from the applications had to be processed within a single machine or server called a "hub". Acting as a central point of control, the hub dealt with all message processing including routing, splitting and combining of messages, mapping, and so on. Hub and Spoke implementations decouple the sending and receiving applications, with either side of the hub can be modified independently of each other.

2.1.3.3 Distributed Integration Architecture

One solution to the Hub and Spoke scalability issue is to perform message translation, routing, splitting, and combining closer to the source and target systems by using smaller computers known as "agents." Agent computers are connected to just one system and reduce the processing load on that system. Agents take information from the application they are connected to, process it, and send it to any target application(s) interested in receiving that information. The end result is Distributed Architecture. It is also known as **Peer to Peer** architecture.

2.1.3.4 Service Oriented Architecture (SOA)

Service Oriented Architecture (SOA) is the latest architectural approach, although it's not really very new. Service Oriented Architecture is essentially an enhanced version of Distributed Architecture that uses loosely coupled software services to support the requirements of business processes and software users. It goes a step further than the previous architectures by providing an integrated environment which spreads out the workload, breaking down the different "silos" of business functionality and opening their processes to other applications.

The breakthrough for SOA came with the acceptance of Web Services. Web Services was the first time that Microsoft and IBM could finally agree on a communication standard. They both wholeheartedly embrace Web Services. After Web Services came Enterprise Service Bus (ESB) technology. Based on Web Services, and exhibiting all of the characteristics of the Messaging and BPM solutions previously supplied by the integration vendors, ESB has become the accepted standard for the creation of an organization's Service Oriented Architecture. Without exception all of the integration vendors now provide an SOA architecture built on the concept of an Enterprise Service Bus (ESB). Thanks to Web Services there's now a thriving integration industry that is creating more and improved services that can be used to construct bigger and better business solutions. There were initial concerns about reliability and security but these have now been dealt with. There seems to be no stopping the universal acceptance of the Enterprise Service Bus and Service Oriented Architecture. When SOA implementation is guided by strategic business goals, chief benefits on an SOA are realized as follows:

Alignment of IT with the business and maximal reuse of IT assets.

Web services are currently the most popular technology for implementing a SOA. The basic web services standards are Simple Object Access Protocol (SOAP) for messaging, Web Service Description Language (WSDL) for describing web service interface, and Universal Description, Discovery, and Integration (UDDI) as an optional technology for implementing the service broker. The SOA architecture is illustrated in Figure 1.

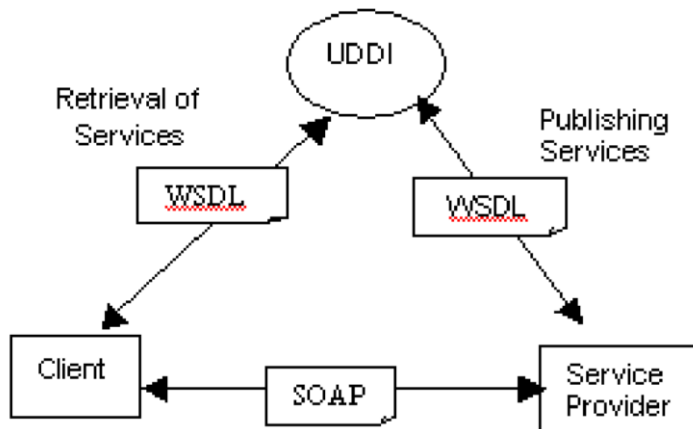


Figure 1: SOA Architecture (adapted from Shah, Patel, 2009)

According to Liu, M. (2009) the following are the key aspects of SOA principles:

1. Loose coupling: relationship that minimizes dependency and only requires that services retain an awareness of each other.
2. Service contract: communications agreement, as described in service description.
3. Autonomy: local control over the logic a service encapsulates.
4. Abstraction: hides logic from outside world.
5. Reusability: logic divided into different compassable services.
6. Composability: services can be coordinated and assembled to form composite services.
7. Interoperability: open standard-based interfaces and protocols for the plug-and-play architectural components.

The SOA architectural style has the following features: It is based on the design of the services comprising the enterprise business processes; Service representation utilises business descriptions to provide context and implements services using service orchestration; It places unique requirements on the infrastructure by recommending that implementations use open standards to realize interoperability and location transparency; Implementations are environment-specific; It requires strong governance of service representation and implementation. SOA is based on three main concepts: services, interoperability through an enterprise service bus, and loose coupling (P. Wauters, et al., 2012).

2.2 SOA Application around the world

2.2.1 SOA Perspective of e-Governance in Indian Context

According to Harekrishna, M. (2009) Service Oriented Architecture (SOA) is a contemporary phenomenon which is targeted for efficient and inclusive business automation. SOA principles and models are being used for building good e-government systems. Good results of e-government systems notwithstanding, such projects are however not free from challenges in many countries. E-governance projects have fallen short of citizen expectations in developing countries. In Indian context, this issue is relevant as it poses a major challenge for governance policy makers to successfully incorporate citizen participation, especially with development perspectives and sustain this participation during scale up. E-governance projects in India need to follow SOA principles in order to make them successful in terms of sustainability, providing appropriate services to citizens. Essentially, SOA principles provide such ambience to extend desired support to e-governance initiatives in India. A scenario is built through SOA architecture to showcase the possible effect of SOA principles in order to appreciate citizen centric services taking scale-up issues into consideration. This framework is discussed to reflect the underpinnings of orchestration of services on demand and service provisioning through e-governance initiatives for effective implementation SOA principles.

Indian E-Governance Systems: Development Perspectives

Interoperability has been a critical evaluation criterion for enabling interstate transactions, managing information flow seamlessly and overseeing the backend process for effective delivery of citizen services. In India, e-governance system is still evolving and is not free from challenges as experienced in global terms. There are however many successful ICT initiatives in India oriented towards rural development with a focus to address some specific issues of rural citizens, thus forming “islands”. The aim is to provide a portfolio of services to the citizens integrated with e-governance backbone to install a good e-governance system without getting affected during scale up phase. This is possible through a SOA based model which would enable service orientation through citizen demands. Aggregated service demanded are the inputs for the 'service provisioning agencies' in the national network engaged for establishing the orchestrated link to manage the 'service brokering' facility and supply the services. This provides a scope for the citizens to receive the desired service through SOA based service model.

SOA Based E-Governance Strategy

SOA principles draw strength from the benefits of well-practiced architectures in software engineering discipline like client-server, distributed architecture. (Erl T., 2008). SOA builds on the strengths of 'application architecture' and 'enterprise architecture' and therefore, has potential to manage e-governance projects. SOA is expected to provide 'universal service identifier' in the system so that desired service can be identified 'on demand' with least transaction time, transaction cost and independent of spatial constraints. It is seen that various service components of SOA can contribute to the Indian e-governance system in order to provided desired services. The components are 'citizen demand on services', 'service on demand aggregation', 'service-on-supply aggregation', 'service orchestrators' and 'service providers'. A seamless integration of all the services and service provisioning components need to collaborate effectively to focus on citizen centric services. In other words, there are concurrent attempts to provision citizen centric services taken by central and state authorities. Of late, central administration has deployed mission mode projects with states collaborating as part of NeGP (Chandrashekhar, 2006). Therefore, convergence of services is of prime importance so as to provide commercial approach to the services and establish sustainable and remunerative information service provisioning.

SOA architecture based treatment to the Indian e-governance therefore reveal that there is a need to carefully conceptualize and to incorporate all the characteristics of SOA in order to provide citizen centric services. It is far more important that countries like India need to carefully articulate services with active collaboration of the citizens in order to deliver good governance systems.

2.3 SOA Application in Africa

2.3.1 M-Shwari application of SOA Architecture

Commercial Bank of Africa (CBA) in partnership with Safaricom Limited launched a revolutionary product in November 2012 known as M-Shwari. M-Shwari is a suite of banking products that are offered to more than 25 million Safaricom M-PESA customers via their mobile phones. The product has given CBA the platform to offer a much needed service to all market segments through mobile-banking services. These electronic accounts are processed by CBA which allows its customers to operate banking services entirely on a mobile phone, saving them from visiting a branch. All a customer needs is a mobile handset and be registered on M-PESA. There are no forms or additional documents required to sign up to M-Shwari.

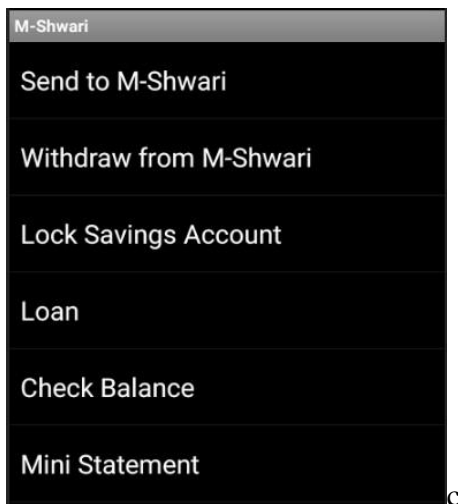


Figure 2: M-Shwari services screenshot

Implementation of SOA

M-Shwari uses SOA architecture as its main integration middleware with other vendors and partners. The SOA architecture provides a seamless real-time exchange of information and up-date of data in the various systems, independent of the applications, data formats, vendors and architectures the various partners and vendors have used. To successfully launch M-Shwari, CBA required a solution with the ability to seamlessly integrate with its partners, such as Safaricom Limited mobile money platform. Fiorano SOA was chosen as the platform, allowing CBA to expose its Core Banking transactions as web service flows besides ensuring guaranteed message delivery and scalability. Fiorano ESB within Fiorano SOA integrates tightly with the Core banking Integration Framework, thus enabling Real-

time update of information between CBA and its vendors, provided a getaway for SMS to be sent out to customer and out-sourcing platform for non-core business added services such as customer care (Fiorano, 2015).

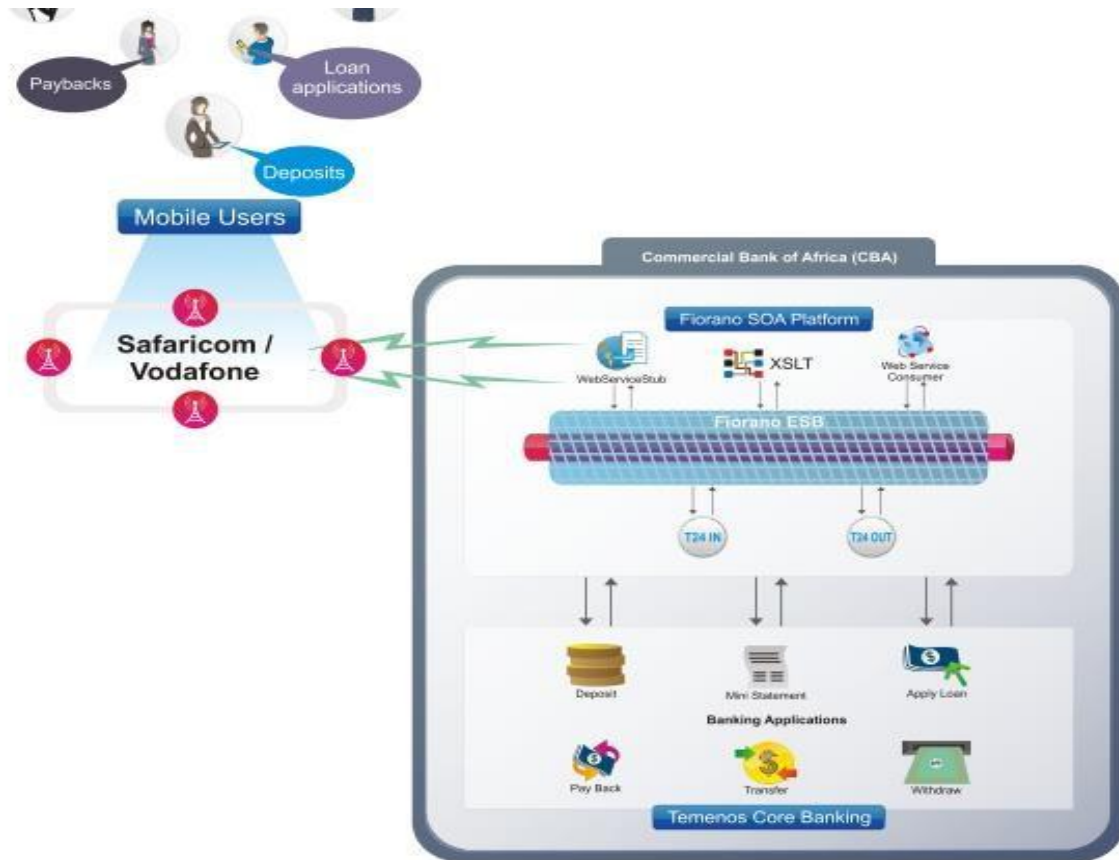


Figure 3: M-Shwari's Fiorano SOA Architecture (Fiorano (2015)).

