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**A Prototype for Monitoring Service Delivery by Citizens in County
Government in Kenya Based on Service
Oriented Architecture
A Case Study of Nairobi City County**

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P53/79083/2015

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A research project presented in partial fulfillment for the Degree of Masters of
Science in Distributed Computing Technology in the School of Computing and
Informatics of University of Nairobi

December 2018

Declaration

I, **Mutie Stephen Kyalo**, hereby declare that this project is my own original work and to the best of my knowledge has not been submitted to any other institution of higher learning.

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This project has been submitted as a partial fulfilment of requirements for the degree of Master of Science in Distributed Computer Technology with my approval as the University supervisor.

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Dedication

To my dear wife Esther, for your prayer, love, patience and understanding

Acknowledgement

I want to thank the almighty God for enabling me in this project; I would like to appreciate the lecturers and fellow students for their support. I also recognize and appreciate the entire panel team of Dr. Agnes Wausi, Dr. Elisha Opiyo and Miss Pauline Wambui and my supervisor Prof. Robert Oboko for his guidance that enabled me to complete this research project.

My colleague at work for the sacrifice you made at work to allow me to study.

I appreciate and heartily thank my wife Esther for great love, support and prayers.

Finally, I would like to thank all interviewees, the questionnaire respondents of Nairobi City County for their contribution towards this project.

Abstract

In 2010, a new constitution was promulgated bringing in a devolved system of government, decentralizing decisions and services at local level of governance. The county government is constituted to provide service to citizens. However in some county government in Kenya, there has being numerous issues regarding poor service delivery to citizens.

Nairobi city government was on the spot over its questionable performance for not effectively addressing the issues regarding services delivery well. There are issues of waste management, sewerage and on site sanitation that are in a poor state. Other problems include: poor health management, poorly managed of Nairobi county hospitals, lack of essential drugs hence they cannot adequately serve city residents. It perform well in revenue collection, However as revenue collection increases, service delivery is on the decline, thus effecting efficient and effective ways to offer better services to county residents.

The use of ICTs provides innovations opportunity for empowering citizens by forming ways for monitoring, reporting services, accessing information and engaging citizens. The research project aimed at investigating application of ICT technologies in solving issues regarding service delivery monitoring in county government, therefore addressing challenges of current systems which it's not automated, limited into monitoring in real time, monitor robust issues, tracking of citizen's issues, analysis of data, and integration with other systems and sharing of data.

In this project two approaches strategy was used. The case study of Nairobi city county governments sectors of Environments and Road and lighting, Eight wards within two sub-counties and citizens within those wards was studied to understand the current monitoring system, processes and applicable of technologies in solving issues regarding service delivery. The design and creation strategy was used to develop prototype based on service oriented methodology. The findings showed that the current systems, methods and processes were not sufficient and effective to monitor service delivery effectively hence use of service oriented monitoring system integrated with (mobile app, SMS and web app) would address such challenges.

The service oriented monitoring system was integrated with three components (mobile app, SMS and web app). Through use of three modes (mobile app, SMS and web app) citizens were able to monitor service delivery in real time. They acknowledged that use of technologies innovation improved service delivery monitoring process. The ward administrators through their web dashboard were able to view and taken an action on reported events in their respective wards through the web and the mobile app. The sector users were responsible for resolving issues forwarded to them by the ward administrators through the web portal and the mobile app. The M & E officers were responsible for seeing if the issues being reported by the citizens were real and if action was taken by the ward administrators and the sector users though web portal and mobile app. The data was also sharable to user application using API. The evaluation of the system showed that it provided effective and efficient way to monitor service delivery.

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Definition of Terms

Application

Programming

Interface - It is the defined interface through which interactions happen between an enterprise and users of its assets.

Devolution - It refers to decentralization of decisions and services, Most of services and decisions are done at local level of governance hence county government responsible to ensure services are delivered.

Monitoring - It is a process of collecting, analyzing, and reporting data on a project or program's inputs, activities, outputs, outcomes and impacts, as well as external factors to track whether actual investment program results are being achieved.

M-Governance - The use of mobile innovations to help in the processes of governance. It can be used within government, between citizens and government and other stakeholders.

Service Oriented

Architecture - Defined as “logical approach of designing a software system to offer services to either end-user applications or to other services distributed in a network, through published and discoverable interfaces”.

Service Delivery - It's getting services as effectively and quickly as possible to the intended recipient. It's defined to meet customer's perception of how well a service meets or exceeds their expectations. It often judged by customers and not by the organization itself.

Abbreviations and Acronyms

API	Application Programmable Interface
CIDP	County Integrated Development Plan
CIMES	County Integrated Monitoring and Evaluation System
COK	Constitution of Kenya
CRC	Citizen Report Card
HTTP	hypertext Transfer Protocol
ICT	Information Communication Technology
JSON	JavaScript Object Notation
MCA	Member of County Assembly
MTDP	Medium Term Development Plan
NIMES	National Integration Monitoring and Evaluation System
REST	Representational State Transfer
SMS	Short Messaging Service
SMTP	Simple Mail Transfer Protocol
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
UNDP	United Nation Development Programme
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
USSD	Unstructured supplementary service data
WSDL	Web Service Description Language
XML	Extensible Markup language

Chapter One: Introduction

1.1 Introduction

Upon the promulgation of the Constitution of Kenya 2010, devolution became a reality in Kenya. Devolution led to the formation of forty seven county governments. It led to transitions of some functions, responsibility and resources to county government since March 2013 which are funded by the national government to facilitate such functions.

The county government has being tasked to the provision of services to its citizen's at all level units as per Article 176(2) of Constitution of Kenya 2010. That mandate county government to satisfactorily undertake their portion of service delivery for devolution to deliver the desired outputs. Their functions as described in fourth schedule of Constitution of Kenya (2010) includes management of county health services , agriculture services , county transports services , county trade development and regulations ,among others functions.

The Nairobi city government has not effectively addressed the issues regarding service delivery well. Some of the issues include waste management, sewerage and on site sanitation that are in poor state. Traffic congestion in Nairobi is notorious and the solid waste system is inadequate. There is also limited social and communities facilities (African Centre for Cities, 2015). County hospitals are also poorly managed. There is also lack of essential drugs. As a result, the county government is not adequately serving city residents.(Kibanya,2015;The Institute for Social Accountability,2014).

Citizen participation in county governance remains a fundamental issue (Mitullah, 2016). 58% are not satisfied with the extent of public participation in county government operations. Further the finding expressed a positive interest of about 50% on public participation if they actively engage in matter of operations of county governance. In another study by The Institute for Social Accountability (2016) on public participation in Nairobi county, some leaders work with citizens in some wards but in others wards there county leaders bar communities from accessing and participating fully in governance operations as envisioned by the constitution. This is an indication that the existing process and system put in place pertaining to citizen's participation has some shortcoming in engagement of citizens in matters of county development. Therefore by use of innovation technology as a tool opened up a space for citizens to express their views

regardless of political status, major or minority group of people, especially in monitoring service delivery hence enhanced engagement of citizens in county government activities leading to improving accountability and transparency.

Murutu (2014) noted that since the promulgation of the Constitution of Kenya 2010 there is minimal citizen's participation in county government levels of governance processes. Therefore by enhancing citizens participation is essential to ensure transparency and accountability in county government. Hence this demonstrates that there are some challenges with existing systems when it comes to engagement of citizen's participation. Therefore use of technology as a tool provided possible solutions with understanding of county governance processes and structures, consequently boosting monitoring of services delivery by citizens.

The study by Anand et al.(2014) and Mukherjee et al.(2011) highlighted that innovations in ICTs such as use of mobile technologies (SMS, mobile App, voice call) has formed innovative ways for data transparency, accessing information, monitoring and reporting services, organizing and engaging citizens and communities, hence ICTs play a role for greater transparency, accountability, and participation in governance. They provide fast data generation and feedback to local community, government agencies and stakeholders.

A government that is responsive and accountable to its people is foundational to a legitimate democracy. One of the most tangible expressions of public sector accountability is a state's ability to meet its citizens' basic needs through effective, efficient, and broadly accessible public services as reported by The World Bank and Reboot (2015). They further stated that over the past two decades, ICTs have radically transformed the way that states interact with their citizens. By enabling rapid, low-cost dialogue between citizens and governments, digital technologies can help states better understand and serve their people and enable citizens to amplify their voices and participate in governance in powerful new ways.

Service oriented architecture (SOA) as described by PAPA ZOGLOU et al.,(2008) is “ logical way of designing a software system to provide services to either end-user applications or to other services distributed in a network, via published and discoverable interfaces. A well-constructed, standards-based SOA can empower a business environment with a flexible infrastructure and processing environment. It achieves this by provisioning independent, reusable automated

business processes and systems functions as services and providing a robust and secure foundation for leveraging these services”.

The use of SOA for government services such as e-government portal has provided transparent governance to citizens by use of IT to enable delivery of service of several government departments. It has transformed the existing applications, data and content into web services. A solution built on SOA lessens the dependency on back-end applications and the call for writing code every time there is a change in policy and the outcome its new software that promotes the direct collaboration of citizen and government departments irrespective of the delivery model (Behara et al. 2009).

The study emphasized use of SOA automating departmental services, process workflows and made the approval process through use of web based service and integration with mobile technologies which boosted citizen’s participation in monitoring service delivery in county government in real time.

1.2 Problem Statement

The Nairobi County government was on the spot over its questionable performance for not effectively addressed the issues regarding services delivery well. There are issues of waste management, sewerage and on site sanitation that are in a poor state, and the solid waste system is inadequate (African Centre for Cities, 2015). Other problems include: poor health management, polluted water, poorly managed of Nairobi county hospitals, lack of essential drugs hence they cannot adequately serve city residents (Kibanya, 2015; Ndanga, 2013). This is despite collecting Sh 9.6 billion on 2015/2016 as revenue according to the budget Implementation Review Report 2015/2016 (Office of the Controller of Budget, 2016). However, as revenue collection increases, service delivery is on the decline, thus effecting efficient and effective ways to offer better services to county residents. This demonstrate that there are weaknesses in the system put in place to address the issues regarding service delivery monitoring in the county government, Therefore by proposing use of ICT technologies as a tool utilizing SOA in monitoring county government service delivery with an understanding of county processes and county government structures can help the county government address the challenge of existing

systems hence improving service delivery responsiveness, operational efficiency, accountability and transparency (Murutu, 2014; The World Bank and Reboot, 2015)

The County Government Act (2012) deals extensively with the subject of public participation at the county level. In fact, public participation is one of its main objectives. Under section 91, it obligates county government to structure its functions to encourage public participation. The structures envisaged inclusion of ICT based platforms among other technologies. Further, Omolo & Finch (2015) reported that the county government should develop monitoring system which facilitates participation processes of citizens, monitor robust issues handling and that can track citizens issues and how county government is responding to them. In the existing system few citizens participate, it's limited to monitoring in real time and tracking of citizen's issues and handling of response to citizen's matters. They are also limited in integration, sharing of data and interoperability. These are gaps which the study investigated and proposed ICT system based on SOA which allowed citizens to participate in monitoring the service delivery in Nairobi county government and addressed the challenges of the existing systems.

The ministry of devolution and planning formulated County Integrated Monitoring and Evaluation System (Ministry of Planning and Devolution and the Council of Governors, 2016) for County governments. It is an observation system for County Governors, County Executive Committee Members and other senior management staff within a county. It verifies whether the activities of each county's priority project or programme are happening according to planned timelines and target presented in the County Integrated Development Plan (CIDP) and whether resources are being used in a correct and efficient manner. This system for monitoring is a manual, paper-based processes, prone to errors, lacks citizen's involvement, has limitation of real time participation since they use it annually and limitation in analysis of data, system compatibility, integration with other systems and sharing of data. Hence this opens a research gap for the need of better system which addresses such challenges.

1.3 Main Objective

The study main objective was to design and develop real time system to improve service delivery responsiveness, efficiency, transparency and accountability of county government administration, through monitoring of services delivery by county residents hence better services

from Nairobi city county government, through a suitable service oriented architecture model which was able to integrate with other systems.

1.3.1 Specific objective

The specific objectives include:-

1. To investigate current service delivery monitoring process in county government.
2. To evaluate the existing service delivery monitoring systems and solutions in county government.
3. To propose a service oriented model that can monitor service delivery effectively and share information and which can be integrated with other systems.
4. To design and build a prototype that can aid in gaining of important information for county government in monitoring service delivery to improve the public service delivery, decision making processes and for other stakeholders.
5. To test the proposed prototype.

1.4 Justification of the Study

The prototype had the following significances;

- 1) The use of system provided real time monitoring of services delivery provided by Nairobi county government sectors by use of web application and mobile; App and SMS.
- 2) The use of system opened opportunity for wards citizens being evolved in monitoring their county government sectors which ascertain whether citizens were getting value for their money.
- 3) It improved citizen participations, engagements and collaborations.
- 4) The system helped county government to improve quality of public services delivery, decision making processes, got citizen's feedbacks and strengthen the social contract between the county leaders and citizens
- 5) The system strengthens governance by providing people a critical tool to engage county government. Hence better services which fostered transparency and accountability.
- 6) It generated new possibilities for open government where citizens and stakeholders were able to monitor county government quality of service delivery counterbalancing county surveillance with civic vigilance.

1.5 Scope of the study

This project involved designing and building a prototype which was based on service oriented architecture (SOA); it included development of the web services dashboard where all services were published and integrated, definition of the service interfaces, description and definition of the service implementation that define processes. Implementation of service monitoring module provided real-time monitoring of services by citizen through reporting an event.

The system involved integration of wards and sectors users who received issues reported concerning service delivery by wards citizens within their administrative level as well as notifications for authentication purpose. The system was integrated with Geo-location using Google map API we users were able to point the exact location of occurrence of issue.

The data management module monitored services on daily, weekly, monthly and yearly output. The system provided generic data analytical tool with visualization and navigation through a web based Dashboard. The system was able to analyse reported issues and enabled users to generate various reports in PDF which was used by county government to know issues reported by citizens and for integration with other system.

In application service interface integrated with mobile technologies (SMS & mobile App) and web based platform which was developed using PHP language which aid the citizens in providing poor service information. The data captured was messaging to central consumer service portal to their service provider through middleware which was connected to their back end MySQL database.

1.6 Limitations and Assumptions of the study

Data gathering was collected from few sub counties due to limitation of budget and time.

Validation of occurrence of issues reported in the system was a challenge in some wards due to low internet connectivity when users wanted to locate using Google map. Some of the service depended on mobile service provider network and in case they had technical hitch it would affect the system.

Some of assumptions of project were that the wards citizens owned mobile phone and some were internet enabled and they can use them sufficiently. The wards citizen knows their roles and responsibilities in participation in county government governance structure.

Chapter Two: Literature Review

2.1 Introduction

The theoretical literature will guide the study of monitoring of services delivery in county government, empirical literature review, research gaps, proposed prototype and conceptual architectural design are outlined in this chapter. The chapter comprises of current study within the related body of literature necessary to find answers and connect to our research objectives.

2.2 Theoretical literature review

It reviews background of county government, county government structure, their roles in monitoring service delivery, citizen's participation in monitoring service delivery, service delivery monitoring process in county government, Nairobi city county government service delivery and Service oriented architecture and its implementations methods. These are investigated and analyzed from the relevant existing research.

2.2.1 Background of County Government

In 2010, a new Constitution of Kenya was promulgated, ushering in a devolved system of government. The system comprises two distinct but interrelated levels of government: the national and county governments. On march 2013, the county governments were formed under the new constitution (Ministry of Planning and Devolution and the Council of Governors, 2016)

The purposes of county governments are established by the Constitution of Kenya at article 176. It defines that on each of 47 counties, it will have county government comprising of county assembly and executive. The county executive comprises of the governor, deputy governor and executive committee members selected by the governor. The county assembly is the legislative arm of each county government. The decentralized unit's administrative structure includes governor, sub-counties, wards and villages and each is headed by the administrator(The Institute for Social Accountability, 2013).

2.2.2 Role of Administrative Leaders in Monitoring County Service Delivery Process

The administrative roles of each county leader are described below in table one regarding issues of engagement of citizens in process of monitoring of service delivery in county government.

Administrative leaders	Roles in Monitoring County Service Delivery
Governor	<ul style="list-style-type: none"> • Promoting and facilitating of citizen’s participations in development of policies and planning and delivery of services in the county. • Creating mechanisms of engagement which involve ensuring and coordinating the participating of communities in governance. • Provide annual report on citizen participation to the county assembly.
County Executive Committee	<ul style="list-style-type: none"> • Supervising the administration, delivery of services and other decentralized units and agencies in county government.(County Government Act, 2012) , section 46 • Monitoring the process of planning, formulations and adoption of integrated development plan by city within the county. • Allow citizens participatory in decision making.
Members of County Assembly	<ul style="list-style-type: none"> • Provide relationship between county assembly and citizens on public service delivery (County Government Act, 2012), section 9 • They oversee implementation of county government’s plans and budgets and misuse of funds. • Facilitation of public participation and involvement in it committees, the legislative and other business of assembly.
Sub-County Administrator	<ul style="list-style-type: none"> • Service delivery and county public services in sub county • Provisions and maintenances of public services infrastructures and facilities. • Coordination and facilitation of citizen participation in the plans, development of policies and delivery of services.
Ward Administrator	<ul style="list-style-type: none"> • Service delivery and the county public services in ward • Development activities for empowering community, provisions , maintenances of public services infrastructures and facilities • Coordinating and facilitating of citizen participation in the plans, development of policies and delivery of services
Village Administrator	<ul style="list-style-type: none"> • Coordinating and ensuring citizens participations at village unit in governances at the local level.

Table 1: Administrative Leaders roles in monitoring County Service Delivery

2.2.3 Foundation of citizen participation in service delivery monitoring in county government

Public participation is key foundation of constitution of Kenya. It instilled national values and ideologies of governance as described in article 10 of constitution of Kenya 2010. Both legislature and executive in national and county levels are required to engage the citizen in process of policy making, monitoring and implementation.

According to the constitution of Kenya (2010), article 174 c, it defines that one objective of decentralized government is “to give powers of self –governance to the people and enhance their participation in the exercise of the powers of state and in making decisions effecting them”. Through the constitution it has given the responsibilities to ensure, facilitates and builds capacity for public participation in governance.

As citizen we have new powers and responsibilities in the devolved system. Our powers comprises of electing and providing oversight to county and national government. We are entitled into participation in decisions that affect our life, such as giving contributions to government plans. Our responsibility includes understanding what the government is doing and ensuring that we participate actively in the decision-making process whenever possible (Murutu , 2014). This is because effective devolution requires citizen’s participation for it to work properly, hence proposed system in participation processes of monitoring helped in improving service delivery to county citizen.

2.2.4 Service delivery monitoring process in county government

The study by Ministry of Planning and Devolution and the Council of Governors (2016) the process of monitoring service delivery it essential belong to department of monitoring and evaluation, who through the county Monitoring & Evaluation (M & E) officer links all programmes or projects for departments to expected outcomes of CIDP.

The project managers responsible for implementation of each CIDP projects, they develop work plan for the projects and sign performance contract with respective directors of departments. The performance contract then is collated by the M & E officer responsible for each departmental project and programmes work plan as outlined in the CIDP.

The study emphasis that county government should establish the needed M & E units , county M&E committee, county intergovernmental forum ,M&E technical committee , sector M&E committee and county citizens participation forums. Such units will help to provide needed M&E reports in the process of projects which help in improving service delivery to county citizens. The table 2 below describes the function of each actor in the process of monitoring projects or programmes under implementations as directed by CIDP which enhances service delivery to citizens.

Committee /forum	Members	Responsibilities	Frequency of meeting
County assembly committee	MCA	<ul style="list-style-type: none"> Receives county M&E reports, review and present to the county assembly 	-

County monitoring and evaluation committee (CoMEC)	Head of technical departments at county level, county chief officers, county assembly clerk, representatives from devolved funds, technical representatives for non-devolved funds.	<ul style="list-style-type: none"> Oversees the overall county compliance and results of projects implementation and service delivery within the CIDP 	Quarterly
M & E technical committee	Technical officers in county departments and non-devolved department	<ul style="list-style-type: none"> Provide expert advice and review of M&E report before it passed to CoMEC. 	Quarterly
M&E unit	M&E officers under director of economic planning	<ul style="list-style-type: none"> Coordinate regular M&E reports produced within the county departments. 	Quarterly
Sector M & E committee	Chief officers of county sector	<ul style="list-style-type: none"> Frequency of SMEC at sector in support of functions of CoMEC in county. 	-
county citizens participation forums	Representatives of NGOs, CSO, rights of minorities, marginalized groups and communities, representative of private sector business community and development partners.	<ul style="list-style-type: none"> Review and give feedback to M&E reports, Promotes the concerns, rights of minorities, marginalized groups, communities and their access to relevant information. 	Annually
county intergovernmental forum	Governors , heads of sectors, county executive committee	<ul style="list-style-type: none"> Receive M&E reports for CoMEC, review, endorse and pass to county assembly committee responsible for finance and planning 	Quarterly

Table 2: Committees for M&E Preparation and reporting

The study emphasises on monitoring and evaluation on the projects and programmes under implementations as guided by the CIDP and the major actors in the entire process. As the county government implement such projects, citizen participation through real time monitoring is important and use of ICT innovation ways improved the process of service delivery, hence giving county citizen opportunity to monitor service delivery within particular sector

2.2.5 Fundamental problems on citizens participation in monitoring service delivery

The issues concerning public participation in monitoring county government service delivery is clearly constituted in administrative roles, but when it comes into reality from citizens, few are

involved in the process of monitoring. The issues as noted by The Institute for Social Accountability (2016) in Nairobi county some leaders work with citizens in some wards but in others wards there county leaders bar communities from accessing and participating fully in governance operations as envisioned by the constitution. Further the study revealed that there are numerous petitions and cases against county government due to projects being implemented but fails to capture the interests and needs of public.

Citizen's participation in some area think is waste of time due to lack of feedback mechanism from previous meeting which discourage them from participation, some area angry citizens disrupt hearing demanding officials to leave because they do not give feedback on projects proposed in prior public hearings. In others MCA use that opportunity to influence meeting resolutions without effective public participations. The proposed innovation technology embraced reporting mechanism that provides feedback where both county leaders and citizens are incorporated hence citizens can know how county government is responding to their issues.

The study by Murutu (2014) and The Institute for Social Accountability (2016) described that there are minimal citizens participation in county government levels of governances processes where planning , coordination's, executions are done. Also some county governments are selective in engagement of citizens in public forums leading to perceptions that such involvement is group managed.

Such loopholes in engagement of citizens its aim of this project to provide reliable solution which citizens can participate any time and their voices are heard. Most counties has not used ICT platform in sharing information and for use in external communications purposes. Therefore by enhancing citizens participation is essential to ensures transparency, accountability, and efficiency and quality service delivery in county government, hence use of ICT technology can provide possible solution, consequently boosting monitoring of services delivery by citizens.

Muriu (2014) noted that the impact of citizen participation on devolved service delivery with some main parameters such as efficiency, accountability, reduction of corruption and equity in service delivery is minimal and such results are neglected on decentralized service delivery. The study describe that citizens in Kenya has suffered a lot because of lack awareness and inadequate capacity to participate in governance process hence their voice are not heard. Citizens in most

cases are consulted on projects which seem to be done and this is not always necessary. Therefore use of ICT technology can provide means where citizens can participate especially in monitoring service delivery within their county government.

2.2.6 Nairobi City County Service Delivery

The county government is responsible for service delivery in many areas. It includes management of county health services, agriculture services, county transports services, county trade development and regulations, county planning and development, assist communities' participation in governance at local level, among others functions.

The Nairobi City County Government operates in window of consultations with residents and operates an open door policy that affords residents the opportunity to participate in governance of the city. The responsibility of managing this city lies with partnership of the resident and the County government (Nairobi City County, 2016). Therefore use innovation technologies shall help residents participate fully in monitoring the service delivery issues in areas of water supply, health, solid waste management, county roads, and sanitation among others sectors.

The county government has not well addressed the issues concerning service delivery well and these is despite collecting Sh9.6 billion on 2015/2016 as revenue according to the budget Implementation Review Report 2015/2016. However as income collection increases service delivery is on the decline, thus the county government stumbling from one crisis to another. The proposed system provided real time participation of resident to monitor, gave feedback according to how the county government is performing which helped the county administration in areas of improving service delivery.

The Nairobi city county was also questionable for the stalled project during public hearing of public sector despite budgetary allocations. Some of issues raised by county residents are poor state of roads, poor drainage and sewerage systems, straight light not working in parts of city even after the transport department in their report showed that it have used 2.7 billion since 2013 to 2016 to repair and maintain roads, construct bridges, install street lights and improve drainage system(The Kenya Alliance of Resident Associations, 2016). It was reported that citizen participation should being encourage so as they own development projects under implementations. By developing ICT solutions platform were citizens can monitor such

development projects , many issues matters will have being resolved rather than waiting when they have such public hearing gathering.

Nairobi City County Government has different ministerial departments or sectors has shown below in table three to provide services to it citizen residents (Nairobi City County Government, 2016).

Department	Service Provision
Roads, Public Works and Infrastructure Services	<ul style="list-style-type: none"> County roads constructions and maintenances, Street lighting installation and maintenances, Traffic and parking management
Water, Energy, Forestry, Environment and Natural Resources Services	<ul style="list-style-type: none"> Solid waste collection, transportation and disposal services, drainage, sanitation ,sewerage and water services , forestry service
Lands ,Housing and Physical planning Services	<ul style="list-style-type: none"> Regularization of property, buildings approval , Urban Renewal and Regeneration of Old Housing and city planning
Education, Youth Affairs Culture, Children and Social Services	<ul style="list-style-type: none"> ECD and Vocational training service , Issues of street families , Education & social services,
Public Service Management Services	<ul style="list-style-type: none"> County government employee relations , monitoring and evaluation
Trade, Industry, Cooperative Development, Tourism and Wildlife Services	<ul style="list-style-type: none"> City Market services, Single Business Permits, Liquor Licensing, Cooperative Development and tourism.
Health Services	<ul style="list-style-type: none"> County health services such as preventive, curative and protective, reproductive health services, public health inspectorate etc.
Security, Compliance and Disaster Management Services	<ul style="list-style-type: none"> Provision of security and enforcement, traffic management and Fire Management.

Table 3: Nairobi City County Service Departments

Service delivery has being divided to different sectors to effectively serve the citizens, the structure of county government it's to devolve services to citizens through respective sub-counties. In most cases due to limitations of resources to devolve some services to respective sub- counties most services are centralized to headquarter of respective county government.

Nairobi city county government has centralized most of services at headquarter, monitoring of services delivery problems are channeled through mobile phones and emails of respective of sectors. Other means includes manual writing complaint, physical reporting to their sector customer care, social media such face book and twitter public page of county government.

The challenges with existing channel such as mobile phones numbers given for monitoring issues are effective means of use to report problems, but in most cases the mobile numbers are unavailable. It cannot handle large number of county citizens who are supposed to be serviced per particular time. But having effective innovation system which can handle multi reporting issues will better service delivery where corresponding sector will get issues reported by county citizen. Manual writing complaints and physical reporting monitoring issues its time consuming. The use of social media in service delivery monitoring issues has being effective. Hence some of limitations includes, analytical of issues reported, integration with systems and issues of privacy. Such gaps embraced in the proposed system.

From the study it evidence that issues of service delivery has not well addressed especially in following services; Solid waste collection, transportation and disposal services, drainage, sanitation ,sewerage service ,County roads constructions and maintenances, Street lighting installation and maintenances and poor health management.

2.2.7 Service Oriented Architecture

It is a standard framework where establishment, management and creation of service are done which aim at increasing the agility of information technology in order to adapt to business changes (Hashemi & Hashemi, 2012) , Service is the building block of SOA , which is a program which can well interacted via well- defined message exchange , these can be created for availability and stability and are characterized by being platform independent , autonomous, loose coupled , interoperability among other hence they help in solving business challenges.

The services can perform functions such as answering simple request ,executing business processes which needs peer to peer relationships between multiple layers of service consumers and providers (PAPAZOGLU et al., 2008; Moinuddin, 2007).

Web service are builds on idea of service oriented computing which provide a building block of designing and executing of business processes which can be distributed over the network and available or accessible through standard interface and protocols. Both service clients and provider's uses internet as mean to facilitate communication and transmission medium.

SOA define the integrations of multiple disparate applications for web- based environment in electronic business and the use of multiple implementation platforms. Rather than describing application integrations configurations for extended enterprise , it defines the interface protocols for electronic business and functions which is made possible by implementation of thin SOAP or

REST layer on top of existing application or component which show web service is mostly practiced in software industry (Joshi, 2012; Papazoglou & Heuvel, 2006), This open an opportunity for business to be more agile to response to change in market need and customer requirements.

The use of SOA in this project helped in the integration of different service of county government sector. Transform their existing applications; data and contents into web services irrespective of their platform which they are running without requiring change to existing applications. The services were exposed using web service transforming the county government as the service provider.

2.2.7.1 Methods of Implementing Service Oriented Architecture and Use of APIs

Service oriented architecture which uses web service as a building block in designing and executing business processes can be implemented using following web service architectural approaches.

2.2.7.1.1 Simple object access protocol (SOAP)

According to Rouse (2014) she defined SOAP as a “messaging protocol which allows programs running on disparate operating systems (window and Linux) to communicate with a program in the same or another kind of an operating system using World Wide Web’s hypertext transfer protocol (HTTP) or simple mail transfer protocol (SMTP) and its extensible markup language (XML) as mechanisms for exchanging information ”. Majority of the operating system platforms now day have most of web protocols, therefore HTTP and XML provides at-hand solutions which allow programs running on different operating systems in a network to communicate with each other.