SOA has enabled:

1. Real-time update of information between CBA and its vendors, for example, crediting scoring, customer information.
2. Provided a getaway for SMS to be sent out to customer.
3. Out-sourcing of some services, for example, Customer care
4. Data consistency between CBA and vendors
5. Efficient addition of services from external vendors, like Hello Doctor

2.3.2 An Electronic Government Integrated System using SOA.

According to Violet L. (2014) the use of SOA model that supports aggregation of information, interaction and personalisation of information to specific user needs can support contextualization and seamless flow of information, thus leading to an improved government information sharing and consequently increasing service delivery to citizens.

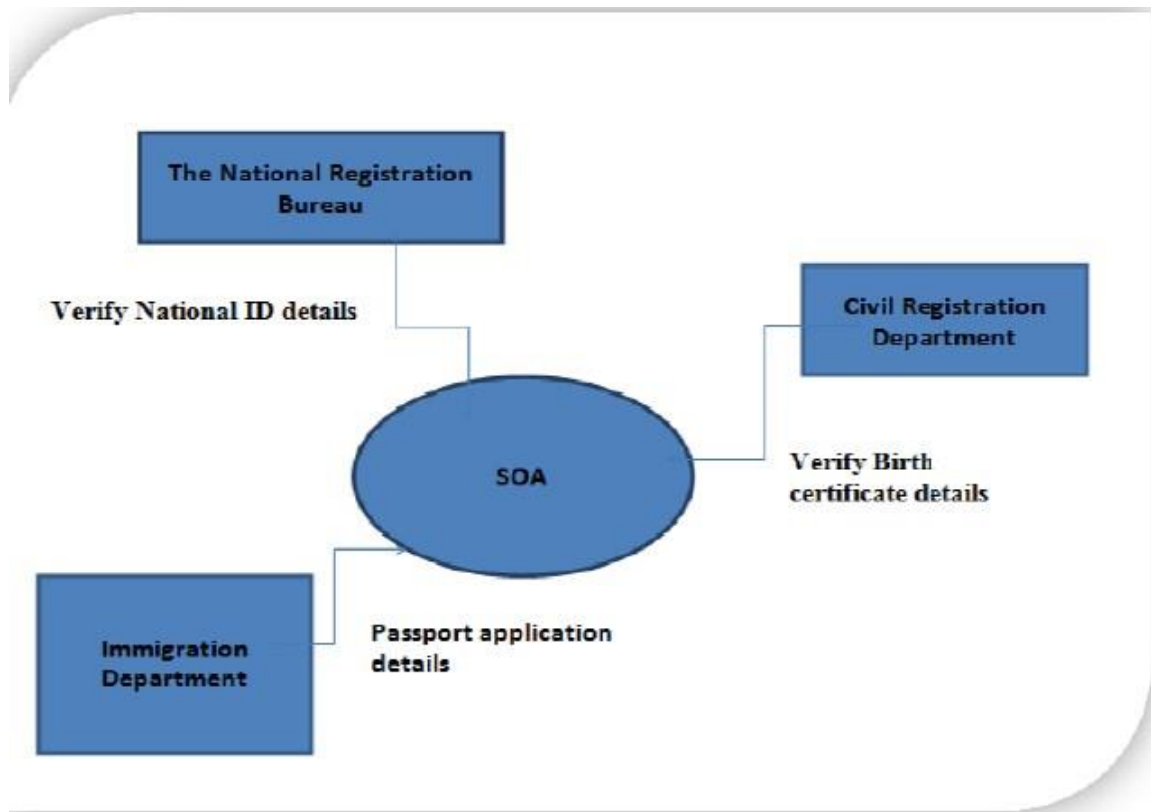


Figure 4: Proposed MoIRP SOA Architecture Integration (adapted from Violet L., 2014)

Violet L. study aimed to investigate the application of Service Oriented Architecture (SOA) as an integration solution to disparate departmental government information systems with the aim of improving service delivery. The specific objectives that the study addressed include identification of business work flows, communication flows, and the common information requirements within the three departments of the Ministry of Immigration and Registrar of Persons; IMD, CRD and NRB; identification of the current and potential integration difficulties of the three systems; development of a SOA model of the proposed integration solution; building a system prototype using JAVA SOAP web services to implement the model; testing, evaluation and validation of the prototype. The data

collection involved interviewing staff at the ministry department and carefully documenting all the processes.

The findings of the study revealed that service delivery can be significantly improved by the adoption of Service Oriented technology. These findings have multiple implications on service delivery and also lowering of costs related to system development.

The study was based on the application of Identification cards and Passports, the took 30 and 14 days respectively, and with use of SOA to integrate the respective departments reduced this 15 and 7 days respectively by using SOA integration to enhance the Validation stages which were initially done manually using files, and thus improved service delivery significantly.

2.4. Current e-Citizen portal in Kenya

The current eCitizen portal offers the following services Business Name Registration, Registrar of Companies, Notice of Marriage, Issuance of a registrar's certificate, Solemnization of marriage, Issuance of a marriage certificate, Special licenses for marriage, Provisional and Interim Driving License, Driving Test Booking, Driving License Renewal, Duplicate Driving License, Driving License Information Corrections, Official Search (Nairobi Blocks), Land Rent Clearance Certificate, Passport application for Adults and Children, and Application for Kenyan Visas. These services are provided in collaboration of various ministries and departments namely Registrar of companies, Registrar of marriages, National Transport and safety Authority, ministry of lands and department of Immigration. The figure below shows the eCitizen Home page on the portal.

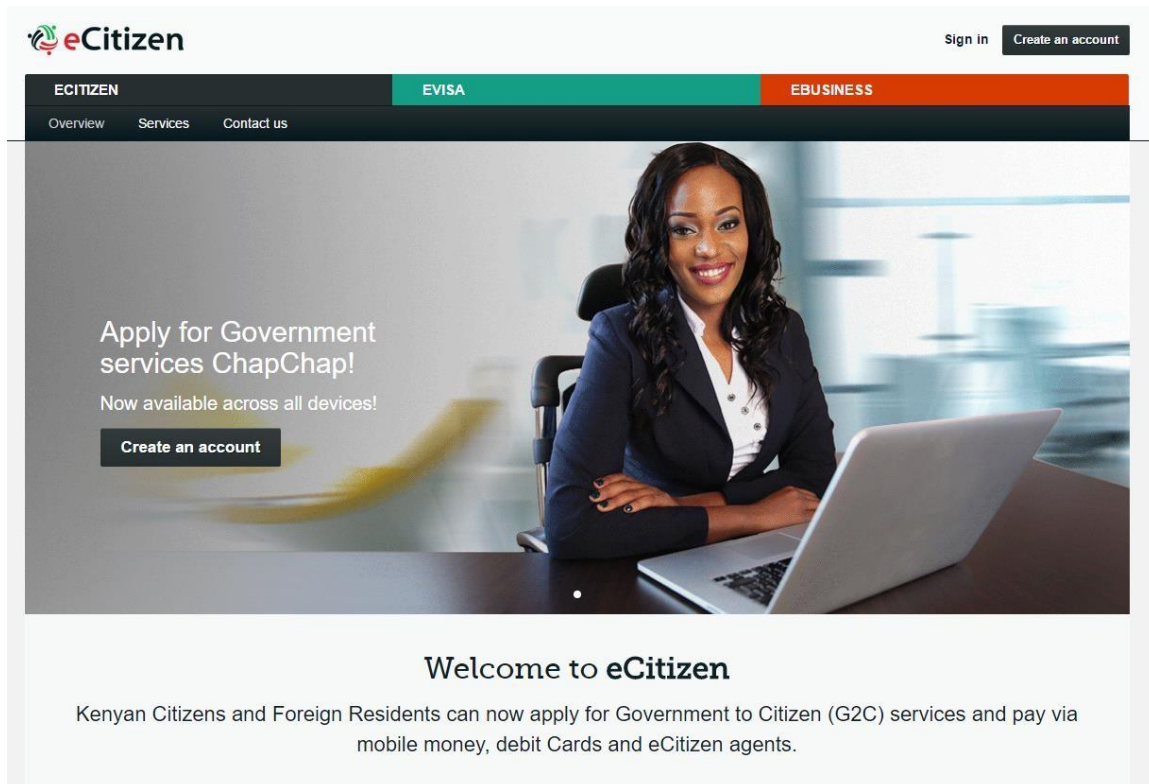


Figure 5: Kenya e-Citizen Home page (adapted from the current eCitizen portal in Kenya).

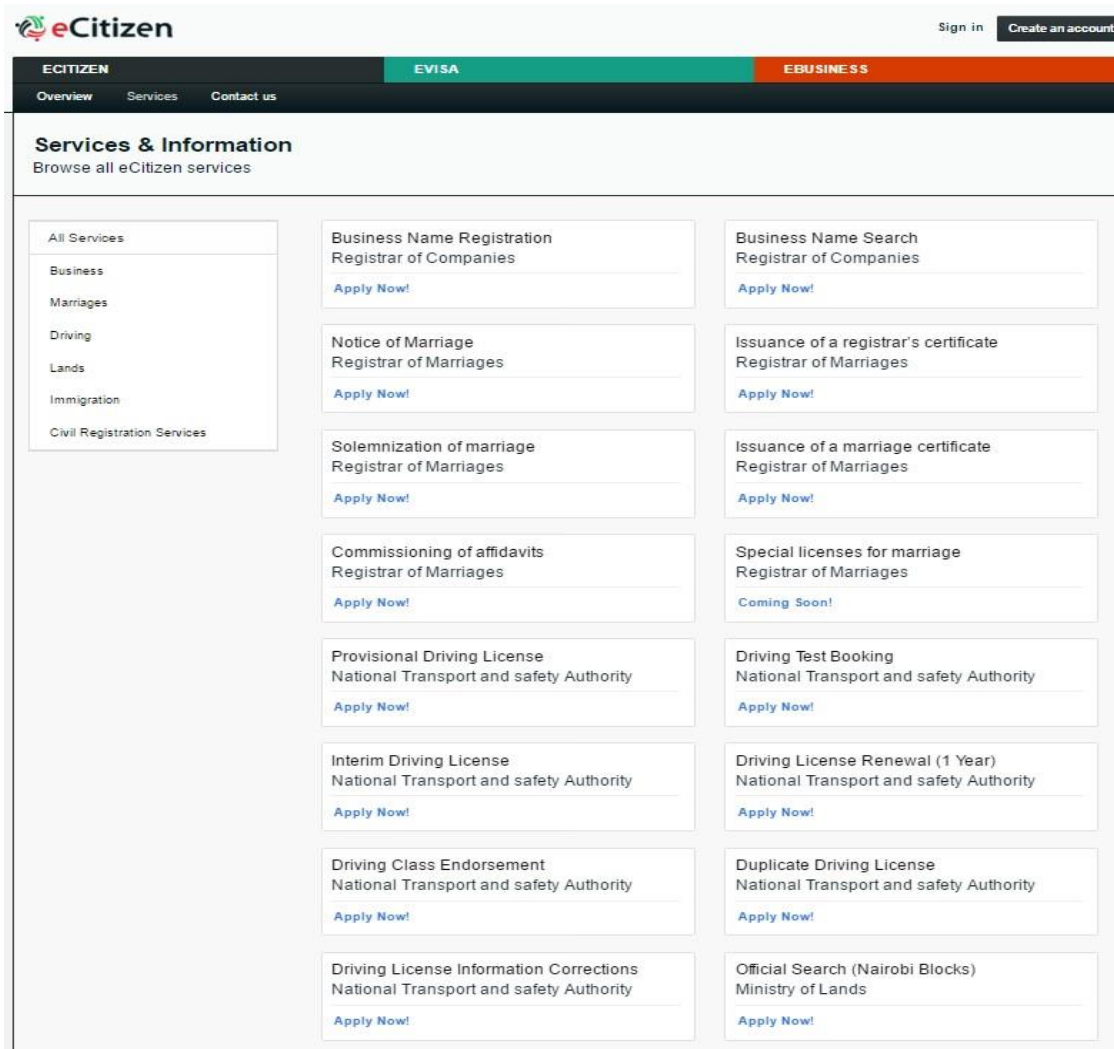


Figure 6: Kenya e-Citizen Services and Information Page (adapted from the current eCitizen portal).

The eCitizen portal in Kenya provide some of the following services

1. Businesses: Business Name Registration, Registrar of Companies, Issuance of a registrar's certificate
2. Marriage: Notice of Marriage, Solemnization of marriage, Issuance of a marriage certificate
3. NTSA: Provisional and Interim Driving License, Driving License Renewal, Duplicate Driving License and Driving License Information Corrections.
4. Ministry of lands: Official Search (Nairobi Blocks), Land Rent Clearance Certificate, Land Rent Clearance Certificate
5. Ministry of Immigration: Passport application for Adults, Passport Application for Children, Application for Kenyan Visa

Implementation

The current e-citizen portal is a system that applies the various e-services links to the various departments and bodies providing this services. Some of the services and information provision is done using manual updates to the e-Citizen system through uploads of files from time to time to update the database. This has led to data redundancy, lack of integrity and inconsistencies, and out-of-date information. The e-Citizen portal consists of an interface, middleware and database that are implemented using Oracle solutions to implement the Graphic User Interface (GUI) and applications providing the services.

Summary

The current e-Citizen system has a couple of challenges that affect the usability of the system. This challenges are;

1. Duplication of Data – The current system duplicates data from the various institutions to the e-Citizen system, thus creating another copy of the same data.
2. Data Consistency – The data may not be up to date especially when multiple updates are done simultaneously.
3. Manual data update – The current system is updated manually using back and forth files sent via email, then updated to the system.
4. High cost of maintenance – The e-citizen has to store the current data in the ecitizen Database thus multiple tables and large storage are required.
5. Scalability – The addition of more services is a time consuming, tedious and expensive process.
6. Usability – The e-Citizen acts as a portal to the various ministry and institution applications and websites, thus multiple authentications, validations and interfaces.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter outlined the method that was used to undertake this study. This chapter presented the research design, time and place of the study, sampling procedures, sources of data, sample size, analytical procedures and the questionnaire to be used in data collection.

3.2 Research design

The research used quantitative research to collect data that led to analysis of e-Citizen system and its challenges, and also the various integration methods currently used by the e-Citizen system and their challenges. The research used descriptive research to quantify the use and challenges of the e-Citizen portal, and the integration methods used.

The research used descriptive research since the research subjects were measured once. The descriptive study established only associations between variables, which in the research case is the e-Citizen system. For an accurate estimate of the relationship between variables the research descriptive study used a sample of 41 subjects thus reducing the likelihood of relationship being biased by a high participation rate in a sample selected randomly from a population.

We used general questions and the System Usability Scale to measure the usability of the current e-Citizen system. The System Usability Scale (SUS) is a reliable, validated and commonly used usability questionnaire. It provides a global assessment of user satisfaction and allows you to evaluate a wide variety of products and services. The SUS consists of 10 items with five response options ranging from "Strongly agree" to "Strongly disagree".

The questions are as follows and were tweaked to suit our case study;

1. I think that I would like to use this system frequently
2. I found the system unnecessarily complex
3. I thought the system was easy to use
4. I think that I would need the support of a technical expert to be able to use this system
5. I found the various functions in this system were well integrated
6. I thought there was too much inconsistency in this system
7. I would imagine that most people would learn to use this system very quickly
8. I found the system very cumbersome to use
9. I felt very confident using the system
10. I needed to learn a lot of things before I could get going with the system

The score is measured as follows;

- 80 or higher is an A - People love your site and will recommend it
- 68 or thereabouts gets you a C. It's OK but needs improvement
- 51 or under gets an F - Make usability your priority now and fix this fast.

From the literature research done, it was narrowed down to come up with the proposed model based on Service-oriented modelling and architecture (SOMA) which is a methodology for modelling service-oriented architecture (SOA) applications, and a prototype will be created based on the model to validate the model.

3.2.1 Target population

The research was on the people that may have used E-government services in Kenya using the eCitizen portal.

Inclusion Criteria:

1. Access to the eCitizen services.
2. Have used the eCitizen services.

Exclusion Criteria

1. Have not used the eCitizen services.
2. Don't have access to E-government services.

3.2.2 Sample size and sampling procedures

The research used random sample sizes to indicate the number of subjects necessary for a reasonably test for the study , and probability sampling thus each element in the population had an equal, independent chance of being selected, and a non-bias sample representative of the target population.

The sample chosen was random, though the target sample was mostly people who have used E-government services one or more times, thus able to collect data appropriate and required for the study, and used to produce accurate results and findings.

3.2.3 Data collection instrument

The main data collection instruments will be;

1. Questionnaires - The main means of collecting data will be physical and online questionnaires that will be filled by a randomly selected group of people. The sample will answer a set of questions that will indicate the use and some of the factors that influence the use of E-government services in Kenya.
2. Interviews - The other means of data collection was through interview both face-to-face an also through calls, and the sample will have a similar set of questions. This was critical for collection of data for integration methods and their challenges from eCitizen and third party sources.
3. Secondary Data - This was data from reports, journals and previous researches about the indicators and factors that influence the use of E-government services in Kenya, and the various integration methods and their implementation.

3.2.4 Data collection procedures

Primary and secondary sources was used in data collection. Open and close-ended questionnaires and interviews was administered to random target respondents. The secondary sources will be from previous research and statistics gathered and analysed on various e-Citizen services and products in terms of usage and the challenges, and also the used integration methods and their challenges.

3.2.5 Data analysis techniques

In the data processing and analysis the research used the following procedure;

- ✓ Recording, storing and reducing data
- ✓ Assessing data quality
- ✓ Statistical analysis

To enhance the quality of the data obtained my research used some unstructured questions whereby the respondents was asked to give various challenges of use and the integration methods of the e-Citizen system. Various data was collected to satisfy this study in accordance with the methodology. The software used for the analysis was online google forms, and System Usability Scale.

3.2.6 Ethical considerations

Some of the ethical considerations are

1. Private privacy - This is privacy of sample data and the interviewers and questionnaires in terms of their personal details. The questionnaires did not have the interviewee's personal details and was anonymous.
2. Sensitivity of Secondary Data - The secondary data was sourced from different institutions and writers, and contents well reference where gotten from a published article, journal or research report.

3.3 Service-Oriented Modelling and Architecture (SOMA)

The Proposed SOA e-Citizen Model was developed using SOMA. Service-oriented modelling and architecture (SOMA) is a methodology for modeling service-oriented architecture (SOA) applications. SOMA is an end-to-end analysis and design method that extends traditional object-oriented and component-based analysis and design methods. SOMA is based on three major phases:

1. Identification - SOMA Identification discovers candidate services, enterprise components and flows.
2. Specification - SOMA Specification makes service exposure decisions, and specifies the services and enterprise components to realize them.
3. Realization - SOMA Realization captures realization decisions.

The phases are used to model the three main elements of SOA, which are:

- Services
- Components that realize the services, which are also known as service components
- Flows that can be used to compose services needed in an SOA application

SOMA validates every step of the design phase, ensuring a fully integrated, flexible and responsive SOA business infrastructure.

SOMA is based on several years of hands-on experience that IBM developed in working with enterprises that were early adopters of SOA. SOMA is a flexible approach to solving enterprise issues that provides maximum return on investment. SOMA helps companies implement SOA to have better visibility into their business processes, giving them the tools they need to improve and grow.

3.4 TESTING THE PROTOTYPE

The tests of the prototype will be based on the following criteria

1. Service Authentication Testing - This involved testing whether prototype allows access to unauthorized users. Ensures access only given when appropriate certificates or/and credentials that are provided.

SAMPLE	Type of authentication	Response
Sample 1		

2. Service Validation Testing - This involves testing weather the prototype is able to validate the data provided in the web request before sending to the respective application server.

SAMPLE	Type of Validation	Response
Sample 1		

3. Communication Channel Testing - The communication channels are specified in the prototypes and each service specify the addresses it remotely connects to, this is, request coming from and is sent back to.

SAMPLE	REQUEST	CHANNEL	RESPONSE
Sample 1			

4. Service Request Testing - This involved testing whether the system gets a service response for each service request.

SAMPLE	Request	Response	Comment
Sample 1			

5. Test Response Time Testing

The time taken for the application to respond to requests. This is time between when web request is sent and web response is gotten.

SAMPLE	Time of Request	Time of Response	TIME TAKEN
Sample 1			

CHAPTER 4: PRE-PROTOTYPE STUDY AND SOA DESIGN.

4.1 Pre-prototype Study and Results.

The current e-Citizen portal was analysed from a User and Support perspective using Questionnaires both online and interviews, thus used to accomplish objective 1 and 2. The Model and prototype was established using Service-oriented modelling and architecture, thus used to accomplish object 3 and 4.

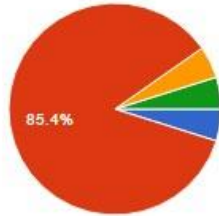
4.1.1 Questionnaire to User

A total of 46 Questionnaires were filled of which 41 were online and 5 were face to face questionnaires. This was done over a period of 8 weeks and people from different parts of Kenya, and diversity of ages, education, gender, marital and employment status.

System Usability Scale

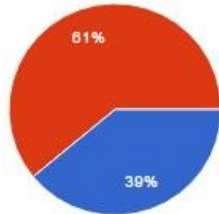
According to Sauro, J. (2011), SUS is a very easy scale to administer to participants, can be used on small sample sizes with reliable results and its valid, this is, it can effectively differentiate between usable and unusable systems. Interpreting scoring can be complex. The participant's scores for each question are converted to a new number, added together and then multiplied by 2.5 to convert the original scores of 0-40 to 0-100. Though the scores are 0-100, these are not percentages and should be considered only in terms of their percentile ranking. A SUS score above a 68 would be considered above average and anything below 68 is below average, however the best way to interpret your results involves normalizing the scores to produce a percentile ranking. General information results was as below;

What is your age



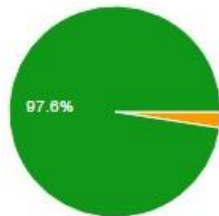
Less than 25 years	2	4.9%
Between 25-35 years	35	85.4%
Between 35-40 years	2	4.9%
Above 40 years	2	4.9%

What is your Gender



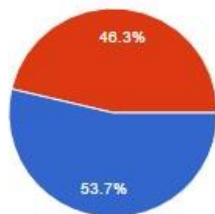
Female	16	39%
Male	25	61%

Education Level



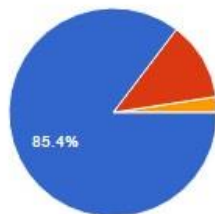
Primary (KCSE)	0	0%
Secondary (KCPE)	0	0%
Diploma	1	2.4%
Degree	40	97.6%

What is your Marital status



Single	22	53.7%
Married	19	46.3%
Divorced/Separated/Widowed	0	0%

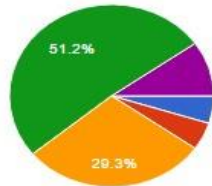
Employment status



Employed	35	85.4%
Self Employed	5	12.2%
Non Employed	1	2.4%

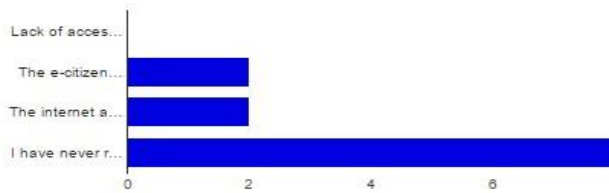
Section A Question Results;

1. What your frequency on the use of Kenyan E-Citizen services?



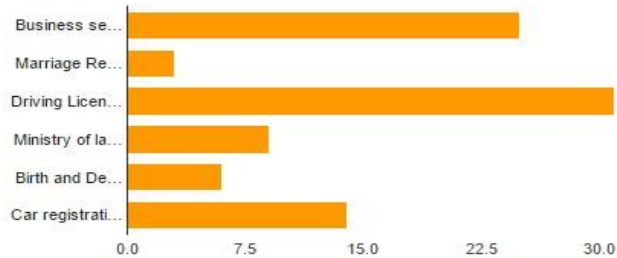
Weekly	2	4.9%
Twice Monthly	2	4.9%
Once Monthly	12	29.3%
Yearly	21	51.2%
Never Used	4	9.8%