SOAP describes XML-based message format which web service enabled applications uses to communicate and interoperate with each other over web. It usage over web has an advantage due to heterogeneous environment which demands applications to support same data encoding protocol and message format since it defines encoding messages standard in XML which can invokes functions in other applications.

Web service description language (WSDL) defines regular set of rules to describe the messages, bindings, operations and location of service. It defines interface of the service which is the structure of XML messages that the service can accept or return. It defines methods those

messages are encoded and indicates what protocols the service supports (i.e. SOAP over HTTP) (Dhingra, 2013; Manes, 2007).

The study by Rouse (2014) SOAP has some advantages such as simple way of communication through the firewall and proxy because HTTP is port 80 compliant hence SOAP programs can communicate with other programs anywhere. SOAP has ability to allow use of different transport protocols. Also its simple and extensible, platform and language independent

SOAP has some disadvantages such as, it quite slow than other types of middleware standards due to use of verbose XML format. It's inadequate to pooling and event notification when using HTTP for transport and not using web service addressing, the roles of interacting parties are fixed, so only one client can use the services of one server in typical situations. Since SOAP use HTTP as transport protocol there will be firewall latency because firewall will analysis the HTTP transport.

2.2.7.1.2 Representational State Transfer (REST)

REST as noted by Dhingra (2013) describe as a set of architectural principle on which data is transferred over standard interface such HTTP. It doesn't have another messaging layer and aims on designing rules for creating stateless services. A stateless protocol is communication protocols that treat each request as an independent communication and that is unrelated to previous communication (Fielding, 2000). A client can access the resources or services using the unique uniform resource identifier (URI) and a representation of the resource is returned, while each new resource representation, the client is said to be transfer state.

When accessing RESTful resources with HTTP protocol, the uniform resource locator (URL) of the resource acts as the resources identifier and GET, PUT, DELETE, POST and HEAD are the standard HTTP operations to be performed on those resource.

It's mostly preferred more than heavyweight SOAP because it does not consume a lot of bandwidth making it better to fit for use over the internet. Due to it decoupled architecture and lighter weight communications between producer and consumer it mostly preferred building style for cloud-based Application programming interfaces (APIs) such as amazon , Google and Microsoft and interacting with lightweight clients such as smartphone (Rouse, 2014; Dhingra, 2013).

REST use smaller messages format than SOAP, in SOAP which uses XML for all messages hence making the message size much larger thus less efficient. REST provide better

performance, good caching, low cost over time, requires less intensive processing thus faster than SOAP.

In addition RESTful services are easy to scale than SOAP services hence its frequently selected as the architecture for services that are expressed through internet such as cloud providers, social networking websites. In devices which are have restricted profile such as mobile phone, its suitable since the overheads of additional parameters are less hence useful for mobile applications. It services are easy for integration with other existing websites and are exposed with XML so that HTML pages can be consumed with an ease.

In the proposed system which utilize SOA, the web service was built based on the REST architectural style because of it scalability, light weighting, less overheads, ease of use and integration.

2.2.7.1.3 Uses of Application programming interfaces

Application programming interfaces 'it's a set of routines, protocols, and tools for building software applications'(QuinStreet Enterprise ,2017). It is an architectural approach that provides programmable interfaces to a set of services to different applications serving different types of consumers. API is used in many cases today, when used in web development; it's defined as a set of hypertext transfer protocol request message, within a defined structure of response message, which is in an extensible markup language (XML) or JavaScript Object Notation (JSON) format (HCL Technologies Limited, 2014).

In web service application, API has being used in different web service oriented architectural such as SOAP or RESTFUL. It creates a loosely coupled architecture that allows a component service to have a wide range of future uses. Also it enables software developer to build application that are rapidly adapting to end user needs. Some of popular **example of API includes; Google Maps API;** where developer embeds Google maps on webpages using JavaScript, It is designed to work on mobile devices and desktop browsers. **YouTube APIs;** Google API let developer integrate you tube videos and functionality into website and applications such YouTube analytics API, data API etc. **Amazon product adverting API;** it gives developer access to amazon product selection and discovery functionality to advertise it products.

2.2.7.2 Empirical study of Service oriented architecture

Saleh et al.(2013) study described the application of SOA in providing a solution for e-government applications for Jordan government. The e-government applications were limited to providing information and not services, also the traditional peer-to-peer integration of application in existence result into lightly coupled system that reduces agility and expansibility of current system. They proposed model of integration mechanism based on the web service of the SOA for solving such challenges. They applied it under a Jordan case study, in context of implementation of web service for issuing of environmental license since it was service requested by multiple governmental agencies and entities. The model provided integrations for all interoperability aspects and e-government interoperability in various stages, reusability of service and sharing of data. The model was limited in measuring the impact of such web services from citizens, businesses and government agencies.

The study by Hashemi & Hashemi (2012), described that electronic cities are built according to current technologies potential since most of activities are done through internet and electronic system. Citizens and other stakeholders access different information systems in substructure of city to provide different services to them. These systems which host different data types were running in diverse platforms, which was a challenge for interaction of these systems. To address such challenges they used service oriented architecture to integrate different information systems and provide collaboration between them. Their SOA model was mainly for integration different systems and limited into building web service application which will describe and publish the service.

Joshi et al.(2012) they described the use of service oriented architecture for patterns of electronic business. They applied SOA for patterns such as self-services, enterprise business patterns, application integration patterns, application patterns and products mapping. SOA was used to implement patterns for electronic business and focusing in creating and integrating insecurely joined services as a substitute of applications for maintaining business and industry. Challenges of business integration, application and runtime patterns were solved by adaptations of SOA. A Runtime patterns issue was addressed by use of middleware nodes to connect logical applications tiers by use services in SOA. Self-service business pattern provided interactions

between users and businesses, extended enterprise pattern addressed the communication and collaboration between business processes in separate enterprises.

2.3 Empirical literature review

2.3.1 County integrated monitoring and evaluation system (CIMES)

The Department of monitoring and evaluation of the ministry of planning and devolution in collaboration with the council of governors came up with county integrated monitoring and evaluation system (CIMES) for the county government, which is an observation system for county governors, county executive committee members and others senior management staff within a county. The aim is to verify whether the activities of each county priority projects or programmes are happening according to planning timelines and the targets presented in county integrated development plan (CIDP) and whether resources are being used in correct and efficient manner (Ministry of Planning and Devolution and the Council of Governors, 2016).

The implementation of CIMES in county governments use the manual way to collect data, analysis, compile the information and generate progress reports on the execution of CIDP. Further the manual system of monitoring at county level is done quarterly and annually to review result of different departments and it used by the county management teams, projects staffs and staff of county monitoring and execution department.

The implementation of CIMES in county level has not being integrated with others systems such as county performances management system (CPMS) which track the performance of individual on the provision of public service delivery in the county, national integration monitoring and evaluation system (NIMES) which track the implementation progress for projects and programme for national government.

Limitations of the system

- The system is mainly for the county management officers with no involvement of county citizens in monitoring how county is implementing the development agenda. The collection of monitoring data and analysis is done quarterly and annually and is not on the regular basic. This limitation of lack county citizen's involvement, real time provision of information in monitoring shall be incorporated in the proposed system embracing real time participation.

- The system is manual paper work process; therefore collection of data, analysis and generating reports is paper based manual processes which are cumbersome process and prone to errors. Further their system does not incorporated use of mobile technology in monitoring process.
- The use of CIMES is manual process. Hence limitation in analytical and integration limitation with other systems. The proposed system shall be integrated with other existing systems regardless of the platform they are running, as well sharing important information's to others level of governance and stakeholders.

2.3.2 National integration monitoring and evaluation system (NIMES)

It's being used by the national government to regular report on implementations progress of the country's priority policies, projects and programs as they are outlined in key documents policy such as medium term plan, vision 2030, devolved funds programmes, sustainable development goals among others. It provides feedback to government policy maker and public on the national government performance progress toward achievement of various economic and social development policies.

The system was developed by the monitoring and evaluation department of ministry of devolution and planning. They have put mechanisms and capacity for working with various entities to be involved in data collection and analysis. The system has not yet being computerized meaning that is still manual system, but they are recommending computerization of NIMES so that it can help in data collection , analysis, publication, dissemination and building an aggregate M& E data collected automatically through interface with other several information systems of sector ministries and others ministries.

Limitations of the system

- The system mainly focus on the issues pertaining national government aiming on progress status on implementation of national agenda and the system has not yet computerized. The main actors are staffs from the M & E department as well other various entities that are incorporated in data collection and analysis. The process of monitoring does not involve the citizens. The system has not being integrated with other systems. Further the system does not utilize use of mobile technology in monitoring progress. These limitations shall be address in the proposed system.

2.3.3 Monitoring System in Ghana

The local government service secretariat (LGSS) of Ghana developed M & E system to enable them effectively and efficiently monitor, evaluate policies, programmes of the secretariat as contained in medium term development plan (MTDP) of 2014 -2017 which is in line with thematic area of national medium term development plan policy framework of 2014-2017. This was a critical system for good governance and accountability. It provided reliable and timely information to support the implementation of programmes and projects; contributing to instructional learning and knowledge sharing; and offers opportunities for feedback which support redesigning of interventions and informing policy formulation(Local Government Service Secretariat of Ghana, 2014).

The system was used to track the progress of programmes, plans and projects quarterly or annual using defined indicators to different levels management such as local government service secretariat (LGSS), regional planning councils (RCCs) and metropolitan, municipals and districts assemblies (MMDAs). The monitoring process was done by respective units within each level of management. The initial task was to identify various stakeholders in local government service who included individuals, institutions and groups of people interested in monitoring process. The units for each respective level of management acted as primary key in data collection, analysis, dissemination and reporting of information while CSOs, NGOs, citizens , town or urban councils and traditional authorities act as secondary stakeholders in monitoring process. The system was not integrated with other systems.

Limitations of the system

- The process of monitoring was done within specific time of year either quarterly or annual, the system did not embrace real time participation of citizens, further the citizens, CSOs, NGOs acted as secondary mean in the monitoring process. These limitations will be addressed in the proposed system where citizens will being primary actors in providing monitoring information, as well a system providing real time participation for citizen to rise issues in the implementation process instead of waiting the monitoring period.

- The monitoring process was not computerized meaning the data collection, analysis and generating reports was manual paper based process. They computerized all information after the monitoring process in the local database system within LGSS.

2.3.4 Service delivery monitoring system for Rwanda governance board

The local government monitoring system was a web based system created to host collected data related to governance issues. The system helps the local authority in gathering data using different formats from other institutions. The system relies more on information collected using others monitoring ways such as citizen report card (CRC), an assessment done annually to check level of community satisfactions with service delivery. It employs uses questionnaires to interview individual's heads of households, community focus group, and service providers on both private and public sector. It also depends on information from Rwanda governance scorecard (RGS), which is an annual assessment tool having questionnaires of well-constructed questions with surrounded indicators which aim at identifying areas for improvement and policy reform (Rwanda Governance Board, 2016)

Limitations of the system

- The system acted as central database store where all information after the annual monitoring of service delivery were kept to being used by the government to improve service delivery to it citizens. It did not embrace real time participation in monitoring service delivery rather it used to stored information after the annual events.
- The monitoring process used citizen scorecard and governance scorecard which did not use innovation ways such use of mobile technologies to help in the process, a gap which in the proposed system shall integrate use of it in monitoring process of service delivery.

2.4 Use of Mobile Phone to Monitor Service Delivery in Government

In Kenya mobile penetration stood at 88.1 per cent according to communication authority of Kenya report of 2015/2016. Due to growth in network coverage has led to reduction of cost of mobile devices. The use of mobile technologies has positive influence on human improvement and enhancing democratic governance. It has influenced growth in parts of health, education, agriculture, employment and crisis prevention (UNDP, 2010).

Mobile technologies in governance have offered means of empowering citizens and other stakeholders in enhancing democratic process and mechanisms. By use of different communications channels has created venues for citizens to participate and gave a voice for those who have being marginalized. It has provided citizens with a tool to engage public institution hence strengthening governance and better services.

The usage of mobile phones is most effective way of solving currents problems and on the other hand the usage of websites is perceived as an effective way of getting information. In developing countries most citizens have features phone. Some service such as SMS should be considered as prime channel due to it accessibility and essentially for helping in solving the needs of the citizens. So utilization of multi-channel method of mobile phone to achieve sustainable development goals it's not only way of understanding technology but a way of knowing the citizens, their needs, views and concerns (Reddick & Turner, 2012; United Nations, 2014). This project aimed at developing monitoring service which leverage the benefit of existing mobile phone penetration and ownership in our county which shall utilize phones services such SMS, mobile app and web support for internet enabled phones.

The use of mobile phones and tablets in data collection processes in an established community based monitoring initiatives has gained interest in providing fast generation and feedback to local community, government agencies and stakeholders. Examples are,

2.4.1 SMS Services of Local Government of Amman

The local government of Amman launched SMS services system which aimed in increasing channels of communications among its authority, municipality of greater Amman Jordan and the citizens. It offered two types of SMS services such as pushing service messages where government institutions and their respective department they sent reminders, awareness campaigns messages etc. The other type was pull messages where citizens can send SMS inquiry and its responded by the concern department automatically. The use of SMS service was recognized as good communication tool by its citizens therefore enhancing quality and efficiency of government services (United Nations, 2014). It supported services such violation of vehicles, complaints and property tax.

The SMS service portal had some limitations such as it was not integrated with systems, despite providing real time participation for citizens to report and inquiry information from respective government departments. It did not provide analytical way of analysis the information rather a way to facilitate service delivery by reporting issues pertaining service and an easy way in which government can communicate with it citizens. Such gaps in that study were addressed in the proposed system integrating use of mobile technologies in monitoring process.

2.4.2 Rapid SMS Application in Uganda

The ministry of health in Uganda launched information technology monitoring initiative called mTrac to assist in provision of timely surveillance data to managers both in district and national levels. The system helped staffs at health facilities to use their own mobile phones to report on issues of stock levels and usage rates of anti-malarial medicines, such data was made instantly via SMS and a web based dashboard to government managers.

In the study, community members used anonymous SMS hotline to contribute their complaints about service delivery in health sector such stock outs and conduct of health workers via SMS which improved response and strengthened accountability and transparency. The village health teams (VHTs) which facilitates community health centers filled and submits weekly reports on health issues. The health care workers (HCW) reported issues on disease surveillance, malaria case management and stock quantities on weekly basis. The district health teams (DHTs) who had internet enabled computer to access the system so as to monitor the issues reported e.g. the quality of reports, reporting compliance, stock quantities of medicine by health facility. They included others stakeholders related to health to ensures improved of healthcare delivery in the county(Cummins & Huddleston, 2013)

The system was solely developed for managing health issues and facilitates health staffs on reporting process, while the citizens reports complains on health matters only via SMS. The system designed for a sole purpose for health sector only. The proposed system in this project shall cover service delivery monitoring across a range of sectors and use multiple ways not only through SMS but also via mobile app and web based platform to provide a convenience means for citizens to address issues regarding service delivery through real time monitoring service module which cut across a range of sector in the county government.