2. I have never used or rarely use e-citizen services because?



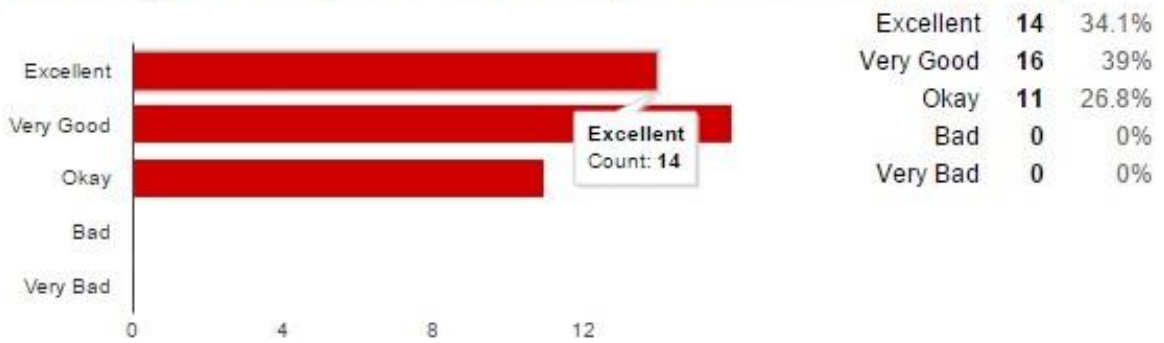
Lack of access of the internet or internet device	0	0%
The e-citizen services are complicated to use	2	18.2%
The internet and e-citizen services are costly	2	18.2%
I have never really needed to use it	8	72.7%

3. Check the three most frequently used e-Citizen services that you use

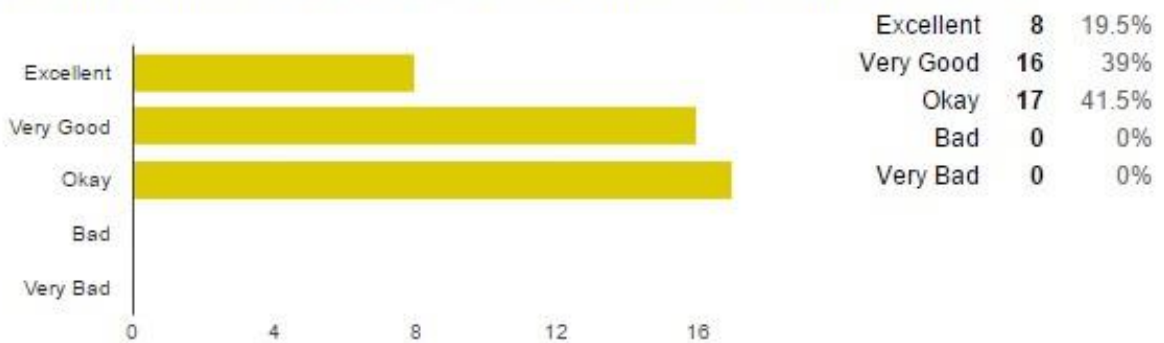


Business search and registration	25	61%
Marriage Registration and Certificate services	3	7.3%
Driving License Services	31	75.6%
Ministry of land services	9	22%
Birth and Death certificates	6	14.6%
Car registration and search	14	34.1%

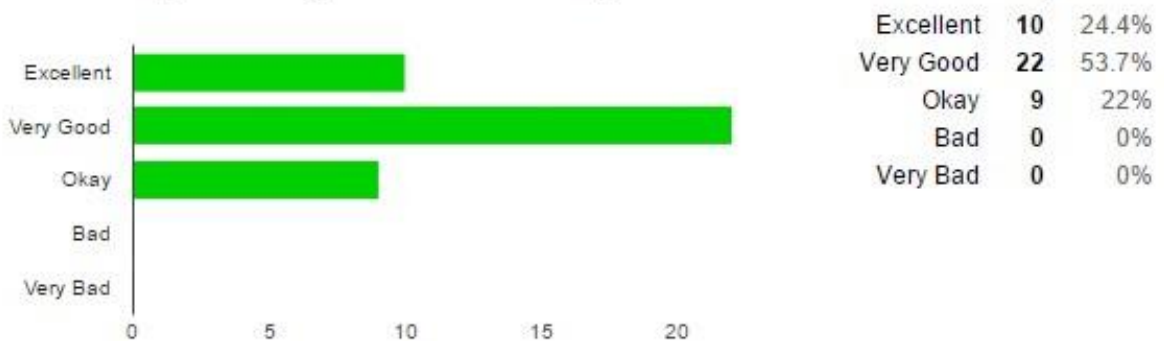
Accessibility [4. How do you rate the following attributes of e-citizen services]



Reliability [4. How do you rate the following attributes of e-citizen services]



Convenience [4. How do you rate the following attributes of e-citizen services]



Affordability [4. How do you rate the following attributes of e-citizen services]



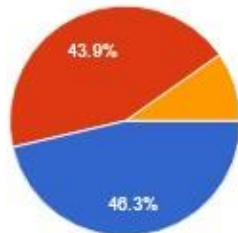
5. In your honest opinion what do think is necessary to improve the use of e-citizen services?

1. Improve response time for the website and offer more guides - Timely response – payment.
2. Marketing of the services - creation of awareness
3. Increase more public services to the portal - It should be a one stop shop like Huduma centre.
4. More detailed guidelines in filling in data
5. They should also come up with an application for the mobile platform – More phones than computers – Mobile application.
6. Automate all service such that when you report to their offices it will just be a matter of 'pick and go' – register online and wait for months and visit office still – synchronised, for example KRA
7. Easier and clear navigation and also there should be a Kiswahili website.
8. The portal needs to be more stable and accessible – redundancy of hardware and software.
9. Need for better integration of services - availability and awareness
10. Easier to use and navigate
11. Better customer care – 24/7 Toll free number to call when you need assistance

Section B results – System Use Scale

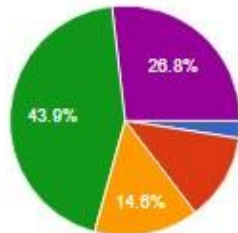
Section B

1. I think I would like to use the e-citizen portal frequently



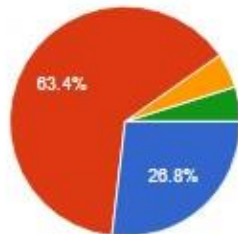
Strongly Agree	19	46.3%
Agree	18	43.9%
Maybe	4	9.8%
Disagree	0	0%
Strongly Disagree	0	0%

2. I found the e-Citizen portal unnecessarily complex



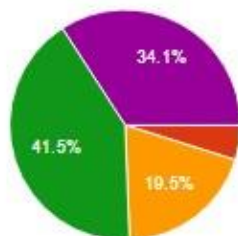
Strongly Agree	1	2.4%
Agree	5	12.2%
Maybe	6	14.6%
Disagree	18	43.9%
Strongly Disagree	11	26.8%

3. I thought the e-Citizen portal was easy to use



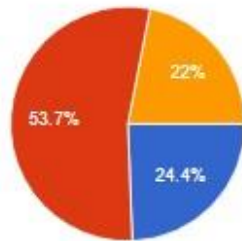
Strongly Agree	11	26.8%
Agree	26	63.4%
Maybe	2	4.9%
Disagree	2	4.9%
Strongly Disagree	0	0%

4. I think that I would need assistance to be able to use the e-Citizen portal



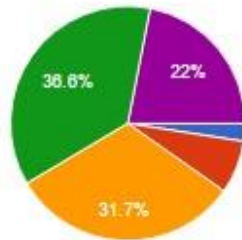
Strongly Agree	0	0%
Agree	2	4.9%
Maybe	8	19.5%
Disagree	17	41.5%
Strongly Disagree	14	34.1%

5. I found the various services in the e-Citizen portal well integrated



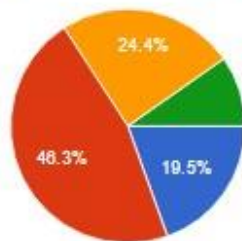
Strongly Agree	10	24.4%
Agree	22	53.7%
Maybe	9	22%
Disagree	0	0%
Strongly Disagree	0	0%

6. I thought there was too much inconsistency the the e-Citizen portal



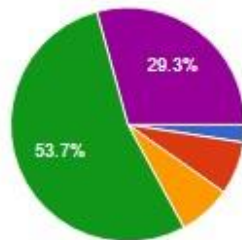
Strongly Agree	1	2.4%
Agree	3	7.3%
Maybe	13	31.7%
Disagree	15	36.6%
Strongly Disagree	9	22%

7. I would imagine that most people would learn to use the e-Citizen website very quickly



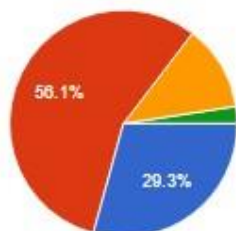
Strongly Agree	8	19.5%
Agree	19	46.3%
Maybe	10	24.4%
Disagree	4	9.8%
Strongly Disagree	0	0%

8. I found the e-Citizen portal very cumbersome to use



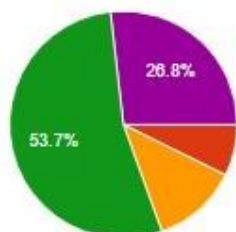
Strongly Agree	1	2.4%
Agree	3	7.3%
Maybe	3	7.3%
Disagree	22	53.7%
Strongly Disagree	12	29.3%

9. I felt very confident using the e-Citizen website



Strongly Agree	12	29.3%
Agree	23	56.1%
Maybe	5	12.2%
Disagree	1	2.4%
Strongly Disagree	0	0%

10. I needed to learn a lot of things before I could use the e-Citizen website



Strongly Agree	0	0%
Agree	3	7.3%
Maybe	5	12.2%
Disagree	22	53.7%
Strongly Disagree	11	26.8%

4.1.2 Questionnaire to ICT Support

The second questionnaire was done to support and third party vendors of the e-Citizen system in Kenya, and the following personnel were interviewed, although they were not willing to be mentioned;

- 1) ICT Officer, e-Citizen through call interview and online questionnaire on **15th August, 2016**
- 2) System Support IPRS, face to face interview held on **22nd August 2016**.
- 3) IT support, National Transport and Safety Authority (NTSA) through call interview at **1st September, 2016**.

1. What are the integration Methods used in the e-Citizen portal in Kenya?

- a) Shared Servers – Jobs to copy and dump data – the updated to e-Citizen
- b) Periodic incremental updates of data – weekly or fortnight or monthly
- c) Full duplication of data periodically

2. What are the current challenges of the e-Citizen portal in Kenya, especially in relation to integration?

- a) Manual Processes – Uploading and formatting of data
- b) Data inconsistency – especially for manually updated data
- c) Manual periodic checks on data integrity and updates
- d) Dependency on processes of third parties

3. Reasons for the current challenges of the e-Citizen portal in Kenya?

- a) The integration methods – too manual
- b) Compatibility issues – data formats and applications
- c) Services addition process is long, a lot of resources
- d) Capacity management challenges – a lot of data is kept that large Databases.

4. Solutions to the current challenges of the e-Citizen portal in Kenya, especially in relation to integration?

- a) Upgrading of the third party systems like IPRS
- b) Open Systems and Data sharing
- c) Use of better integration methods like SOA

5. Any additional comments and recommendations?

- a) Timely procedures for purchase of equipment and software especially during emergency changes – quicker recovery
- b) Better Business continuity plans and recovery techniques, for example redundancy of networks and application and database servers
- c) Upgrade of old systems and hardware like legacy systems like IPRS
- d) Improved infrastructure – internet, electricity (reduced blackouts)

4.2 SOA Design and Implementation.

4.2.1 Identification Stage

The identification phase includes the SOA services, components and flows in the proposed integration system.

4.2.1.1. Business Flow Charts

The following chart indicate the processes that go into ensuring that each of the above services are delivered to the citizens.