2.4.3 Jihusishe ICT Based SMS Platform in Kenya

The system was developed by TISA which aims at educating public on civic education which concerns on public participation in county government, their roles and invitation to public forums and events in their communities. Upon subscriptions the user will be receiving updates about their county and be able to participate in the county activities (The Institute for Social Accountability, 2016). The SMS platform runs on one subscriber mobile network.

Some of limitations of the above SMS system despite embracing the citizen's participations it did not really embrace real time monitoring process of issues affecting service delivery in county government, a gap which shall addressed in the proposed system. The system did not provide any analytical results on any specifics needs raised by citizens as well as where citizens can view whether their issues have being resolved or not. In addition the system was based on specific mobile network thus limits users of other network or forcing users to have multiple SIM cards. This creates interoperability issues with other mobile network and with legacy systems.

The system was limited to integration with other systems in county government hence limiting way of sharing information. Such gaps shall be addressed by proposing a system which citizens can access irrespective of system architecture and system being able to be integrated with other systems in county government.

2.4.4 Lungisa monitoring tool in South Africa

In South Africa, Cape Town region resident citizens used a tool called lungisa "fix it" through use of SMS, web, Facebook or tweet to report problems concerning service delivery such as sanitation , water , schooling , electricity, health care and other public services. This tool was developed by non- organization who after the citizens reports such problems to them they forward them to respective authorities and they follow it up for such issues to being resolved. The use of this tool enabled many reported issues being resolved and voice of citizens being heard, hence receiving better service delivery promoting accountability, transparency and better governance (United Nations, 2014; Cell-Life, 2012).

The use of this tool was specifically for reporting purpose, citizens they were able to track whether the problem was resolved or not, but it lacked analytical way of analysis the problems reported by citizens, also lacked integration with other existing systems. Such setbacks were

addressed in the proposed solution promoting direct collaboration of citizens and county government departments and other stakeholders rather than relying on third party in the case mention above.

2.5 Research Gaps

The literature review in this research has built the consensus on the necessity to have web based service oriented monitoring prototype which use web based platform and integrate mobile technologies (SMS and App). This was used by the county citizens to monitor services delivery in some of sectors within Nairobi city county government using any mean of channel (web based platform ,SMS and mobile App) rather than some studies which pointed out one mean of channel or never incorporated use of technologies solution in monitoring service delivery.

Further in reviewed literature most of service delivery monitoring was done at the end of projects under implementation (annually), other studies pointing that citizen were used as secondary way of gathering data, minimal involvement of them, but not giving an opportunity for citizens to participate in real time monitoring as the projects are being implemented a gap which shall be tackled in this research.

Research work in service delivery monitoring was done and gave people, government institutions, non- organization reliable ways of knowing problems affecting citizens especially in service delivery in government institutions , however they were limited in analytical ,integration , sharing of information with existing system and platform dependent. The literature reviewed does not address effective ways of tracking problems citizens reported and analysis reports.

The study reviewed research on SOA empirical study which most of studies mainly focuses on the integration, interoperability and reusability of different information systems to enhance sharing of information but some of studies were limited in development of SOA applications, incorporation with other technologies such as mobile technology. The SOA applications was developed for monitoring service delivery which incorporated use of mobile technologies (SMS, App), in additional of providing reusability, interoperability, and integrations and secure interaction of different systems and different departments within county government.

2.6 Proposed Prototype

This study envisions at designing and developing web based service oriented monitoring service prototype which integrated different county government service departments into web services hence transforming the county government and it departments as service providers.

I proposed mobile; SMS, mobile App and web based platform solutions which was integrated with service oriented monitoring service prototype enabling county citizens and other stakeholders to actively participate any time in monitoring process of different services in their county government.

The system incorporated different actors from the county government administrative structure such as, ward, sectors users and M & E officers who were able to receive the issues citizens reported regarding service delivery, verifications of matters reported, in addition of using Geo-location Google map API for verification of issue reported location.

The system has feedback and track mechanism where service consumer (citizens) can give their views or opinions as well as track the progress of issues reported. It has analytical mechanism to analysis reported problems such as issues responded per sector, not responded per sector, overall reported problems , overall responded problems embracing different type of report formats such as PDF and graphical . The data from the system was integrated with other existing systems.

2.7 Conceptual Architectural Design

The diagram below in figure one, shows the relationship between different actors in the conceptualized architectural model. The variables such as integration, analysis, tracking and platform independent were built into service oriented monitoring prototype.

It describes the process of the monitoring of service delivery in the county government. The citizens reported issues concerning service delivery in real time using the system and notification service will occur immediately to their respective administrative leaders, as well as notification to the concerned department within county government and the citizen reported such problem.

Once the problems are verified or updated, the citizen or stakeholder who reported got a notification about the issue status and how it will be respond and problem status was change immediately.

The actors responsible from each level of administrative role in the system was able to update the problems once resolved and being put under all report module. The system was able to analysis the reported, resolved and rejected issues. The analysis results was generated and reported in PDF format.

The data from the system can be integrated with other existing systems and data shared with departments by use of API in Json format. The use of system was influenced by accessibility, ease of use and reliability. The system was evaluated by citizens and sectors based on some perceived output variables such as improved efficiency, transparency, accountability and decision making.

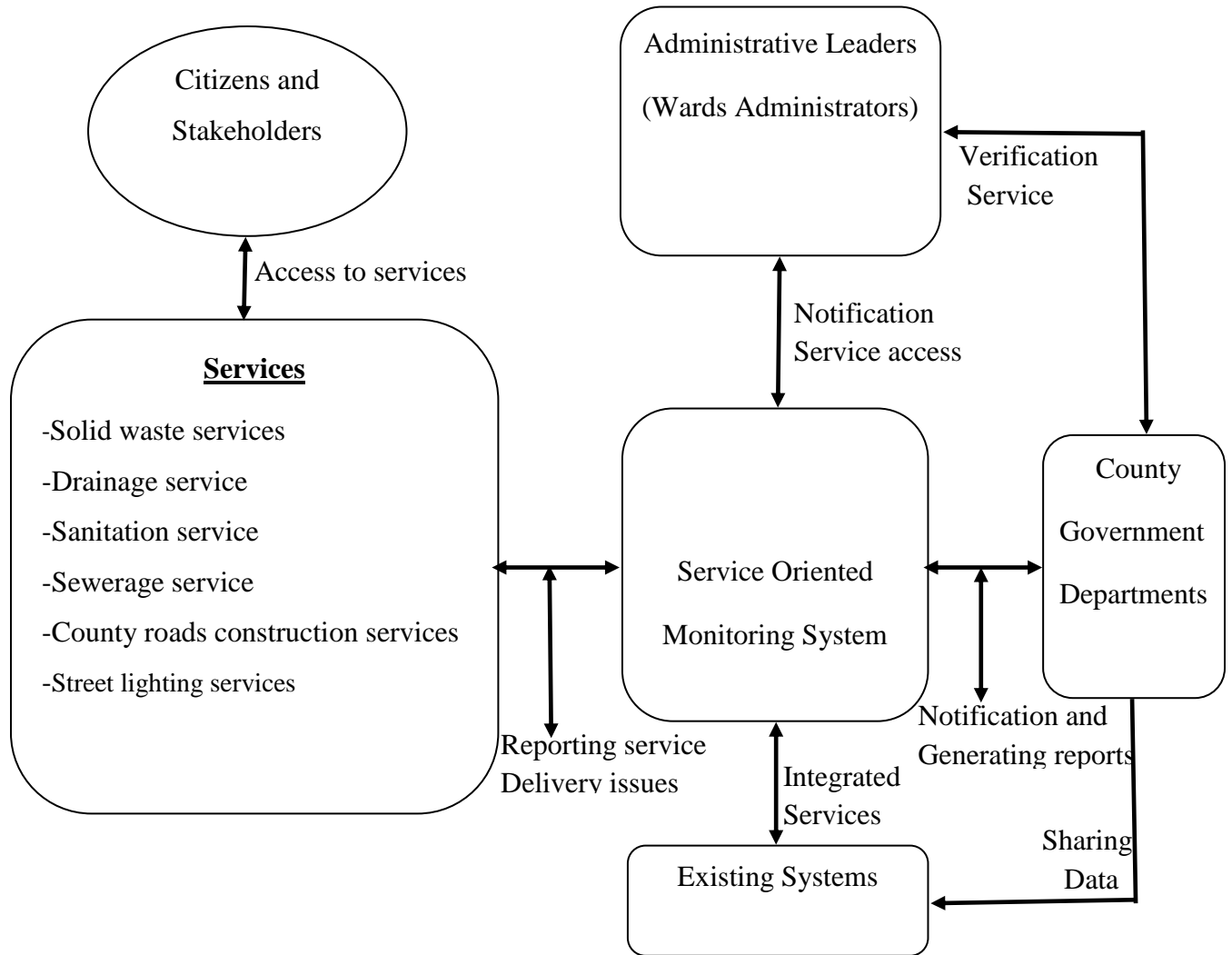


Figure 1: Conceptual architectural model design

Chapter Three: Research Methodology and System Development

3.1 Introduction

Research methodology is defined as a systematic way of solving research problem. It's a science of studying how the research is to be carried out. Essentially, the procedures of which researchers describes, explain and predict phenomena of their work. It defines the combination of strategies and methods adopted in the study (Kothari, 2004; Rajasekar et al., 2013).

System development as described by the association of modern technologies professionals as a framework that is used into structuring, planning and controlling the process of developing information system. There are several system development methodologies for software design and development. In this research project iterative and incremental development methodology was adapted.

3.2 Research Design

It's defined "as the arrangement of conditions for collection and analysis of data in manner that aims to combine relevance to the research purpose with economy in procedure", it's the conceptual structure within which a research is conducted; it constitutes the blueprint for the collection , measurement and analysis of data (Kothari, 2004).

The research was endeavoring at designing and developing web based service oriented monitoring service prototype, which integrated selected Nairobi city county government service departments. County citizens within selected wards was able to monitor service delivery problems by use of mobile phone; SMS, app and web based platform in real-time.

This research followed iterative and incremental development methodology which is a method for designing and developing a system through repeated cycles (iterative) and in smaller portions at a time (incremental). It was an advantage to learn from the earlier phases of development (Larman & Basili, 2003).

The methodology was chosen because iterative approach allows understanding of the research problem though successive refinement and incremental grow of effective solution over several repetitions.

3.3 Iterative and Incremental Development Methodology

This research followed service oriented design and development methodology based on an iterative and incremental process that contains one preliminary and eight different phases that

focus on business processes , considerable as reusable building blocks that are self-governing of applications and the computing platforms that they are running as described by Papazoglou (2006).The phases were planning, analysis and design (A&D), construction and testing, provisioning, deployment, execution and monitoring as shown in figure 2 below.

a. Planning

It involved carrying out the preliminary study, understanding business processes in an organization. It included analyzing the business needs and requirements in measurable goals, reviewing of the current technology landscape and systems.

b. Analysis and design (A&D)

In this phase it applied gathered requirements in designing components of the required system services. It also involves analysis of best approaches to meet the requirements. The conceptualizing of the requirements of the new environment, its effects on existing systems and map them to a new system.

c. Construction and testing

In this phase components were coded using appropriate tools. The various services were constructed and appropriate interfaces defined.

d. Provisioning

It's a combination of technical and business aspects for supporting service client's activities and involved choices for service governance, service certification, service enrolment and managing operations that control the behavior of services during its use.

e. Deployment

This included publication of the service interface and service implementation descriptions on how applications and users find the services.

f. Execution

This phase ensured deployment and operationally of web services of system. The service requesters were finding the service definition and invoking all defined service operations.

g. Monitoring

It was concern with service level measurement and monitoring which was a continuous and closed-loop way of measuring, monitoring, reporting, improving the quality of service of system.

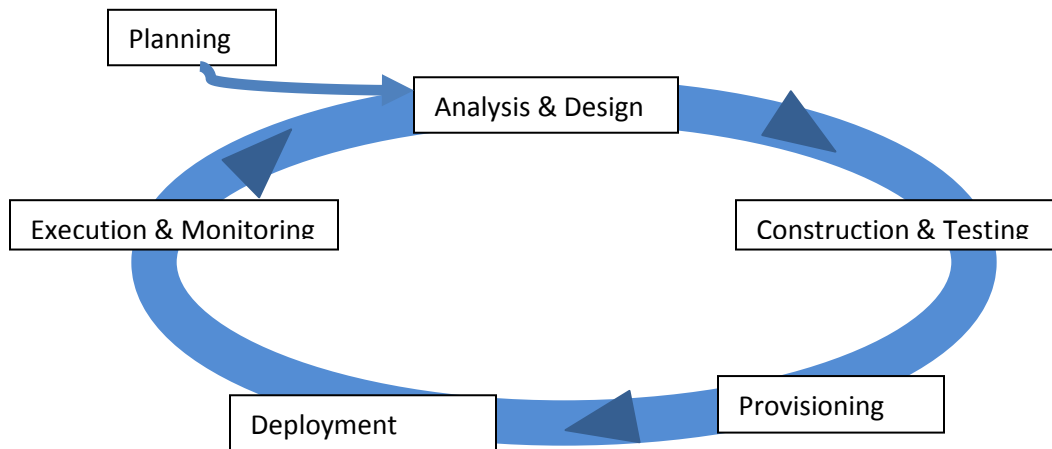


Figure 2 : Service oriented design and development methodology phases (Papazoglou, 2006)

3.3.1 Service oriented design and development methodology Phases

3.3.1.1 Planning Phase

This phase was concern with the feasibility study in the context of monitoring of service delivery and integrations with selected sectors within the Nairobi city county government. The most important necessity in this phase was; understanding the business environment and ensuring required measures were incorporated and considerable in the design and development of the service oriented monitoring system.

The tasks included; analyze business need and requirements in measurable goals, review existing technology landscape, conceptualize the needs of new environment of selected sectors in Nairobi city county government and map it to system.

3.3.1.1.1 Feasibility study

This summaries the feasibility of this project, It entails the initials investigations and analysis after the construction of the system.

Feasibility	What to investigated	Study outcome
Operational	<ul style="list-style-type: none"> Will the system be effective after it has being developed and deployed? Will the system meet the intended expectation and functionality? 	<ul style="list-style-type: none"> It was found the system worked after deployment System was evaluated by users, meets intended functionality
Technical	<ul style="list-style-type: none"> The technical resources needed for development, purchasing, installation and operating the proposed system Available technology and infrastructures for 	<ul style="list-style-type: none"> It was found that there are resources to develop, purchase, install and operate the system effectively The high growth of mobile penetration

	development implementations of the proposed system	networks and ownership of mobile phones in Kenya
Economic	<ul style="list-style-type: none"> Will the projected benefits of the proposed system outweighing predictable expenses? 	<ul style="list-style-type: none"> Benefits of the system outweigh costs since it helped many stakeholders as per system requirements analysis
Schedule	<ul style="list-style-type: none"> Will the project carried out in an acceptable time frame? Was time allocated to the project reasonable and adequate? 	<ul style="list-style-type: none"> The research was carried out in a set of three milestones and deadlines was adhered to A project schedule was prepared and time allocation was enough for completion.
Political	<ul style="list-style-type: none"> How the existing system structure going to work with new system? Will the proposed system bring restructuring of the county government processes? Will the county citizens and other stakeholders resist or accept the proposed system? 	<ul style="list-style-type: none"> The existing system structure worked with system after deployment. The system would help in improving the county government processes as per requirement analysis. All stakeholders used and accepted the system as per requirement analysis
Legal	<ul style="list-style-type: none"> Will proposed system implemented within existing legal requirements? 	<ul style="list-style-type: none"> The research adhered to constitution and county government act of Kenya The research ensured confidentiality of information gathered, privacy of personal information and rights of participants was well protected throughout the research

Table 4 : Feasibility Study

3.3.1.1.2 Requirement gathering

The research was aiming into understanding the monitoring process, existences of any current monitoring systems in order to propose and build a SOA prototype that was to help in improving the public service delivery. For such requirement to be attained the research used several data collection techniques.

The research used closed and open questionnaires to the following Nairobi city county department's officers

- Environment
- Road public works

The research also used structured interviews to the following Nairobi city county sector's officers

- Information communication technology (ICT)
- Monitoring and Evaluation(M & E)

The research also used closed and open questionnaires to the following ward administrators and citizens in Starehe and Mathare Sub County of Nairobi city county government.

- Starehe Sub County wards such Ngara, Pangani, Nairobi central and kariokor.
- Mathare Sub County wards such as Huruma, mabatini ,Ngei and Mlango Kubwa.

I targeted citizens in their meeting points such churches, mosques, meeting hall, sub- county frequency forums meeting places, their business point etc. It enabled to understand, describe how they participate in process of service delivery monitoring and which technology they can use in process of service delivery monitoring.

3.3.1.1.3 Requirement analysis

Requirement analysis is important for understanding business processes, environment and ensuring required measures was incorporated and considerable in the design and development of the service oriented monitoring system. This was referenced for this project;

- Structured interview conducted from M & E officer at M & E sector at Annex house 3rd floor on 4th July 2017
- Structured interview conducted from ICT officer at ICT sector at Annex house 4th floor on 5th July 2017
- Closed and open questionnaire sampled from officers of Environment sector at Annex house 1st floor on 5th July 2017
- Closed and open questionnaire sampled from officers of Road public works sector at city hall 2rd floor on 5th July 2017
- A closed and open questionnaire sampled from ward administrators of Starehe Sub County wards such Ngara, Pangani, Nairobi central and kariokor between 16th June and July 30th 2017.
- A closed and open questionnaire sampled from ward administrators of Mathare Sub County wards such as Huruma, mabatini,Ngei and Mlango Kubwa between 16th June and July 30th 2017.

The analysis from such requirements informed business processes and services as listed below

- | | |
|---|--|
| a) Notifying the issue | f) Reported slip |
| b) Physical confirmation of the issue | g) Notification of issue |
| c) Recording of the issue in official record | h) Verification of issue |
| d) Compiling the notified issues by sector officer or ward administrator | i) Processing the issue |
| e) Reporting of issue | j) Generating report |
| | k) Sharing of data |
| | l) Integration with other systems |

3.3.1.2 Analysis Phase

It Involved process of collecting the actual data, reviewing and studying the processes involved, identifying the problems and recommending appropriate solution that was undertaken and detailing steps in the construction of proposed system. Also it involved study of real business processes, operation procedures and the information flow that enabled in designing solution that aligned to core county goals.

3.3.1.2.1 Population and Sample size

Population is defined as the entire group of individuals, events or objects having a common observable characteristic (Mugenda & Mugenda, 2003). In this research a population was chosen as Nairobi City County as a case study.

Sample size is described as the number of items to be selected from the universe to constitute a sample(Kothari, 2004).

In this study a sample size was chosen which were citizens and administrative leaders in Starehe and Mathare Sub County through simple random sampling and the finding was generalized to whole population. Purposive sampling method was used for selecting sectors of environment and road public works was used because from literature review they were most affected services. The selection of ICT and Monitoring and Evaluation departments was through purposive sampling since they provided valuable information that met the purpose of the research. To attain the sample size, the research used the following formulas as adapted from Kothari and Mugenda

$$n = ((Z\text{-Score}) \times \text{stdDev} \times (1\text{-stdDev})) / (\text{margin of error})$$

Where n = desired sample size,

z- Score is the confidence level; for this research is 95%, thus z- score is 1.96,

stdDev is the variance expected responses which will be 0.5 for this research,

Margin of error will be 5%,

Thus necessary sample size $n = (1.96)^2 \times 0.5 \times (0.5)^2 / 0.05^2 = 384.1$,

According to Mugenda, the following formula was recommended

$$nf = \frac{n}{1 + n/N}$$

This formula was used to calculate sample size, where

nf = desired sample size when the population is less than 10,000,

n = desired sample size when the population is more than 10,000,

N = estimate of the population size (this research set it at 520)

$nf = (385 / (1 + (385/520))) = 221.2$, 221 (*citizens, ward administrator and sectors officers*)

This was number of persons the research was used on requirements gathering.

3.3.1.2.2 Data collection and analysis

These were the views and input collected from the stakeholders such as citizens, ward administrator and sector officers in process of service delivery monitoring.

3.3.1.2.2.1 Analysis of responses from Environment and Road Sectors Officers

The sectors officers were key participants in this research, they were officers responsible in various duties within their sectors, and their participations provided important information regarding this research, below are finding from some of participants conducted through use of closed and open questionnaire;

A) Do they have any information system in place for monitoring service delivery in their sectors?

In the response of 12 participants as shown in table 5 below, the outcome was no information system current in place for service delivery monitoring. From this study it implies that, there is need for system since currently no one in place for service delivery monitoring.

Table 5: Any information system in place for monitoring service delivery

Choice	Frequency	Percentage
Yes	0	0%
No	12	100%
Total	12	100%

B) Do they have any other ways for service delivery monitoring in their sectors?

8 out of 12 participants responded they have other ways as shown in table 6 below.

From the study, 12.5% represent daily, weekly and monthly report which they performance manual within their sectors as other way of monitoring service delivery. 25% they use website to monitoring service delivery, this is through providing official mobile number of their sectors and officers concerned with those sectors. 37.5% they preferred going to field to know issues concerning service delivery. From the study issues done through daily, weekly, monthly report and field visit constitute up to 75%, where the whole process is done manual, clearly explaining the gap which the proposed system enhanced the process of service delivery monitoring.

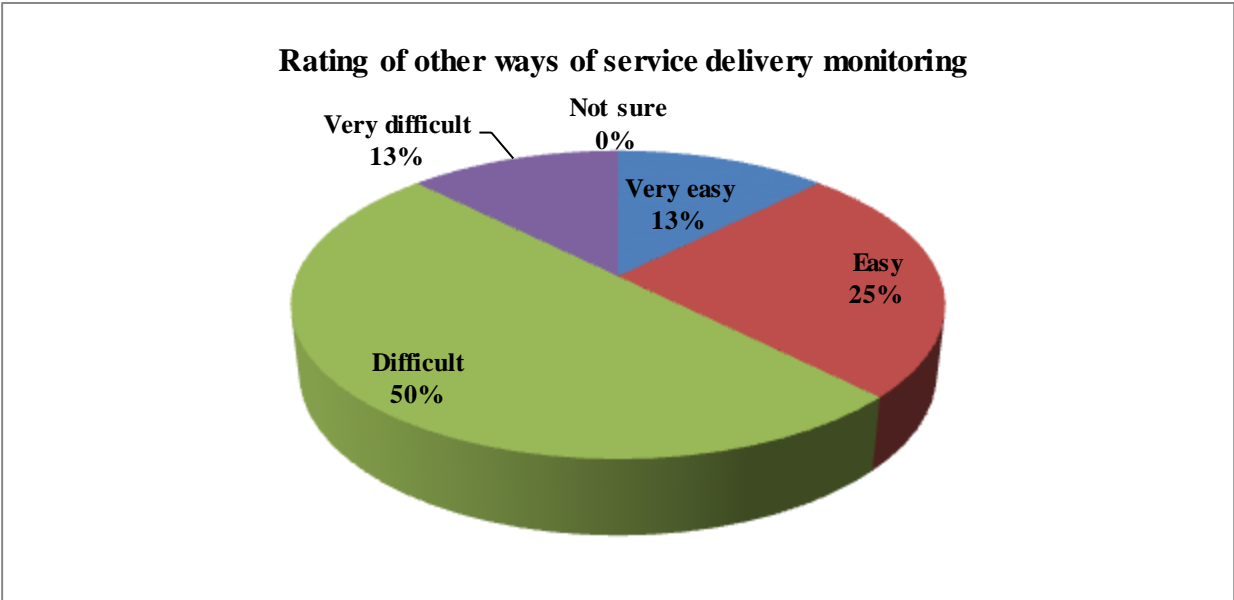
Table 6 : Other ways of monitoring service delivery in their sectors

Methods	Frequency	Cumulative Frequency	Rating in Percentage	Cumulative Percentage
Daily report	1	1	12.5%	12.5%
Weekly report	1	2	12.5%	25.0%
Monthly report	1	3	12.5%	37.5%
Website	2	5	25.0%	62.5%
Field visit	3	8	37.5%	100.0%
Total	8	8	100%	100%

C) How they rated other ways of service delivery monitoring in their sectors

The results are as shown in figure 3 below, out of 8 respondents, 1 respondent chosen very easy representing 13%, 2 respondents chosen easy representing 25%, 4 participants chosen difficult representing 50%, 1 participant chosen very difficult representing 13% and 0% for not sure. The analysis of such rating was evidence that the current other ways for service delivery monitoring are not easy, so the proposed system would aid in improving the current ways.

Figure 3: Rating of other ways of service delivery monitoring



D) What are their experiences in knowing new information of issues concerning service delivery monitoring in their sectors?

The findings are shown in table 7 below.

Table 7 : Experience in knowing issues of service delivery monitoring in their sectors

Rating	Frequency	Cumulative Frequency	Rating in Percentage	Cumulative Percentage
Very easy	1	1	8%	8%
Easy	3	4	25%	33%
Difficult	5	9	42%	75%
Very difficult	2	11	17%	92%
Not sure	1	12	8%	100%
Total	12	12	100%	100%

From the table above in percentage rating for their experience in knowing issues for service delivery monitoring; 8% was for very easy, 25% was for easy, 42% was for difficult, 17% was for very difficult and 8% was for not sure. From respondents was clearly that they experienced difficult in knowing new issues concerning service delivery monitoring.

E) What are major challenges encountered in finding new information of issues concerning service delivery monitoring in their sectors.

From the respondents 20% represented failure of county citizens to report the issues, 47% was for lack of enough resource for service delivery monitoring, 33% was for lack of technology in service delivery monitoring and nil percentage for any other specified and not sure.

Table 8: Challenges in finding issues of service delivery monitoring in their sectors

Challenges	Frequency	Cumulative Frequency	Challenges in Percentage	Cumulative Percentage
County citizen's failure to report	3	3	20%	20%
Lack of enough resource for Monitoring	7	10	47%	67%
Lack of technology in monitoring	5	15	33%	100%
Other specify	0	15	0%	100%
Not sure	0	15	0%	100%
Total	15	15	100%	100%

F) How helpful was in improving service delivery process if an integrated information

system was used to monitor service delivery in their sectors.

Table 9: The rating if integrated information system was used in service delivery process

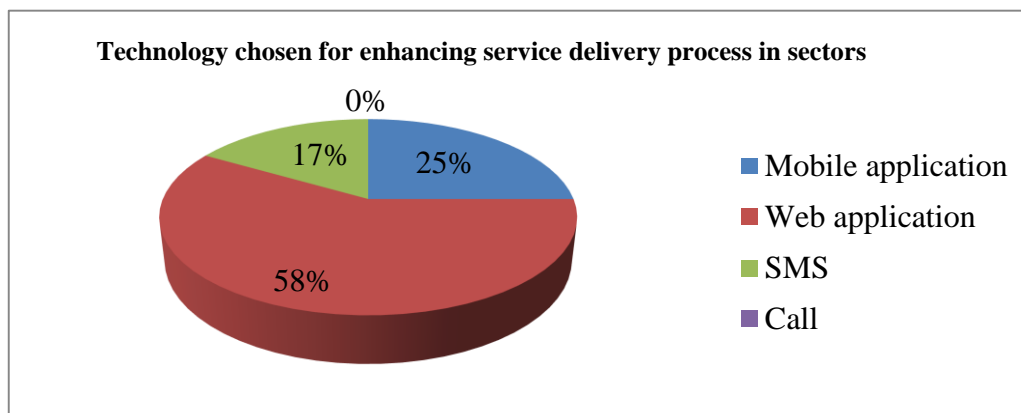
Rating	Frequency	Cumulative Frequency	Rating in Percentage	Cumulative Percentage
Very helpful	6	6	50%	50%
Helpful	6	12	50%	100%
Little help	0	12	0%	100%
Not helpful	0	12	0%	100%
Am not sure	0	12	0%	100%
Total	12	12	100%	100%

From the study 50% was for very helpful and helpful the system will help in process of service delivery. So from analysis was evidence that the proposed system would improve process of service delivery monitoring.

G) Which technology they are likely to use to enhance service delivery monitoring process in their sectors if they are made available to them?

The results are as shown in figure 4 below, out of 12 respondents, 3 respondents chosen mobile application representing 25% , 7 respondents chosen web application representing 58% , 2 participants chosen SMS representing 17% and 0% for call. It was clearly that the most preferred technology for improving service delivery monitoring process was web application, mobile application and SMS respectively.

Figure 4: Technology chosen for enhancing service delivery monitoring process in their sectors



H) If an integrated information system was used to monitor service delivery, how helpful was to their sectors to respond to issues reported by their county citizens?

The results are as shown in table 10 below, out of 12 participants, 7 participants said was very helpful representing 58%, 5 participants said was helpful representing 42% and zero percentage for little help, not helpful and am not sure. The outcome was that, by the use of proposed system would help the sectors respond to issues reported by their county citizens.

Table 10: Responsiveness of their sectors if used integrated information system

Responsiveness	Frequency	Cumulative Frequency	Responsiveness in Percentage	Cumulative Percentage
Very helpful	7	7	58%	58%
Helpful	5	12	42%	100%
Little help	0	12	0%	100%
Not helpful	0	12	0%	100%
Am not sure	0	12	0%	100%
Total	12	12	100%	100%

I) How efficiency was their sectors in delivery their service if an integrated information system was used to monitor service delivery?

The results are as shown in table 11 below, out of 12 participants, 6 participants said was very effective representing 50%, 6 participants said was effective representing 50% and zero percentage was for slightly effective, not effective and I don't know.