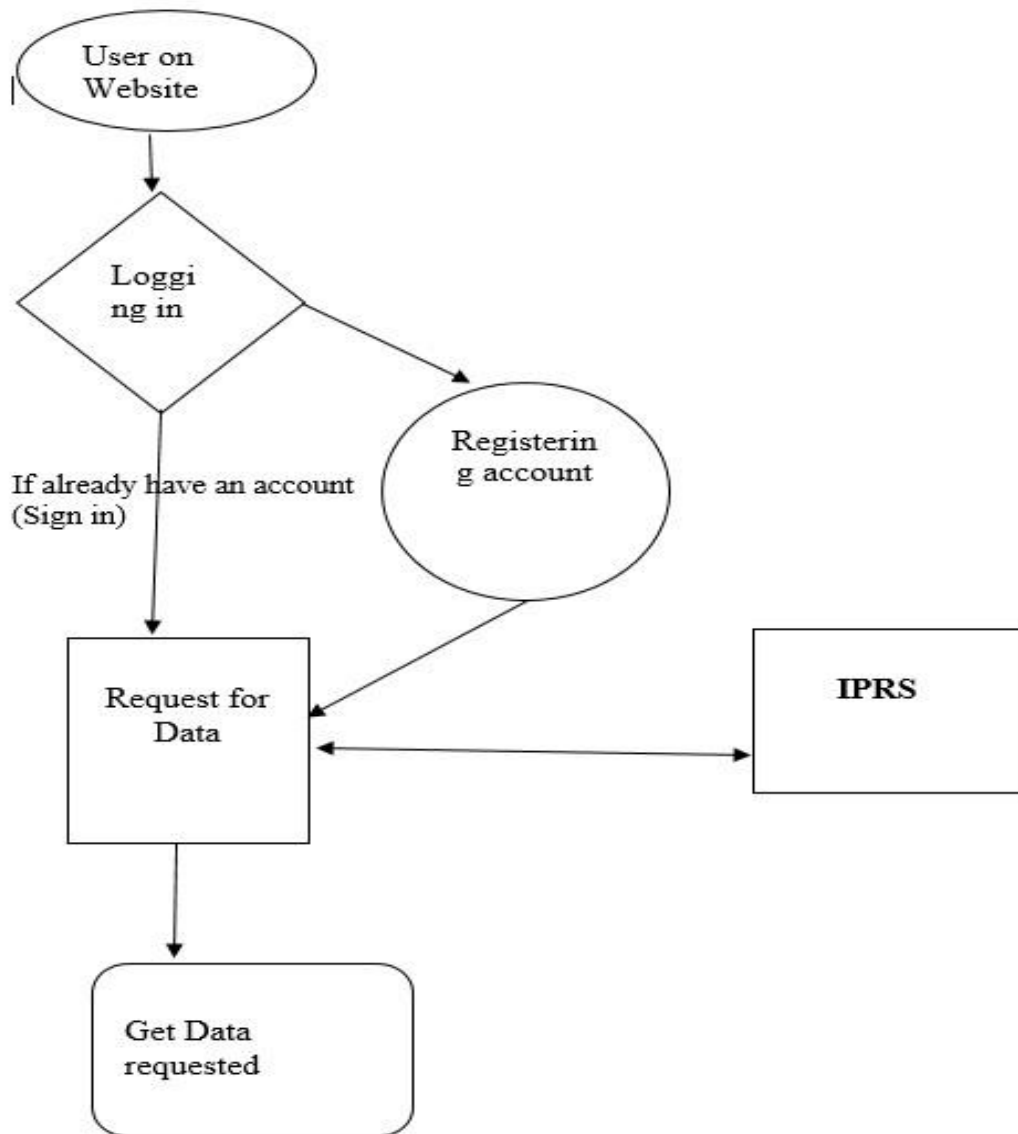


Figure 7: Current e-Citizen IPRS Data request Flow

Some challenges noted in the current system and flow are inefficiencies, effort duplication and redundant data entry, this is due to manual interventions involved to ensure the flow is complete.

4.2.1.2 Solution Management

The use of SOA based integration to integrate the e-Citizen portal and the IPRS system thus data is retrieved directly from the IPRS database through its IPRS Application.

This is through the use of SOA application servers and the use of web services to send service requests and expect service responses.

4.2.1.3 Product Perspective

The SOA integration architecture will manage requests and responses between application servers using various technologies and systems, replacing the current updating of files to the e-Citizen system periodically.

The SOA integration solution help to enable business objectives while building an enterprise-quality system. The SOA architecture will have 5 horizontal layers;

1. Consumer Interface Layer

These are Graphical user interfaces for the end users or applications accessing the services, through the various channels, either the website, ussd, messages or applications. For the prototype we are using requests on a basic website page.

2. Business Process Layer

These are services representing business use-cases in terms of applications. This are made of the Application and Database servers which in our prototype we will use a SOA server and on the IPRS side they will have an application server that contains the weblogic.

3. Services

Services are consolidated together for whole-enterprise in-service inventory with the use of Oracle WebLogic Server 11g which will act as the SOA application server that will contain the web services and WSDLs.

4. Service Components

The components used to build the services, such as functional and technical libraries, technological interfaces etc. The prototype stores the service components in the Enterprise service bus that we are currently using as the Oracle Service Bus.

5. Operational Systems

This layer contains the data models, enterprise data repository, technological platforms etc. This comprises the application server in the prototype which is the IPRS application server.

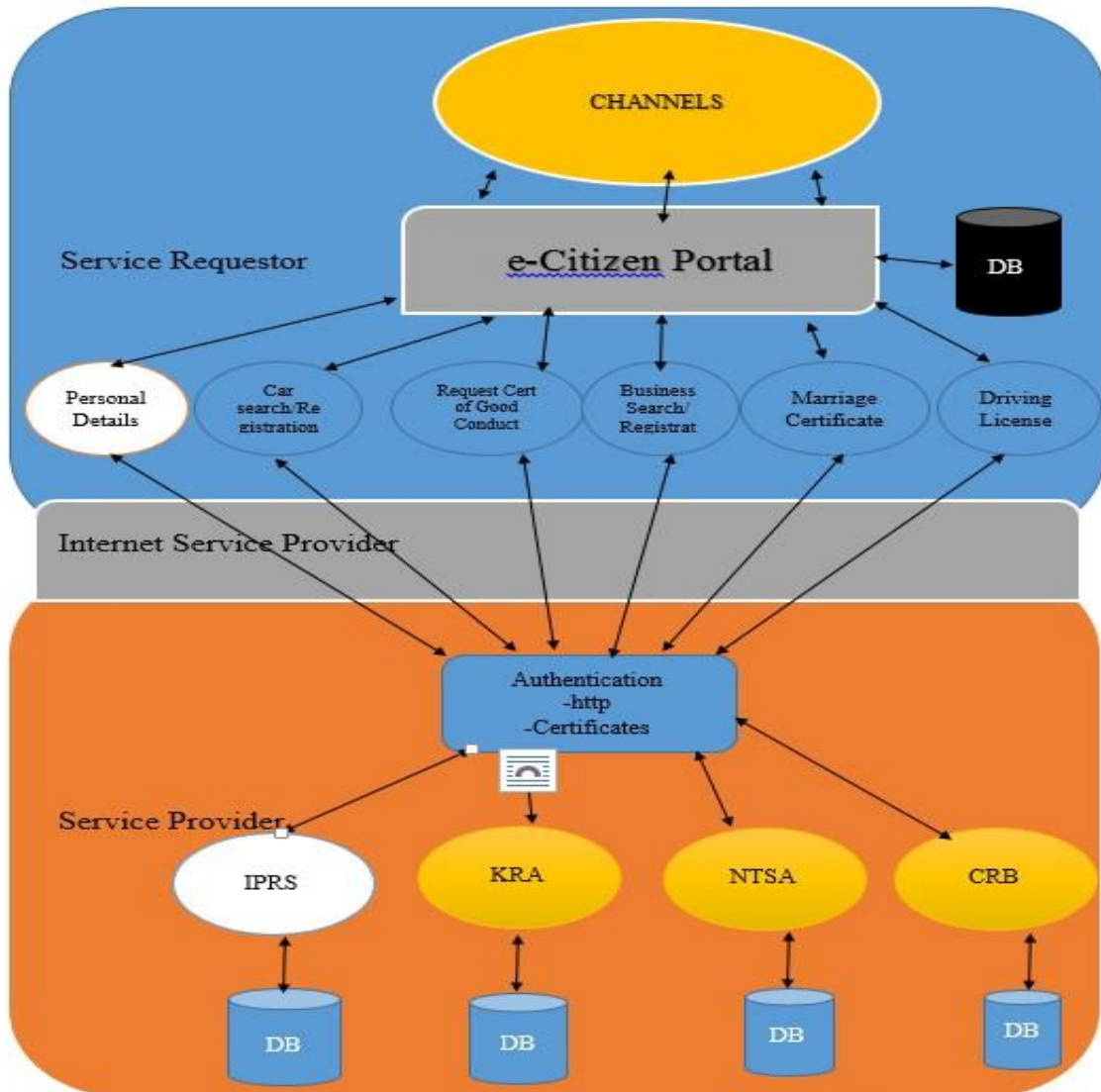


Figure 8: The Proposed Kenya e-Citizen SOA Architecture

The general of the e-Citizen system is to provide services and information to citizens. Thus below are Key Performance Indicators (KPIs) and metrics were identified and used to measure, monitor and quantify the success of SOA solution in fulfilling business needs. Thus a service is needed to send a request from e-Citizen system to the IPRS system, and a response is sent back to e-Citizen system to relay the information to the user, and also allow a user to request changes to their information, and provide information and legal documentation used to validate these amendments.

4.2.2 Specification Stage

The proposed e-Citizen system will be applied using SOA model implementing web services to integrate the various applications and systems to an integrated system where citizens and businesses can access services and information in a single one stop system, one secure authentication protocol and simple usable interface. The SOA model will use Web Service Definition language protocol as a communication language between the Applications for both service requests and service responses.

The proposed e-Citizen was implemented using a SOA composite which is an assembly of services, service components, and references designed and deployed together in a single application. The wiring between the service, service component, and reference will enable message communication. The SOA composite processed the information described in the messages. The diagram below illustrates the components and their connection.

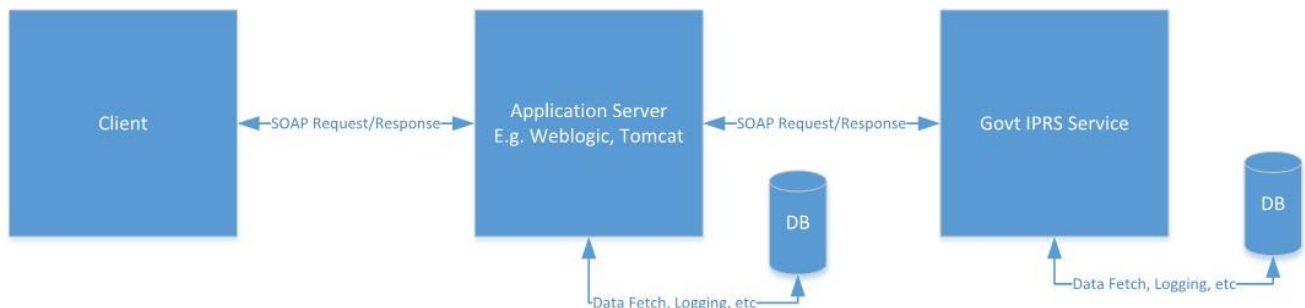


Figure 9: High Level Proposed e-Citizen SOA integration Model

4.2.2.1 The SOA Components

1. Web Services

The proposed e-Citizen used web services that are usable across various institutions and individual users. For the prototype we have user get_IPRS_info as the main service that gets information from the IPRS application server.

2. WSDL

The Web service definition language ensured the web services are described in detail in XML and the requests and responses are in a similar format. It creates and validation requests and responses to and from an application, as it defines the data required in the request and the expected response.

3. BPEL

The concept used business process execution language to link the web services together, and define how they interact with each other. The BPEL in our prototype is contained in the Enterprise service bus which we are using in our prototype as the Oracle service bus.

4. ESB

The enterprise service bus used to manage the messages between the many web services and various applications calling these web services. Its main functions will be to monitor and route the messages, Resolve contention, Version web services, Event and Exception handling, and security and validation. For our prototype we are using the Oracle Service bus.

5. SOAP

SOAP is an XML-based messaging protocol that defines a set of rules for structuring messages that can be used for simple one-way messaging but is particularly useful for performing RPC-style (Remote Procedure Call) request-response dialogues. This is used as a security measure for intruders who want to intercept data.

The specification stage is used to establish and validate exposure decisions at a high-level service model, and requires provision for

- Services
- Service functionalities
- Service dependencies on other services, components, applications and flows.

A service portfolio was created for all the services required for each request, and the required dependency on other services, information, components, applications and flows to other components. A service portfolio is created for each department on the information and services they will provide, and this will provide the basis for the eCitizen portfolio.

Service	Improvement	Comment	Business Alignment
Providing of personal details from the IPRS system	Reduces time taken to update personal details when modified	Increase the accuracy and consistency of data, and provides real time data.	Yes
Modifying personal details from the IPRS system	Reduces the time taken to modify the personal details when requested.	Reduces inconsistency of data, and time taken to update the data	Yes

Table 1: Service and Business alignment

The business service is associated with one or more service database and one service provider. The service provider is a web service that services service requests.

The service broker listens to incoming and outgoing requests, and connects the service requestor to the service provider.

Service requestor ←-----→ **Service Broker** ←-----→ **Service Provider**

A service requestor sends a request through the service broker, who queries data from the service data, and then returns results to the service broker, that routes back the results to the service requestor as a response.

4.2.3 Realization Stage

A diagram of the detailed components was done on a reference architecture that provided a view of the proposed SOA architecture model for the E-Citizen portal and Integrated Populations Registration System (IPRS).