The outcome from analysis was; by the use of proposed system would help the sectors to be more efficiency in service delivering monitoring.

Table 11: Efficiency of their sectors if used integrated information system

Efficiency Rating	Frequency	Cumulative Frequency	Efficiency in Percentage	Cumulative Percentage
Very effective	6	6	50%	50%
Effective	6	12	50%	100%
Slightly effective	0	12	0%	100%
Not effective	0	12	0%	100%
I don't know	0	12	0%	100%
Total	12	12	100%	100%

J) Supposed an integrated information system was used to monitor service delivery in their sectors, how would they rate it in improving transparency?

The results are as shown in table 12 below, out of 12 participants, 5 participants said was very helpful representing 42%, 7 participants said was helpful representing 58% and zero percentage for little help, not helpful and am not sure. The use of proposed system would improve transparency in their sectors.

Table 12 : Transparency of their sectors if used integrated information system

Transparency Rating	Frequency	Cumulative Frequency	Transparency in Percentage	Cumulative Percentage
Very helpful	5	5	42%	42%
Helpful	7	12	58%	100%
Little help	0	12	0%	100%
Not helpful	0	12	0%	100%
Am not sure	0	12	0%	100%
Total	12	12	100%	100%

K) How accountability was their sectors if an integrated information system was used to monitor service delivery?

Table 13: Accountability of their sectors if used integrated information system

Accountability Rating	Frequency	Cumulative Frequency	Accountability in Percentage	Cumulative Percentage
Very effective	4	4	33%	33%
Effective	8	12	67%	100%
Slightly effective	0	12	0%	100%
Not effective	0	12	0%	100%
I don't know	0	12	0%	100%
Total	12	12	100%	100%

From the result shown above in table 13, out of 12 participants, 33% was for very effective, 67% was for effective, zero percentage was for slightly effective, not effective and I don't know. It was evidence that the system would improve accountability in their sectors.

3.3.1.2.2.2 Analysis of responses from ICT and M & E Officers

The table 14 below summaries the finding from ICT and M & E officers from the Nairobi county government, the data was collected through structured interview.

Table 14: Finding from ICT and M & E Officers

Structured interview questions	Interview outcome
--------------------------------	-------------------

Do they have any information system for monitoring service delivery?	<ul style="list-style-type: none"> • Currently no information system for monitoring service delivery.
Do they have any other ways of monitoring service delivery?	<ul style="list-style-type: none"> • They use log book
What are their experiences in monitoring service delivery in Nairobi city county government sectors?	<ul style="list-style-type: none"> • It was difficult to them
How do they rate the current service delivery monitoring process in their county government sectors?	<ul style="list-style-type: none"> • It was not easy to them
If integrated information system was used to monitor service delivery in their sectors how would they rate it in improving service delivery process?	<ul style="list-style-type: none"> • It would be very helpful in improving process of service delivery monitoring
Which technologies are suitable for monitoring service delivery within their county government sectors and improve process?	<ul style="list-style-type: none"> • Mobile application and SMS
If an integrated information system was used to monitor service delivery, how helpful was to their sectors to respond to issues reported by their county citizens?	<ul style="list-style-type: none"> • It would be very helpful to enable their sectors respond to issues reported by county citizens
How efficiency was their sectors in delivery their service if an integrated information system was used to monitor service delivery?	<ul style="list-style-type: none"> • It would be very effective in improving efficiency of their sectors
Supposed an integrated information system was used to monitor service delivery in their sectors, how would they rate it in improving transparency?	<ul style="list-style-type: none"> • It would be very helpful in improving transparency in their sectors
How accountability was their sectors if an integrated information system was used to monitor service delivery?	<ul style="list-style-type: none"> • It would be very effective in improving accountability in their sectors

3.3.1.2.2.3 Analysis responses from ward administrators

These are data collected through closed and open questionnaire from wards administrator of two sub-counties;

- Starehe Sub County wards; Ngara, Pangani, Nairobi central and kariokor
- Mathare Sub County wards; Huruma, mabatini, Ngei and Mlango Kubwa

The following were finding from 8 respondents according to different questions;

A) How they rated current method of monitoring service delivery in their wards?

Table 15: Rating of current method of service delivery monitoring in their wards

Rating	Frequency	Cumulative Frequency	Rating in Percentage	Cumulative Percentage
Very effective	1	1	13%	13%
Effective	2	3	25%	38%
Slightly effective	4	7	50%	88%

Not effective	1	8	13%	100%
I don't know	0	8	0%	100%
Total	8	8	100%	100%

From the table 15 above, out of 8 participants, 13% was for very effective, 25% was for effective, 50% was for slightly effective and 13% was for not effective. The current method of service delivery monitoring in their wards was not effective and stand at 63%, combination of slightly effective and not effective hence the proposed system would improve the current methods.

B) What was their experience in knowing new issues concerning service delivery monitoring in their wards?

From the table 16 below, out of 8 participants, there was a tie of 50% for easy and difficult.

Table 16: Experience in knowing issues of service delivery monitoring in their wards

Experience Rating	Frequency	Cumulative Frequency	Experience in Percentage	Cumulative Percentage
Very easy	0	0	0%	0%
Easy	4	4	50%	50%
Difficult	4	8	50%	100%
Very difficult	0	8	0%	100%
Not sure	0	8	0%	100%
Total	8	8	100%	100%

C) What were their major challenges in learning new issues concerning service delivery monitoring in their wards?

Table 17: Challenges in learning new issues of service delivery monitoring in their wards

Challenges	Frequency	Cumulative Frequency	Challenges in Percentage	Cumulative Percentage
County citizen's failure to report	5	5	29%	29%
Distance to cover while investigating the report	2	7	12%	41%
Lack of enough resource in monitoring	6	13	35%	76%
Lack of technology in monitoring process	4	17	24%	100%
Other specify	0	17	0%	100%
Not sure	0	17	0%	100%
Total	17	17	100%	100%

From the table 17 above, 29% was for county citizen’s failure to report, 12% was for distance to cover while investigating the reported issue, 35% was for lack of enough resource in monitoring process and 24% was for lack of technology in monitoring process. The issue of county citizens failure to report could being minimized in the proposed system which integrate the use SMS, mobile application and web application and citizens would have channel of choices for reporting the occurrence of issue. It was clear that; lack of technology in monitoring process was a challenge to them, but this would improve by introduction of system in service delivery monitoring.

D) Suppose an integrated information system was used by wards citizens to inform them about new information of service delivery problems, how would you rate it?

In the table 18 below, out of 8 respondents, 100% responded it would be very helpful in informing issues concerning service delivery.

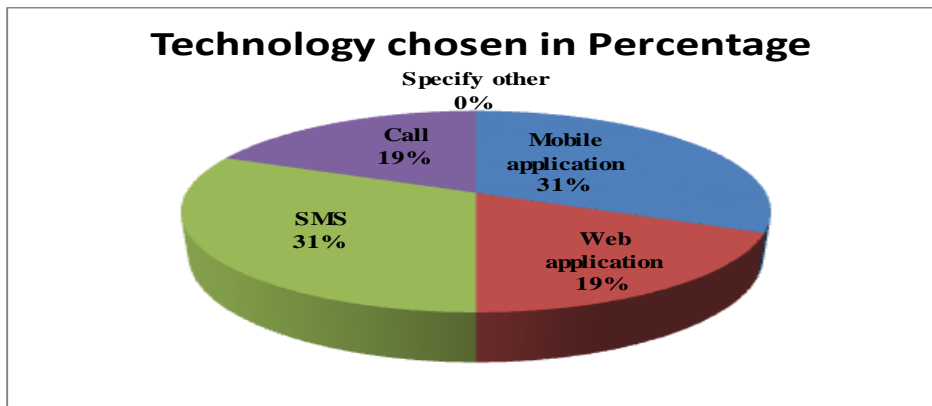
Table 18: Rating of integrated information system in informing service delivery problems

Rating	Frequency	Cumulative Frequency	Rating in Percentage	Cumulative Percentage
Very helpful	8	8	100%	100%
Helpful	0	8	0%	100%
Little help	0	8	0%	100%
Not helpful	0	8	0%	100%
Am not sure	0	8	0%	100%
Total	8	8	100%	100%

E) Suitable technology methods preferred by ward administrators to enable ward residents to use them in service delivery monitoring process

In the figure 5 below, respondents were allowed to choose more than one technology , out of 16 respondents, the most preferred technology method to be used in monitoring process was; mobile application and SMS was 31% out of 5 respondents, 19% was for web application and call out of 3 respondents.

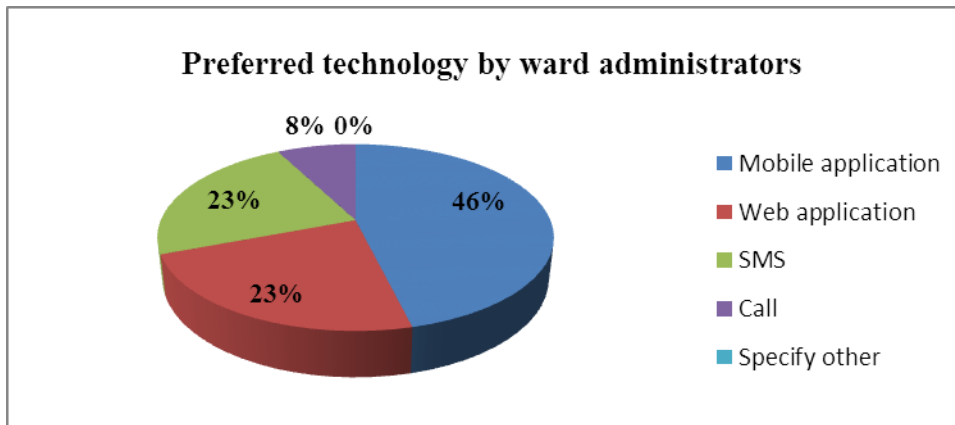
Figure 5: Technology chosen by ward administrators for residents in wards



F) Ward administrator’s technology interaction selected to enhance service delivery monitoring process in their wards

In the figure 6 below, out of 13 respondents, 6 respondents were for mobile application representing 46%, 3 respondents were for web application and SMS representing 23% and 1 respondent was for call representing 8%.

Figure 6: Preferred technology by ward administrators



G) Ward administrators rating current system of monitoring service delivery in their county government?

Table 19: Rating of current system of service delivery monitoring

Rating	Frequency	Cumulative Frequency	Rating in Percentage	Cumulative Percentage
Very effective	1	1	13%	17%
Effective	1	2	13%	33%
Slightly effective	3	5	38%	83%
Not effective	3	6	38%	100%
I don't know	0	6	0%	100%
Total	8	6	100%	100%

In the table 19 above, out of 8 participants, one participant rated very effective and effective representing 13%, 3 participants rated slightly effective and not effective representing 38%. It was clearly that from the outcome finding, the current system for service delivery monitoring was not effective.

H) Rating of an integrated information system if was used to monitor service delivery in their wards and county government sectors in improving responsiveness, efficiency, transparency and accountability

Table 20: Rating of an integrated information system

Rating	Frequency	Cumulative Frequency	Rating in Percentage	Cumulative Percentage
Very helpful	8	8	100%	100%
Helpful	0	8	0%	100%
Little help	0	8	0%	100%
Not helpful	0	8	0%	100%
Am not sure	0	8	0%	100%
Total	8	8	100%	100%

From the table 20 above, out of 8 respondents, they rated 100% if an integrated information system was used to monitor service delivery in their wards and county government sectors in improving responsiveness, efficiency, transparency and accountability.

3.3.1.2.2.4 Analysis responses from county citizens

These are data collected through closed and open questionnaire from wards citizens of two sub-counties;

- Starehe Sub County wards; Ngara, Pangani, Nairobi central and kariokor
- Mathare Sub County wards; Huruma, mabatini, Ngei and Mlango Kubwa

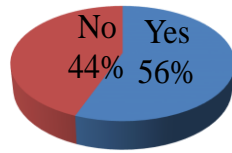
The following were finding according to different questions;

A) Did they notify their wards of new problems in service delivery?

In the figure 7 below of pie chart; out of 199, 111 participants they notified, signifying 56%, 88 participants they have never notified, signifying 44%. It was found that majority of wards citizens they notify respective officers or sectors, but a number of them they do not notify, but they gave reasons why they do not do that.

Figure 7: Problem notification by wards citizens

Problem Notification



B) Participants reason not to notify wards of new problems in service delivery

Table 21: Participants reason for not notifying problems

Reason Choices	Frequency	Cumulative Frequency	Percentage	Cumulative Percentage
Distance to ward office	18	18	20%	20%
Process is tedious	26	44	30%	52%
I feel no need	15	59	17%	69%
I don't know the process	23	82	26%	96%
Other specify	6	88	7%	100%
Total	88	88	100%	100%

In the table 22 above, out of 88 participants, distance to ward office was 20%, process was tedious was 30%, they feel no need was 17%, they don't know the process was 26% and other specify was 7%. The process is tedious was the leading issue, secondly was they don't the process, thirdly was the distance to ward office, they feel no need and least was other reason specified by participants. Such challenges can be overcome by introduction of easy ways to enable wards citizens to report issues concerning service delivery.

C) Participants preferred officers or sector for notifying problems in service delivery

The table 23 below, it describe the officers or the sector which the wards citizens notified the problem. Out of 111 participants, wards administrators was 37%, Chief was 32%, county sectors were 28% and other specified was 4%. It found that most of wards citizens they channeled issue concerning service delivery through wards administrators.

Table 22: Notifying authority by wards citizens

Officers/Sector	Frequency	Cumulative Frequency	Officers/Sector	Cumulative Percentage

Ward Administrator	41	41	37%	37%
Chief	35	76	32%	68%
County Department	31	107	28%	96%
Other Specify	4	111	4%	100%
Total	111	111	100%	100%

D) Methods used by wards citizens to notify problems in service delivery

Table 23: Notification Methods by ward citizens

Notification Methods	Frequency	Cumulative Frequency	Notification Methods in Percentage	Cumulative Percentage
Social media	18	18	16%	16%
Call	19	37	17%	33%
SMS	8	45	7%	41%
Website	7	52	6%	47%
Physical going there	56	108	50%	97%
Specify any other	3	111	3%	100%
Total	111	111	100%	100%

From the table 24 above, out of 111 participants, social media was 16%, Call was 17%, SMS was 7%, website was 6%, physical going there was 50% and other specified was 3%. The preferred way was physical going there, followed by a call, social media, SMS, website and other ways specified by participants.

E) How they rated the current process of monitoring service delivery in their wards

Table 24: Rating of current process of service delivery monitoring in their wards

Process Rating	Frequency	Cumulative Frequency	Process Rating Percentage	Cumulative Percentage
Very easy	5	5	3%	3%
Easy	32	37	16%	19%
Slightly easy	45	82	23%	41%
Not easy	91	173	46%	87%
I don't know	26	199	13%	100%
Total	199	199	100%	100%

From the table 25 above, out of 199 participants, very easy was 3%, easy was 16%, slightly easy was 23%, not easy was 46% and I don't know was 13%. From the result it was found that the current process of monitoring service delivery in their wards by majority decisions it was not easy process.