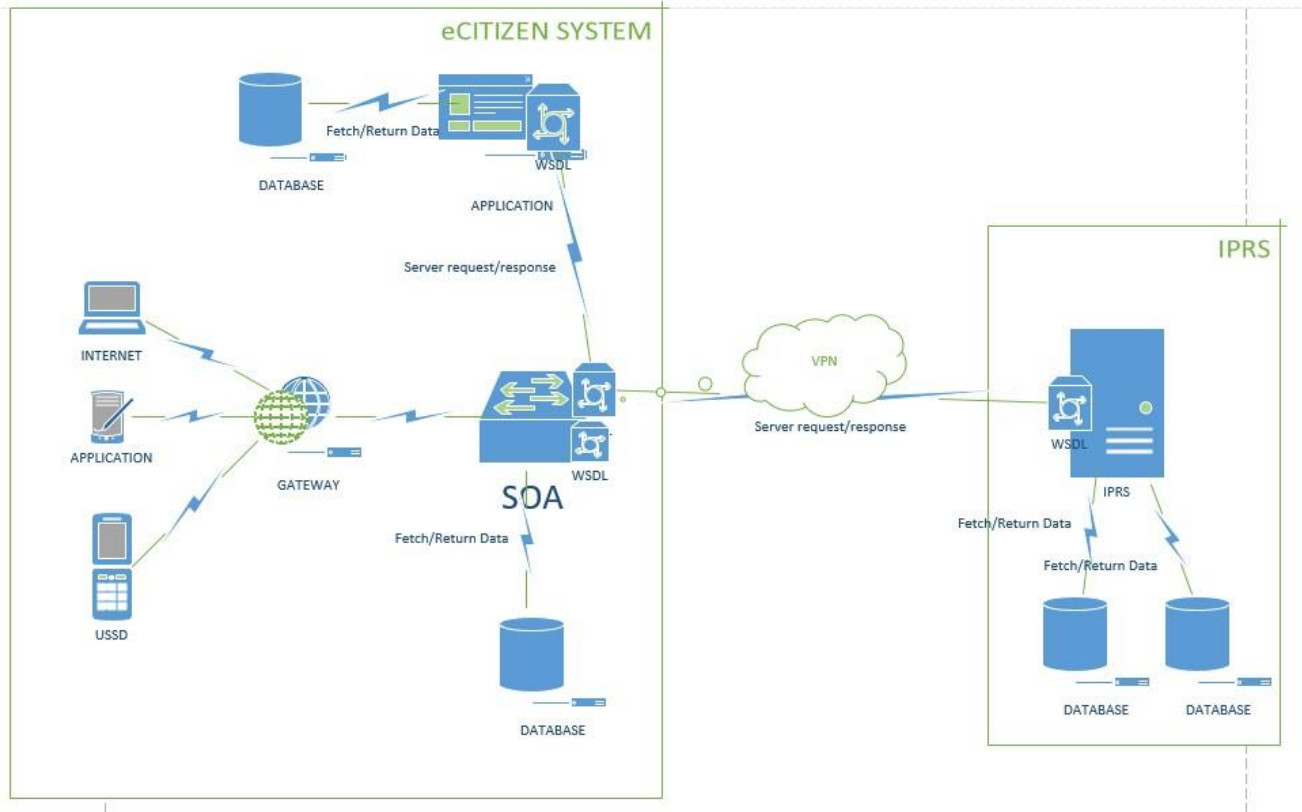


Figure 10: Low Level Proposed e-Citizen SOA integration Model

4.2.4 Implementation Stage

4.2.4.1 System Requirements

This are the requirements that are requires for the prototype to work successfully.

Client Side

SOAP client used to host the services which for the prototype we will be using Oracle Service Bus to manage the service. Authentication layer on the channel used, in our case website, which will contain password and username as part as the authentication.

Server Side

SOAP web service that will accept the service request through is WSDL process the request that will be validated by the WSDL before being pushed back to the client side as a service response.

Functional requirements

Authentication – Some form of authentication is required, and for the prototype we have ensure correct username and password inserted before accessing the service.

Primary parameter – the system will use the Identification Number (ID) as the primary parameter to fetch data.

Hardware requirements

The prototype will run on a normal PC that has access to the VPN from where we can run the Oracle Service Bus on an enterprise server that is also connected to the VPN.

Communication Requirements

Connection to the internet – use of IPS either via LAN or Wi-Fi or Modem.

Speeds – The internet speed of both the client and server side affect the response time.

Performance Requirements

View information queries are expected to take less that 10 seconds in Turn Around Time (TAT), this from when the query is requested and received.

Security Requirements

Channels will use credentials, this is, user name and password, which are authenticated at the client side level before access to the services.

Security measures also provided by the ISP and Service Provider, through SOAP and encryption of data during transit to and from the client and server side.

4.2.4.2 Service Interface

The prototype had a simple interface that the users could use as shown in the figures below.

Login



A screenshot of a login form. It features a title "Login" in blue. Below the title are two input fields: "Username:" and "Password:". Below these fields is a "login" button. The background of the form is light green.

Figure 11: Login Page

Figure 11 above shows the log-in page where the users log in with their username and password as their credentials, and used for validation and security.


IPRS Query



A screenshot of an IPRS Query form. It features a title "IPRS Query" in blue. Below the title are two input fields: "ID No" and "ID Type". The "ID Type" field is a dropdown menu showing "National ID". Below these fields is a "Submit" button. The background of the form is light green.

Figure 12: IPRS Query page

IPRS Query



A screenshot of the IPRS Query form with input. The "ID No" field contains the value "25431496". The "ID Type" dropdown menu is set to "National ID". The "Submit" button is visible below the fields. The background of the form is light green.

Figure 13: IPRS Query page input

In Figure 12 and 13 above is the IPRS query page where the user inputs the National Legal ID as the main request input for the service request.

Click [HERE](#) to send a new query

BIO DETAILS	
Govt. IPRS Details	
First Name:	JOSEPH
Other Name:	KAIBIU
Surname:	GITAU
Citizenship	Kenyan
Clan:	ANGUI
Date of Birth:	29/5/1988
Ethnic Group:	KIKUYU
Gender:	Male
IPRS PIN:	18805290280049
Identity Document No:	25431496
Place of Birth:	NAIROBI DISTRICT - STAREHE
Date of Issue:	17/7/2009
Registration Office:	KIAMBAA KIAMBU
Serial No:	226290433

Figure 14: IPRS Response Page

Figure 14 shows the output details of the service request through the service response, as per the information provided in the service request.

CHAPTER 5: POST PROTOTYPE TESTING AND RESULTS

5.1 Introduction

This chapter includes the results of the System Usability Scale questionnaire, and tests done using the prototype and the outcome. The tests of the prototype will be based on the following criteria.

5.2 System Usability scale calculation

Scoring of SUS is as follows;

- For odd items: subtract one from the user response.
- For even-numbered items: subtract the user responses from 5
- This scales all values from 0 to 4 (with 4 being the most positive response).
- Add up the converted responses for each user and multiply that total by 2.5.

This converts the range of possible values from 0 to 100 instead of from 0 to 40. The average SUS score is 68. A SUS score above a 68 would be considered above average and anything below 68 is below average.

5.2.1 Current eCitizen portal

Calculations Per Question was as follows;

- Question 1 = $5-1 = 4$
- Question 2 = $5-2 = 3$
- Question 3 = $4-1 = 3$
- Question 4 = $5-2 = 3$
- Question 5 = $4-1 = 3$
- Question 6 = $5-2 = 3$
- Question 7 = $4-1 = 3$
- Question 8 = $5-2 = 3$
- Question 9 = $4-1 = 3$
- Question 10 = $5-2 = 3$

Total = $31*2.5 = 77.5$

5.2.2 Proposed SOA integrate eCitizen protocol Calculations

Per Question was as follows;

- Question 1 = 5-1 = 4
- Question 2 = 5-2 = 3
- Question 3 = 4-1 = 3
- Question 4 = 5-1 = 4
- Question 5 = 5-1 = 4
- Question 6 = 5-2 = 3
- Question 7 = 5-1 = 4
- Question 8 = 5-2 = 3
- Question 9 = 4-1 = 3
- Question 10 = 5-1 = 4

Total = 35*2.5 =87.5

12 responses

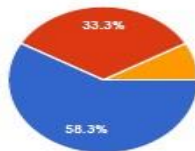
[Edit this form](#)

[View all responses](#) [Publish analytics](#)

Summary

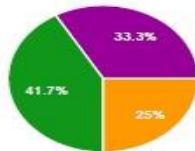
Section B

1. I think I would like to use the e-citizen portal frequently



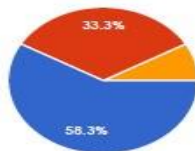
Strongly Agree	7	58.3%
Agree	4	33.3%
Maybe	1	8.3%
Disagree	0	0%
Strongly Disagree	0	0%

2. I found the e-Citizen portal unnecessarily complex



Strongly Agree	0	0%
Agree	0	0%
Maybe	3	25%
Disagree	5	41.7%
Strongly Disagree	4	33.3%

3. I thought the e-Citizen portal was easy to use



Strongly Agree	7	58.3%
Agree	4	33.3%
Maybe	1	8.3%
Disagree	0	0%
Strongly Disagree	0	0%

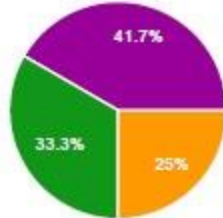
4. I think that I would need assistance to be able to use the e-Citizen portal

Strongly Agree 0 0%

docs.google.com/forms/d/1yANrb7pf0JH_PsCKQ2PX3-VWkLYOwzO8IPcyY5Ujno/viewanalytics

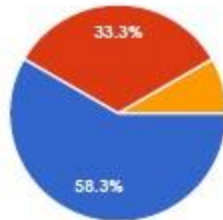
316

Assessment of the E-Citizen portal in Kenya - Google Forms



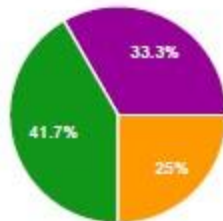
Agree 0 0%
 Maybe 3 25%
 Disagree 4 33.3%
 Strongly Disagree 5 41.7%

5. I found the various services in the e-Citizen portal well integrated



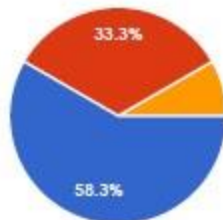
Strongly Agree 7 58.3%
 Agree 4 33.3%
 Maybe 1 8.3%
 Disagree 0 0%
 Strongly Disagree 0 0%

6. I thought there was too much inconsistency the the e-Citizen portal



Strongly Agree 0 0%
 Agree 0 0%
 Maybe 3 25%
 Disagree 5 41.7%
 Strongly Disagree 4 33.3%

7. I would imagine that most people would learn to use the e-Citizen website very quickly



Strongly Agree 7 58.3%
 Agree 4 33.3%
 Maybe 1 8.3%
 Disagree 0 0%
 Strongly Disagree 0 0%

8. I found the e-Citizen portal very cumbersome to use

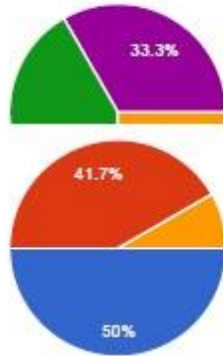
Strongly Agree	0	0%
Agree	0	0%
Maybe	3	25%
Disagree	5	41.7%
Strongly Disagree	4	33.3%

cs.google.com/forms/d/1yANrb7pfUJH_PsCKQfPX3-VWkLYOwzO8fPcyY5Ujno/viewanalytics

23

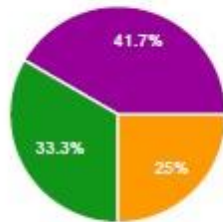
8

Assessment of the E-Citizen portal in Kenya - Google Forms



Strongly Agree	6	50%
Agree	5	41.7%
Maybe	1	8.3%
Disagree	0	0%
Strongly Disagree	0	0%

10. I needed to learn a lot of things before I could use the e-Citizen website



Strongly Agree	0	0%
Agree	0	0%
Maybe	3	25%
Disagree	4	33.3%
Strongly Disagree	5	41.7%

Thank you for your time. Much appreciated

Figure 17: Post Prototype validation results

5.3 TESTING

5.3.1 Service Authentication Testing

This involved testing whether prototype allows access to unauthorised users. Ensures access only given when appropriate certificates or/and credentials that are provided.

SAMPLE	Type of authentication	Response
Sample 1	Right user Right Password	Logged In
Sample 2	Right user Wrong Password	Failed Log in
Sample 3	Wrong user Right Password	Failed Log in

5.3.2 Service Validation Testing

This involves testing weather the prototype is able to validate the data provided in the web request before sending to the respective application server.

SAMPLE	Type of Validation	Response
Sample 1	Valid ID	Response
Sample 2	Invalid ID	No Response

5.3.3 Communication Channel Testing

The communication channels are specified in the prototypes and each service specify the addresses it remotely connects to, this is, request coming from and is sent back to.