F) How they rated the current process of monitoring service delivery in their county government?

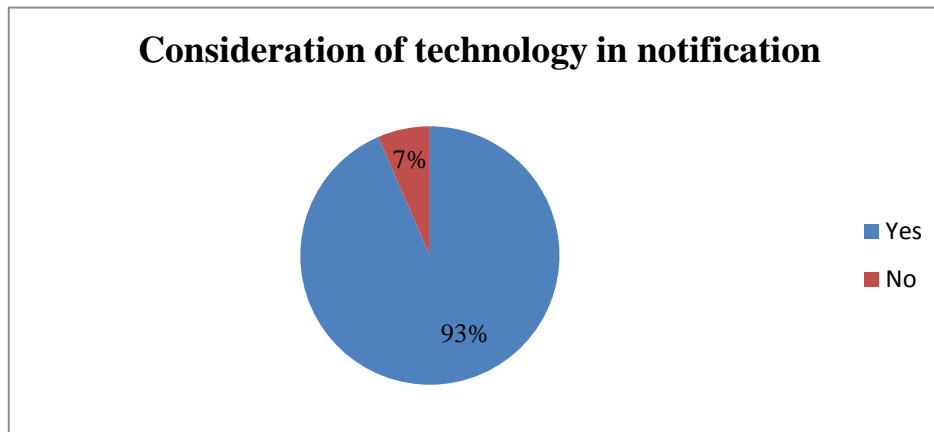
From the table 26 below, out of 199 respondents, very easy was 4%, easy was 11%, slightly easy was 23%, not easy was 50% and I don't know was 13%. The process of service delivery in the county government was found that it was not easy, which was 50% from the result. Such result prompted a question of what can be done to improve such process especially in the service delivery monitoring

Table 25: Rating of current process of service delivery monitoring in their county government

Process Rating	Frequency	Cumulative Frequency	Process Rating in Percentage	Cumulative Percentage
Very easy	7	7	4%	4%
Easy	21	28	11%	14%
Slightly easy	45	72	23%	36%
Not easy	100	172	50%	86%
I don't know	26	199	13%	100%
Total	199	199	100%	100%

G) Could the wards citizens consider use of technology to notify service delivery problems?

Figure 8: Consideration of technology in notification



From the pie chart above, out of 199 respondents, 186 respondents said yes signifying to 93%, 13 respondents said no signifying to 7%. It shown that most respondents would consider use of technology to notify problems in service delivery

H) The technologies which wards citizens would use to notify service delivery problems

In this question the participants were allowed to choose more than one answer, from the table 27 below, out of 219 respondents, mobile application was 42%, Web application was 23%, SMS

was 20% and call was 15%. It was found that most respondents would consider use of mobile application for notifying problem in service delivery, followed by web application, SMS and last was call.

Table 26: Technology chosen for notification

Technology	Frequency	Cumulative Frequency	Technology chosen in Percentage	Cumulative Percentage
Mobile application	92	92	42%	42%
Web application	51	143	23%	65%
SMS	44	187	20%	85%
Call	32	219	15%	100%
Total	219	219	100%	100%

I) How they rated wards administrators effectiveness in attending problems reported concerning service delivery?

Table 27: Effectiveness wards administrators in addressing problems reported

Effective Rating	Frequency	Cumulative Frequency	Effectiveness in Percentage	Cumulative Percentage
Excellent	14	14	7%	7%
Very good	13	27	6.5%	14%
Good	76	103	38%	52%
Poor	85	188	43%	94%
I don't know	11	199	6%	100%
Total	199	199	100%	100%

From the table 28 above, out of 199 respondents, excellent was 7%, very good was 6.5% , good was 38%, Poor was 43% and I don't know was 6%. It was found that by majority decisions wards administrators they do address the problems reported to them.

J) Does the use of technology prior to visiting the wards offices or county sectors would ease service delivery monitoring and it process?

Table 28: Facilitation of service delivery monitoring by use technology

Use of technology	Frequency	Cumulative Frequency	Use of technology in Percentage	Cumulative Percentage
Yes	147	147	74%	74%
No	9	156	5%	78%
May be	28	184	14%	92%
Not Sure	15	199	8%	100%
Total	199	199	100%	100%

From the table 29 above, out of 199 respondents, yes was 74%, No was 5%, maybe was 14% and not sure was 8%. It was found that by majority decision that the use of technology would ease the service delivery monitoring and it process.

K) If communication methods for service delivery monitoring were made available, choose the most preferred methods

Table 29 : Communication methods preferred by wards citizens

Preferred technology	Frequency	Cumulative Frequency	Preferred Technology in Percentage	Cumulative Percentage
Mobile application	86	86	38%	38%
Web application	48	134	21%	60%
SMS	52	186	23%	83%
Call	38	224	17%	100%
Total	224	224	100%	100%

From the table 30 above, the respondents were allowed to select more than one preferred method for service delivery monitoring, out of 224 respondents, mobile application was 38%, web application was 21%, SMS was 23% and call was 17%. The use of mobile application was leading preferred method, followed by SMS, web application and call. Such method was integrated in service oriented monitoring system.

3.3.1.2.2.5 Analysis Summary

Further analysis of current system, method and service delivery monitoring processes as evidenced in the above data collection methods showed that;

- The current processes are difficulty
- The current systems were manual
- Other ways of service delivery monitoring are not easy.
- Difficult experience in knowing issues concerning service delivery.
- Current methods are not effective
- Current systems are not efficiency
- Limitation of integration and sharing of data

3.3.1.2.3 Services Decomposition as Per Analysis

The following were the services breakdown from analysis of existing services portfolio at the Nairobi city county government.

- A) Accessing services
- B) Reporting service
 - Reporting occurrence of issue by citizens

- Sending acknowledgement of received issue
 - Receiving feedback on reported issue via email, SMS
- C) Verification services
- Viewing issues reported by county citizens
 - Verification of occurrence location
 - Resolving or forwarding or rejecting issue from citizens
 - Making the notification feedback
- D) Data consumer services
- Viewing records on reported issues
 - Generating reports
 - Exporting data for use in other applications
- E) Administrator Services
- Registering wards administrators
 - Registering data consumer's user (sectors users)
 - Registering services sectors
 - Registering of ward and sub-counties
 - Viewing reports on resolved or forwarded or rejected events
- F) Integration services
- Integrate with other applications

3.3.1.3 Design Phase

In this phase conceptualized processes and services of analysis requirements were transformed into a set of related, platform interfaces. The project was based on two development approach; one that produced services which was Nairobi City County (service provider) and requestor of services which was the county citizens. It conformed to design principles such as service coupling and cohesion that guaranteed that the services which was developed were self-contained, modular and reusability.

3.3.1.3.1 Design Specifications

It was actualized by the following important two elements specification (Johnstone, 2005)

- **Structural service specification**

In the specifications for the SOA system it was implemented using the RESTful services architectural style. It has standardized interface such HTTP for transmitting data and how the end users can access the services using the unique uniform resource identifier (URI). It integrated use of web platform and mobile; App and SMS who's their components communicated via interfaces which had clearly defined methods and dynamic code hence their way of communicating consisted of independent pairs of requests and responses through service broker.

- **Architectural specification of the system**

It describes the required hardware infrastructures, software components and their interfaces and the established framework for the computer system. It consisted of client and server side infrastructures.

In the **client side infrastructures** it comprised;

- An internet enabled PC which is used by the clients, which are the wards citizens to report an issue and view the status of reported issue. Wards administrators and sectors users were also able to view reported issue to either resolved or forwarded or rejected events. Monitoring and Evaluation to oversee reported events.
- An internet enabled Smartphone which was used by the clients, which are the wards citizens to report an issue and view the status of reported issue. Wards administrators and sectors users were also able to view reported issue to either resolved or forwarded or rejected events. Monitoring and Evaluation to oversee reported events
- Mobile phones which were used by the wards citizens to send and receive update of status of issue reported.

The **server side infrastructures** it consist;

- Web server – Its internet server that hosted web applications of system and enabled HTTP requests, RESTful messages to deliver it services
- Database server- it's a computer program that offered database services to other computer programs or computers and was used by service clients and other external data consumer.
- SMS gateway – was used for integrating SMS in several applications and routing messages to mobile message centers.

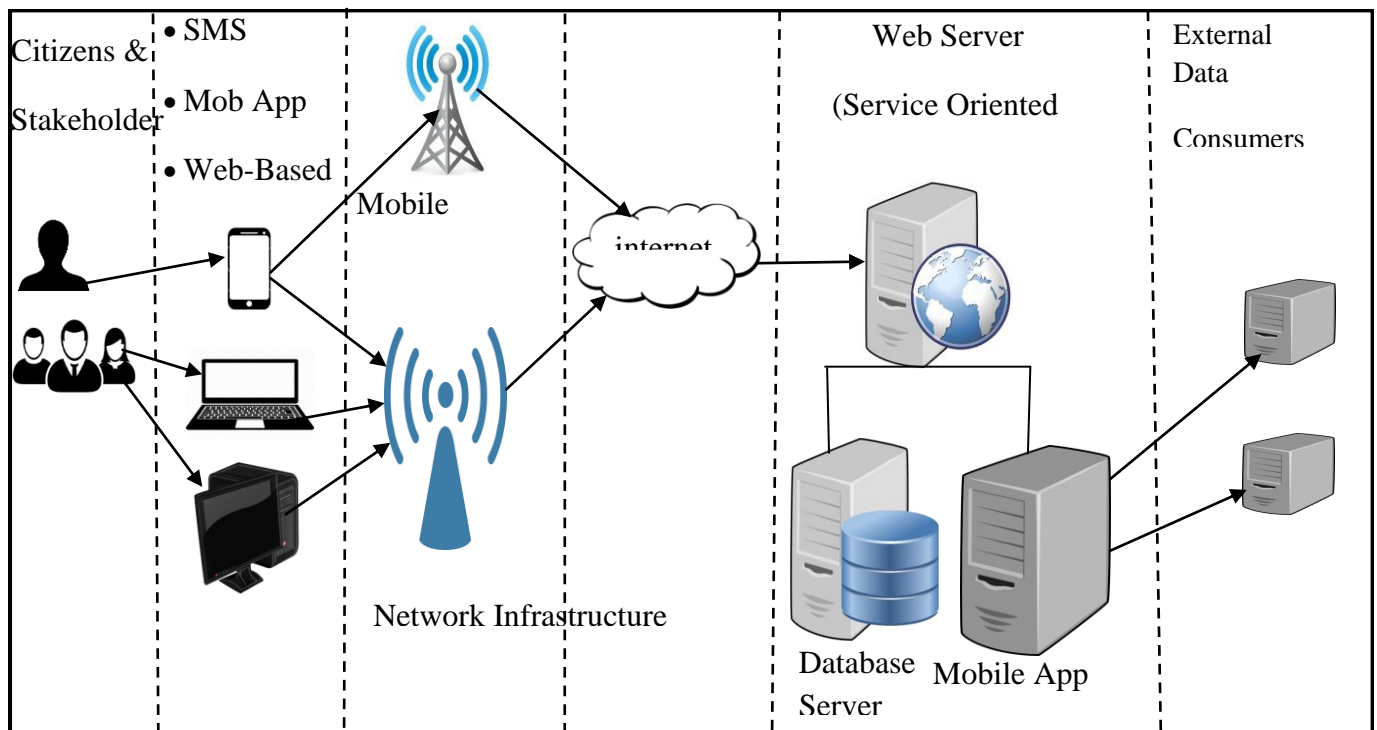


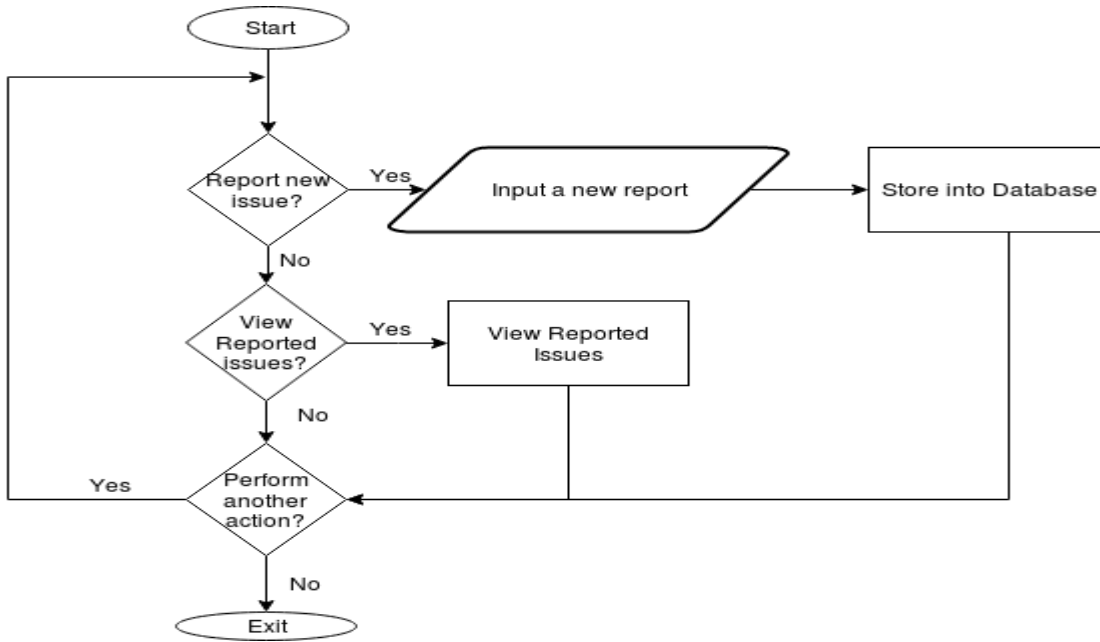
Figure 9: System Architectural Diagram

3.3.1.3.2 System design diagrams

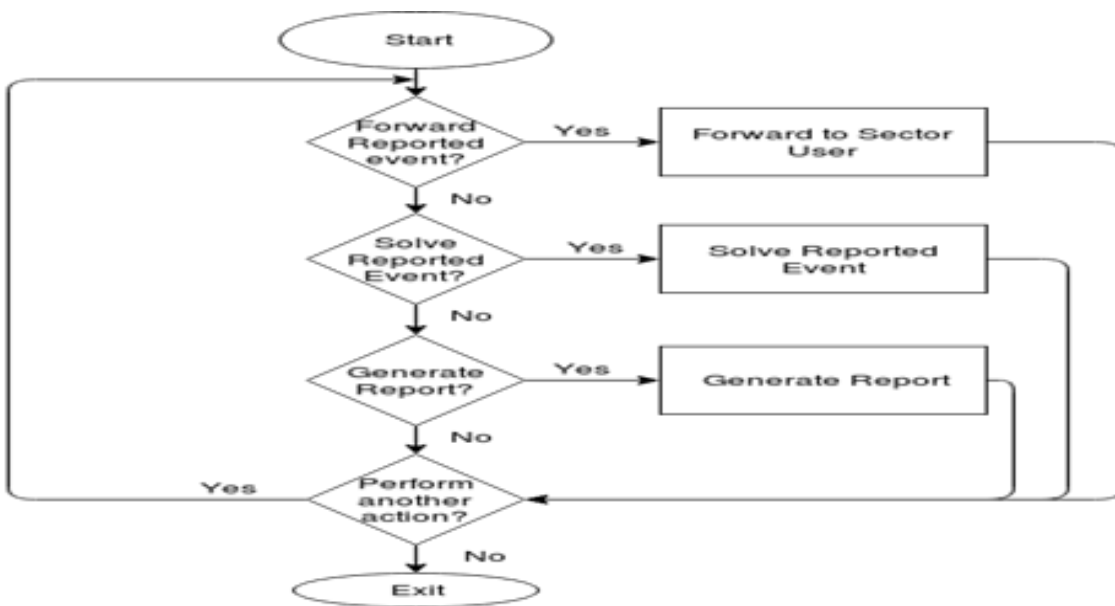
- **Flowcharts**

The following were flowcharts of different actors in this project. They show the processes of each user.