SAMPLE	REQUEST	CHANNEL	RESPONSE
Sample 1	Complete	Website	Response
Sample 2	Incomplete	Website	Error
Sample 3	Complete	Code	Response
Sample 4	Incomplete	Code	Error

5.3.4 Service Request Testing

Service Request Testing - This involved testing whether the system gets a service response for each service request.

SAMPLE	Request	Response	Comment
Sample 1	IPRS info right ID	Info received	Worked
Sample 1	IPRS info wrong ID	Info Received	Worked

5.3.5 Test Response Time Testing

Test Response Time Testing - The time taken for the application to respond to requests.

This is time between when web request is sent and web response is gotten.

SAMPLE	Time of Request	Time of Response	TIME TAKEN
Sample 1			1sec 259 msecs
Sample 2			1sec 298 msecs

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter summarizes the major findings of this study, and based the conclusions on the results. It also provides recommendations for the use of Service Oriented Architecture.

The purpose of this study was to investigate the adoption of Service Oriented Architecture in the provision of e-Government services in Kenya. The study sought to answer five research questions which were; what are the challenges of the use of the eCitizen system in Kenya. What are the current integration methods used in the e-Citizen system in Kenya? What are the current integration challenges of the e-Citizen system in Kenya? What are the current applications of SOA architecture Models in Kenya. Will the proposed SOA Model improve the usability of the e-Citizen system in Kenya? The researcher conducted a literature review based on the study objectives and research questions from various journals and related research papers online. The study sample was 46 users of the eCitizen portal, and 3 technology support staff from the eCitizen and two third party institutions. The data was collected using google forms and analysis done automatically by the same forms through its results. The study conducted descriptive and qualitative statistics summarized into pie charts, and tables.

6.1 Conclusion

The User questions contained questions that measured the System Usability using the system usability scale, thus is a measure of how usable a system is. The score is measured as follows;

- 80 or higher is an A - People love your site and will recommend it
- 68 or thereabouts gets you a C. It's OK but needs improvement
- 51 or under gets an F - Make usability your priority now and fix this fast.

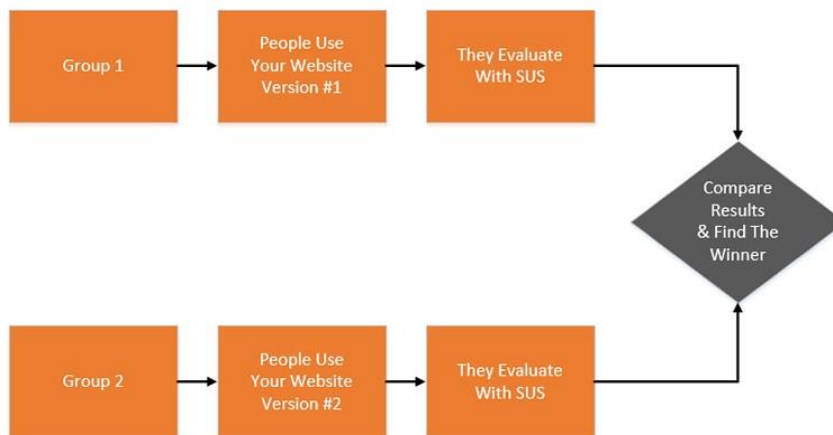


Figure 15: Using SUS to compare websites or applications or systems

The System Usability scale was used to measure the current eCitizen portal and the proposed eCitizen portal and the results were 77.5 and 87.5 respectively.

The results of 77.5 means that the current eCitizen portal is above average but needs improvements to a standard that people would love it and recommend it to others to use, while the proposed eCitizen model measure 87.5 meaning people would love the site and will recommend it. This is a clear indication that the SOA model has been used to improve the usability of the eCitizen system among many other benefits.

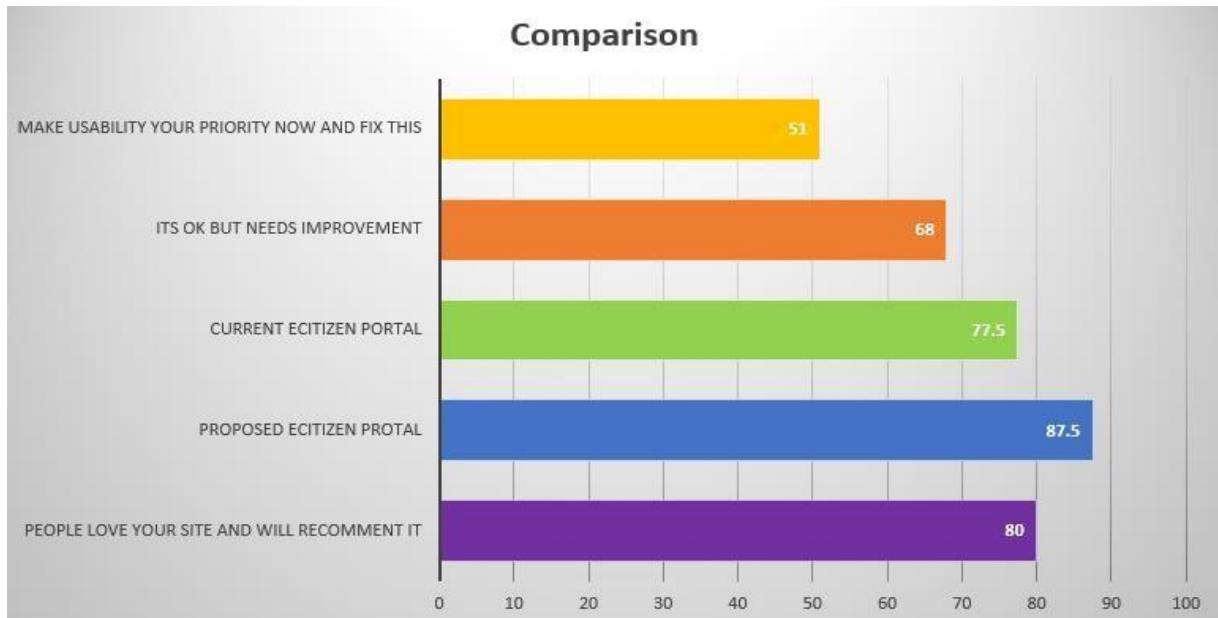


Figure 16: Comparison System Usability Scale Chart

6.1.1 Challenges of the current eCitizen system

The questionnaires' results by the users and technological support staff showed a wide range of challenges of the current eCitizen system. The main challenges by the users being improving the response time, services awareness, increase of more services, more channels of access like mobile applications, addition of alternative language like Kiswahili, better customer care and easier navigation between pages and services. The main integration challenges noted by the back end staff is the manual processes, data inconsistency, lack of data integrity and dependency of third party processes.

6.1.2 Proposed SOA Model and prototype validation

The SOA model proposed would make use of minimal additional resources and software, and would also make use of the current systems for its adoption. From the layout and implementation the model if implemented will sort some current challenges noted in the questionnaires like the

- Easier addition of services thus more services provided.
- Provision for more channels
- Consistency and Integrity of data and
- Minimizes manual processes like dumping and uploading of files.

6.2 Recommendations

Based on the study findings the following are the recommendations

- Government institutions should do more research and study on better integration methods like Service Oriented Architecture.
- Government institutions should adopt the use of Service Oriented Architecture for effective and efficient integration of various services.
- Government institutions should collaborate with the private sector for better services provision and delivery.
- Concerns on the use of Service Oriented Architecture should be considered in the development of the ICT strategy. The concerns include but not limited to security, privacy, legal issues, infrastructure, affordability of services and service delivery.

Aspects of e-Government services to improve

- Improve response time for the website
- Marketing of the services - creation of awareness of services
- Increase more public services – one stop shop like Huduma centres.
- More channels of accessing services like mobile applications.
- Easier and clear navigation, for example the use of Kiswahili □ Better customer care – 24/7 toll free number

Benefits of adopting SOA

- Improve government information sharing.
- Enabled multiple channels of access.
- Increase of service delivery.
- Consistency and integrity of data.
- Reusability and easier introduction of services.

6.3 Limitations

The introduction of the SOA model to the eCitizen portal in Kenya would come with some potential issues that would include, but not limited to;

i. Security

The security of the SOA model is a multiplexed matrix that includes the security policies, software and hardware of the connected parties, including the service provider, service user, internet providers and other infrastructure.

ii. Infrastructure

The SOA Model is dependent of the internet and its reliability and speeds, the electricity and national grid, and other structural dependencies.

iii. Expertise and Skill

The SOA Model is also dependent of available expertise and skill available in-house or for consultancy, and their availability for the design and implementation of the model, and even most important the maintenance in terms of monitoring, upgrades, structuring and troubleshooting.

iv. Legal issue

The SOA Model works around sharing of data and information between institutions both governmental and private, each of which have their own laws and policies of sharing such data and information.

The research was carried over a limited time and resources thus a limited use of SOA could be exploited. Government bureaucracy made access to information in various institutions a difficult task, and provision of limited information by staff due to fear of loss of their jobs. Also due to the time a limited sample was used for the research. The limitation of resources and time also limited the number of implementations and their tests that could be done.

REFERENCES

David, S. and Monica, K (2012) *INTERNET GOVERNANCE IN KENYA – AN ASSESSMENT for the Internet Society*

International Telecommunication Union (ITU) (2014) *ICT Facts and figures 2014*

ICT Authority of Kenya (2014) *The Kenya National ICT Master Plan 2013/14 – 2017/18*

Fiorano (2015) *M-Shwari logs 40,000 customers per day crossing Ksh1 billion in transactions a month with core banking integration from Fiorano*
(<http://www.fiorano.com/customers/casestudies/commercial-bank-of-africa.php>)

Gottschalk, P. (2009). Maturity levels for interoperability in digital government.

Government of Kenya *Integrated data system to make e-government a reality*
(<http://www.president.go.ke/2015/03/11/integrated-data-system-to-make-egovernment-a-reality/>)

Harekrishna, M. (2009). Understanding SOA perspective of e-Governance in Indian Context: Case base study.

Alfred, N. (2012) *Challenges facing e-government projects in Kenya*

P, Wauters. K. Declercq, S. van der Peijl, P. Davies (2012) *Study on cloud and service oriented architectures for e-government for Deloitte*

Shah, D. and Patel, D. (2009). *Architecture framework proposal for dynamic and ubiquitous security in global SOA. International Journal of Computer Science and Applications*

Sauro, J. (2011). *Measuring Usability with the System Usability Scale (SUS)*

Violet L. (2014) *AN ELECTRONIC GOVERNMENT INTEGRATED SYSTEM USING SERVICE ORIENTED ARCHITECTURE (SOA).*

ONLINE RESOURCES

- i. Commercial Bank of Africa. (2016). *M-Shwari available from* <http://cbagroup.com/m-shwari/>
- ii. Kenya eCitizen. (2016). Portal <https://www.ecitizen.go.ke/ecitizen-services.html>
- iii. Kenya immigration department. (2016). [http://www.identity.go.ke/index.php?option=com_content &view=article&id=90&Itemid=115](http://www.identity.go.ke/index.php?option=com_content&view=article&id=90&Itemid=115)
- iv. Liu, M., (2009) “NET BPEL Microsoft SOA Web Services”. <http://www.packtpub.com/article/soaservice-oriented-architecture>
- v. Oracle SOA - Service-Oriented Architecture. (2016). <http://www.oracle.com/us/products/middleware/soa/overview/index.html>
- vi. Safaricom. (2016). *M-Shwari available from* <http://www.safaricom.co.ke/personal/m-pesa/do-more-with-m-pesa/m-shwari>
- vii. Rich, S. (2014). SOA Life cycle <http://searchsoa.techtarget.com/tip/Understanding-the-SOA-lifecycle>
- viii. SOA-Glossary. (2016), *Cambridge Technology Enterprises*”, available from <http://www.ctepl.com/soaterms.shtml>.
- ix. Zimmermann, O. *et al* (2014). “Analysis and design techniques for ServiceOriented Development and Integration”, available from <http://www.perspectivesonwebservices.de/download/INF05-ServiceModelingv1>

APPENDICES

APPENDIX I: Questionnaire 1 Dear respondent,

My name is **Joseph Kaibiu Gitau**. I am conducting a research on the Service Oriented Architecture Model for integration of e-government systems in Kenya. The research is for partial fulfilment for awards of Masters in Science of Information Technology Management from the University of Nairobi, Kenya. The questionnaire should take less than 5 minutes to answer. Kindly respond to the following questions to the best of your knowledge. If you have any questions concerning this research, do not hesitate to call the researcher at +254 721242533 or write me an email at joekaibiu@gmail.com

General information

<p>1.1 Age:</p> <table border="1"> <tr> <td>Less than 20yrs</td> <td></td> </tr> <tr> <td>Between 21-30 yrs</td> <td></td> </tr> <tr> <td>Between 31-35 yrs</td> <td></td> </tr> <tr> <td>More than 35yrs</td> <td></td> </tr> </table>	Less than 20yrs		Between 21-30 yrs		Between 31-35 yrs		More than 35yrs		<p>1.2 Gender:</p> <table border="1"> <tr> <td>Male</td> <td></td> </tr> <tr> <td>Female</td> <td></td> </tr> </table>	Male		Female			
Less than 20yrs															
Between 21-30 yrs															
Between 31-35 yrs															
More than 35yrs															
Male															
Female															
<p>1.3 Education level:</p> <p>_____</p> <p>None</p> <table border="1"> <tr> <td>Primary (K.C.P.E)</td> <td></td> </tr> <tr> <td>Secondary (K.C.S.E)</td> <td></td> </tr> <tr> <td>Diploma</td> <td></td> </tr> <tr> <td>Degree</td> <td></td> </tr> </table>	Primary (K.C.P.E)		Secondary (K.C.S.E)		Diploma		Degree		<p>1.4 Marital status:</p> <table border="1"> <tr> <td>Single</td> <td></td> </tr> <tr> <td>Married</td> <td></td> </tr> <tr> <td>Divorced/Separated/Widowed</td> <td></td> </tr> </table>	Single		Married		Divorced/Separated/Widowed	
Primary (K.C.P.E)															
Secondary (K.C.S.E)															
Diploma															
Degree															
Single															
Married															
Divorced/Separated/Widowed															
<p>1.5 Employment status:</p> <p>_____</p> <p>Employed</p> <table border="1"> <tr> <td>Self-Employed</td> <td></td> </tr> <tr> <td>Non-employed</td> <td></td> </tr> </table>	Self-Employed		Non-employed												
Self-Employed															
Non-employed															

Section A

1. What your frequency on the use of the Kenyan E-Citizen services?

Daily	<input type="text"/>
Weekly	<input type="text"/>
Monthly	<input type="text"/>
Yearly	<input type="text"/>
Never Used	<input type="text"/>

If Never why;

Lack of access to internet or internet devices	
Complicated to use	
The internet and services are costly	
I have never needed to use it	

2. How do you rate the following attributes of E-government service?

Factors	Excellent	Very Good	Okay	Bad	Very Bad
Accessibility					
Reliability					
Convenience					
Affordability					

3. Mention which three e-citizen services you use most frequently.

e-Citizen service	
Business search and registration	
Marriage registration and certificates	
Driving License services	
Ministry of Lands services	
Birth and Death Certificates	
Car registration and search	

4. What do you think is necessary to be improved for the use E-citizen services?

.....

Section Two: System Usability Scale

System Usability Scale

Instructions: For each of the following statements, mark one box that best describes your reactions to the website *today*.

		Strongly Disagree				Strongly Agree
1.	I think that I would like to use this website frequently.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.	I found this website unnecessarily complex.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.	I thought this website was easy to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	I think that I would need assistance to be able to use this website.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.	I found the various functions in this website were well integrated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	I thought there was too much inconsistency in this website.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.	I would imagine that most people would learn to use this website very quickly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8.	I found this website very cumbersome/awkward to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.	I felt very confident using this website.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10.	I needed to learn a lot of things before I could get going with this website.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

APPENDIX II: Questionnaire 2 Section one: General information

<p>1.1 Age:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 70%;">Less than 25yrs</td> <td style="width: 30%;"></td> </tr> <tr> <td>Between 26-35 yrs</td> <td></td> </tr> <tr> <td>More than 35yrs</td> <td></td> </tr> </table>	Less than 25yrs		Between 26-35 yrs		More than 35yrs		<p>1.2 Technical level:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 70%;">Entry Level</td> <td style="width: 30%;"></td> </tr> <tr> <td>Middle Level</td> <td></td> </tr> <tr> <td>Management Level</td> <td></td> </tr> <tr> <td>Vendor/Partner</td> <td></td> </tr> </table>	Entry Level		Middle Level		Management Level		Vendor/Partner	
Less than 25yrs															
Between 26-35 yrs															
More than 35yrs															
Entry Level															
Middle Level															
Management Level															
Vendor/Partner															

Section 2:

6. What are the integration Methods used in the e-Citizen portal in Kenya?

.....
.....

7. What are the current challenges of the e-Citizen portal in Kenya, especially in relation to integration?

.....
.....

8. Reasons for the current challenges of the e-Citizen portal in Kenya?

.....
.....

9. Solutions to the current challenges of the e-Citizen portal in Kenya, especially in relation to integration?

.....
.....
.....

10. Any additional comments and recommendations?

.....
.....

APENDIX III: Sample XML Service Request

```
<soapenv:Envelope
  <soap:Header xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  </soap:Header>
  <soapenv:Body>
  <tem:GetDataByIdCard xmlns:tem="http://tempuri.org/">
    <tem:log>Test123</tem:log>
    <tem:pass>Test4567</tem:pass>
    <tem:id_number>23456789</tem:id_number>
    <tem:serial_number/>
  </tem:GetDataByIdCard>
  </soapenv:Body>
</soapenv:Envelope
>
```

APENDIX IV: Sample XML Service response

```
<s:Envelope xmlns:s="http://schemas.xmlsoap.org/soap/envelope/">
  <s:Body>
    <GetDataByIdCardResponse xmlns="http://tempuri.org/">
      <GetDataByIdCardResult xmlns:a="http://schemas.datacontract.org/2004/07/IPRSManager"
        xmlns:i="http://www.w3.org/2001/XMLSchema-instance">
        <a:ErrorCode/>
        <a:ErrorMessage/>
        <a:ErrorOcurrred>>false</a:ErrorOcurrred>
        <a:Citizenship>Kenyan</a:Citizenship>
        <a:Clan>ANGUI</a:Clan>
        <a>Date_of_Birth>5/29/1988 12:00:00 AM</a>Date_of_Birth>
        <a:Ethnic_Group>KIKUYU</a:Ethnic_Group>
        <a:First_Name>JOSEPH</a:First_Name>
        <a:Gender>M</a:Gender>
        <a:ID_Number>25431496</a:ID_Number>
        <a:Occupation i:nil="true"/>
        <a:Other_Name>KAIBIU</a:Other_Name>
        </a:Photo>
        <a:Pin>18805290280049</a:Pin>
        <a:Place_of_Birth>
          NAIROBI
          DISTRICT - STAREHE
        </a:Place_of_Birth>
        <a:Place_of_Death i:nil="true"/>
        <a:Place_of_Live i:nil="true"/>
        <a:Signature i:nil="true"/>
        <a:Surname>GITAU</a:Surname>
        <a>Date_of_Issue>7/17/2009 12:00:00 AM</a>Date_of_Issue>
        <a:RegOffice>KIAMBAA KIAMBU</a:RegOffice>
        <a:Serial_Number>226290433</a:Serial_Number>
      </GetDataByIdCardResult>
    </GetDataByIdCardResponse>
  </s:Body>
</s:Envelope>
```

APENDIX V: IPRS WSDL

```
<?xml version="1.0" encoding="utf-8"?>
<wsdl:definitions      name="ServerInterface"      targetNamespace="http://tempuri.org/"
xmlns:wSDL="http://schemas.xmlsoap.org/wSDL/"      xmlns:soap="http://schemas.xmlsoap.org/wSDL/soap/"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:wsu="http://docs.oasisopen.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:soap12="http://schemas.xmlsoap.org/wSDL/soap12/" xmlns:tns="http://tempuri.org/"
xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing"
xmlns:wsp="http://schemas.xmlsoap.org/ws/2004/09/policy"
xmlns:wsoap="http://schemas.xmlsoap.org/ws/2004/08/addressing/policy"
xmlns:wswa="http://www.w3.org/2006/05/addressing/wSDL"
xmlns:mSC="http://schemas.microsoft.com/ws/2005/12/wSDL/contract"
xmlns:wsa10="http://www.w3.org/2005/08/addressing"
xmlns:wSX="http://schemas.xmlsoap.org/ws/2004/09/mex"
xmlns:wSAM="http://www.w3.org/2007/05/addressing/metadata"> <wSDL:types>
<xsd:schema targetNamespace="http://tempuri.org/Imports">
<xsd:import schemaLocation="IPRSWS_v2_xsd0.xsd" namespace="http://tempuri.org/">
<xsd:import      schemaLocation="IPRSWS_v2_xsd1.xsd"
namespace="http://schemas.microsoft.com/2003/10/Serialization/">
<xsd:import      schemaLocation="IPRSWS_v2_xsd2.xsd"
namespace="http://schemas.datacontract.org/2004/07/IPRSManager"/> </xsd:schema>
</wSDL:types>
<wSDL:message name="IServiceIPRS_Login_InputMessage">
<wSDL:part name="parameters" element="tns:Login"/>
</wSDL:message>
<wSDL:message name="IServiceIPRS_Login_OutputMessage">
<wSDL:part name="parameters" element="tns:LoginResponse"/>
</wSDL:message>
<wSDL:message name="IServiceIPRS_GetDataByIdCard_InputMessage">
<wSDL:part name="parameters" element="tns:GetDataByIdCard"/>
</wSDL:message>
<wSDL:message name="IServiceIPRS_GetDataByIdCard_OutputMessage">
<wSDL:part name="parameters" element="tns:GetDataByIdCardResponse"/>
```

```

</wsdl:message>
<wsdl:portType name="IServiceIPRS">
<wsdl:operation name="Login">
<wsdl:input wsaw:Action="http://tempuri.org/IServiceIPRS/Login"
message="tns:IServiceIPRS_Login_InputMessage"/>
<wsdl:output wsaw:Action="http://tempuri.org/IServiceIPRS/LoginResponse"
message="tns:IServiceIPRS_Login_OutputMessage"/>
</wsdl:operation>
<wsdl:operation name="GetDataByIdCard">
<wsdl:input wsaw:Action="http://tempuri.org/IServiceIPRS/GetDataByIdCard"
message="tns:IServiceIPRS_GetDataByIdCard_InputMessage"/>
<wsdl:output wsaw:Action="http://tempuri.org/IServiceIPRS/GetDataByIdCardResponse"
message="tns:IServiceIPRS_GetDataByIdCard_OutputMessage"/> </wsdl:operation>
</wsdl:portType>
<wsdl:binding name="BasicHttpBinding_IServiceIPRS" type="tns:IServiceIPRS">
<soap:binding transport="http://schemas.xmlsoap.org/soap/http"/>
<wsdl:operation name="Login">
<soap:operation soapAction="http://tempuri.org/IServiceIPRS/Login" style="document"/> <wsdl:input>
</wsdl:operation>
<wsdl:operation name="GetDataByIdCard">
<soap:operation soapAction="http://tempuri.org/IServiceIPRS/GetDataByIdCard" style="document"/>
<wsdl:input>
<soap:body use="literal"/>
</wsdl:input>
<wsdl:output>
<soap:body use="literal"/>
</wsdl:output>
</wsdl:operation>
<wsdl:service name="ServerInterface">
<wsdl:port name="BasicHttpBinding_IServiceIPRS"
binding="tns:BasicHttpBinding_IServiceIPRS"> <soap:address
location="http://10.1.1.5:9004/IPRSServerWCF"/> </wsdl:port>
</wsdl:service>
</wsdl:definitions>

```

APPENDIX VI: SERVICES OFFERED IN THE ECITIZEN PORTAL IN KENYA

Services offered in the eCitizen portal in Kenya		
1	Business name Registration	Registrar of companies
2	Business Name search	Registrar of companies
3	Notice of Marriage	Registrar of Marriages
4	Issuance of a registrar’s certificate	Registrar of Marriages
5	Solemnization of marriage	Registrar of Marriages
6	Issuance of a marriage certificate	Registrar of Marriages
7	Commissioning of affidavits	Registrar of Marriages
8	Special licenses for marriage	Registrar of Marriages
9	Provisional Driving License	National Transport and safety Authority
10	Driving Test Booking	National Transport and safety Authority
11	Interim Driving License	National Transport and safety Authority
12	Driving License Renewal	National Transport and safety Authority
13	Driving Class Endorsement	National Transport and safety Authority
14	Duplicate Driving License	National Transport and safety Authority
15	Driving License Information Corrections	National Transport and safety Authority
16	Official Search (Nairobi Blocks)	Ministry of Lands
17	Land Rent Clearance Certificate	Ministry of Lands
18	Application for official copy	Ministry of Lands
19	Passport application for Adults	Department of Immigration
20	Passport Application for Children	Department of Immigration
21	Application for Kenyan Visa	Department of Immigration

Table 2: Services offered in the eCitizen portal in Kenya