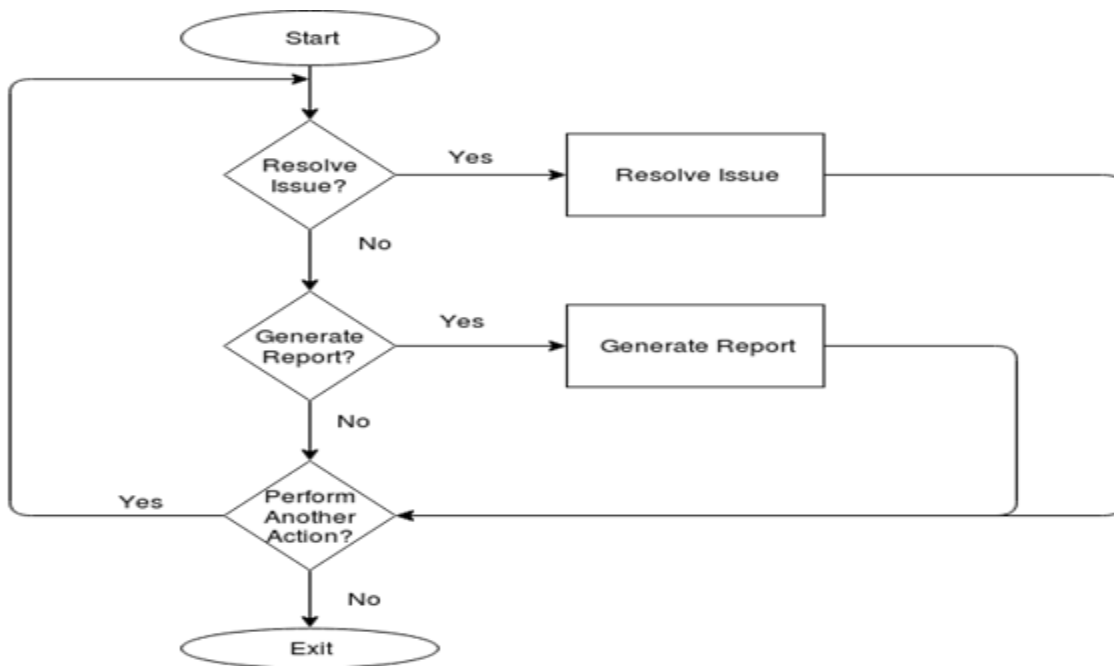
- **Citizens**



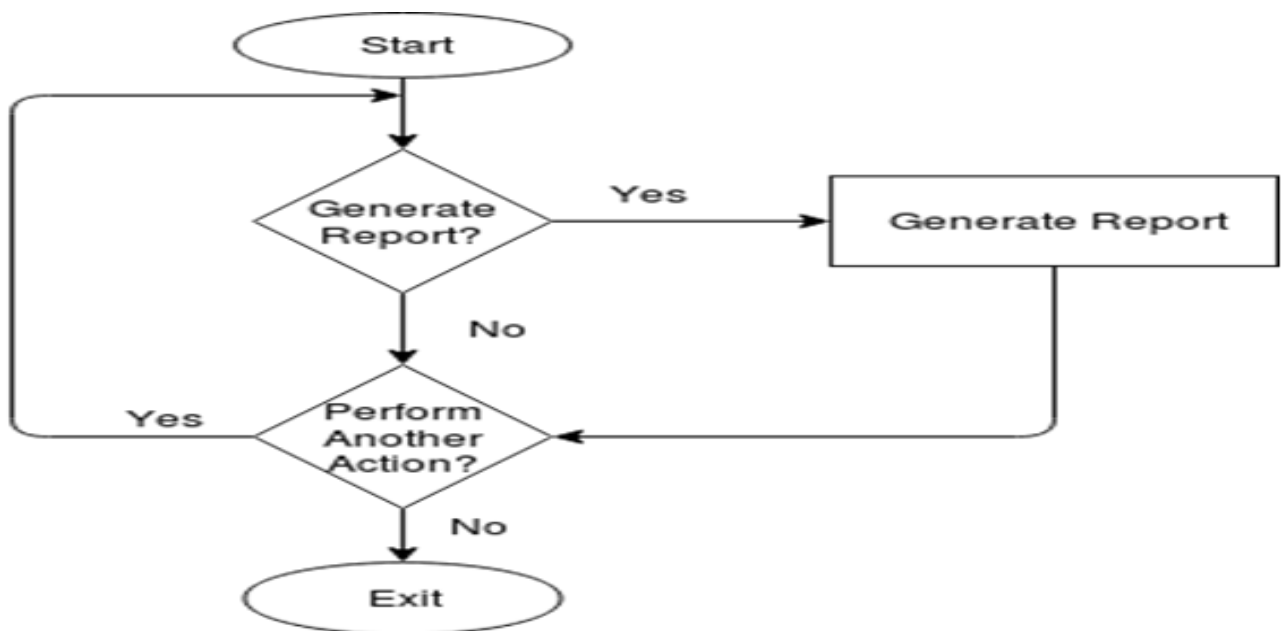
- **Ward administrator**



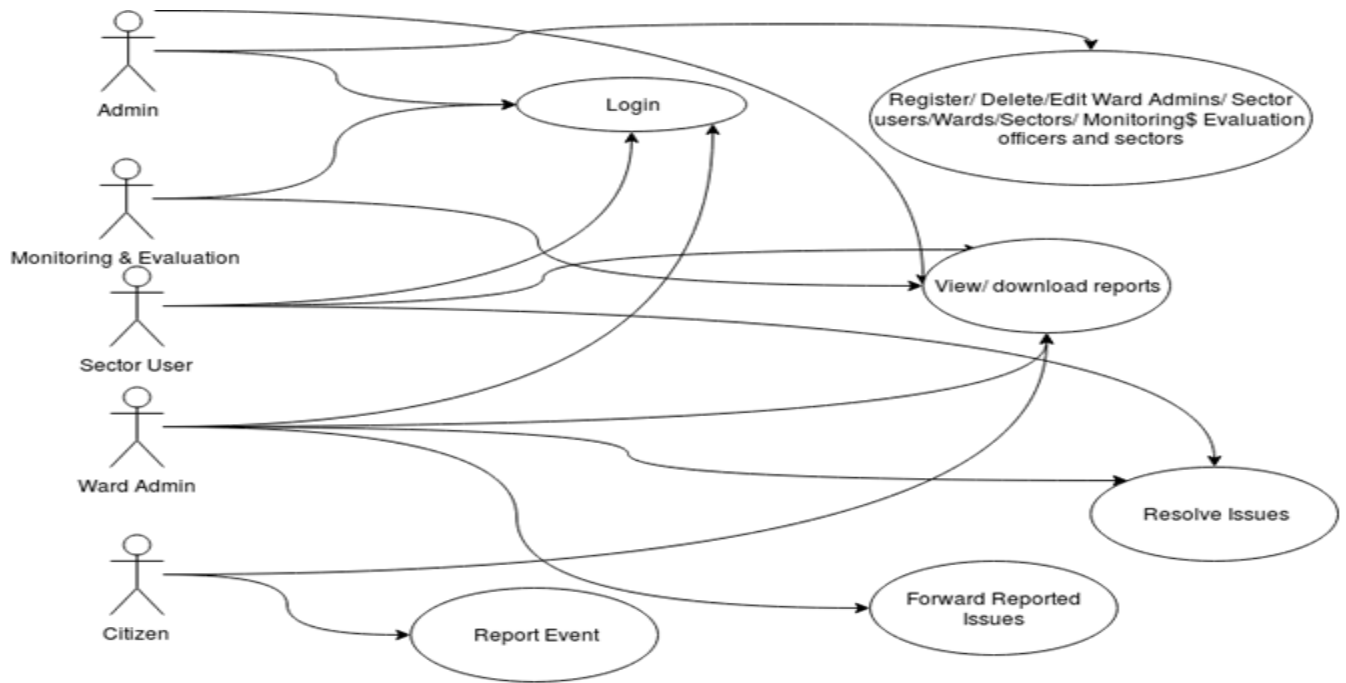
- Sector user



- Monitoring and Evaluation



- **Use case model**



- **Database design**

It describes different SQL tables used for this project

- **Parent sector table**

Field	Data Type	Description
parent_id	Int (Auto_increment)	The primary key of the table
Name	Text	The name of the parent sector

Table 30: Parent sector table

- **Admin table**

Field	Data Type	Description
adminid	Int (Auto_increment)	The primary key of the table
Name	Text	The name of the administrator
Email	Text	The email of the administrator
Telephone	Varchar	The telephone number of the administrator
Password	Text	The password of the administrator
About	Text	About the administrator
Profile_pic	Text	The link to the profile picture of the administrator

Table 31: Admin table

- **Sector user table**

Field	Data Type	Description
userid	Int (Auto_increment)	The primary key of the table
Name	Text	The name of the sector user
Email	Text	The email of the sector user
serviceid	Int	The foreign key to the services table
Telephone	Varchar	The telephone number of the sector user
Password	Text	The password of the sector user
About	Text	About the sector user
Profile_pic	Text	The link to the profile picture of the sector user

Table 32 : sector user table

- **Service table**

Field	Data Type	Description
Serviceid	Int (Auto_increment)	The primary key of the table
Name	Text	The name of the service
Description	Text	The description of the service
Brief	Text	The shortened name of the service
Parentid	Int	The foreign key to the parent_sector table

Table 33: Service table

- **Reports table**

Field	Data Type	Description
Reportid	Int (Auto_increment)	The primary key of the table
Name	Text	The name of the person reporting
Email	Text	The email address of the person reporting
Telephone	Varchar	The telephone number of the person reporting
Wardid	Int	The foreign key to the wards table
Report	Text	The actual report
Status	Text	The status of the reported event
Comments	Text	Comments from sector users or ward administrator after the issue has been resolved
Serviceid	Int	The foreign key to the services table
Longitude	Int	The longitude of the location where the event has been reported
Latitude	Int	The latitude of the location where the event has been reported
Reportdate	Date/time	The date when the event has been reported
Reporttime	Date/time	The time when the event was reported
Attachment	Text	The link to the photo/video that has been attached
Nearest	Int	The nearest location to the reported event
resolver	Text	The person who has resolved the event (sector user/Ward Admin)

Table 34 : Reports table

- **Wards table**

Name	Data Type	Description
wardid	Int (Auto_increment)	The primary key of the table
name	Text	The name of the sub county
sub_countyid	Int	The foreign key to the sub_county table

Table 35 : Wards table

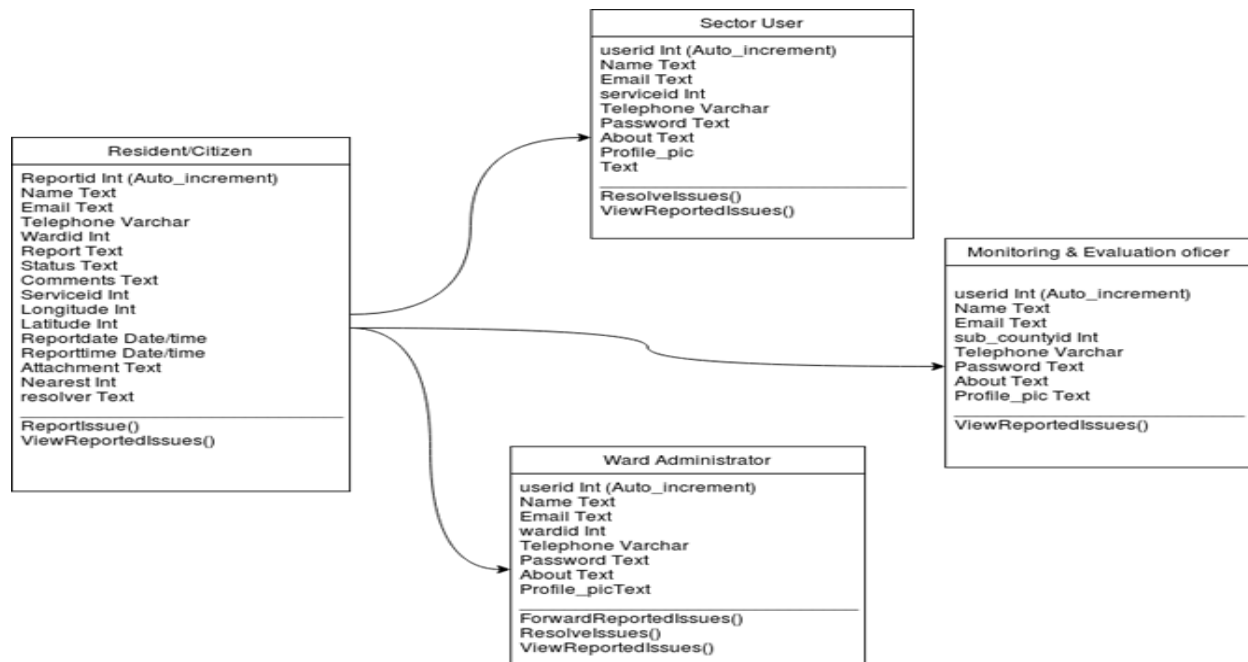
- **Wards admin table**

Field	Data Type	Description
userid	Int (Auto_increment)	The primary key of the table
Name	Text	The name of the ward administrator
Email	Text	The email of the ward administrator
wardid	Int	The foreign key to the wards table
Telephone	Varchar	The telephone number of the ward administrator
Password	Text	The password of the ward administrator
About	Text	About the ward administrator
Profile_pic	Text	The link to the profile picture of the ward administrator

Table 36 : Wards admin table

- **Class diagram**

Figure 10 : Class diagram



- **Entity Relationship Model**

It describes how data was managed in a database in regard to what there is and how it is connected

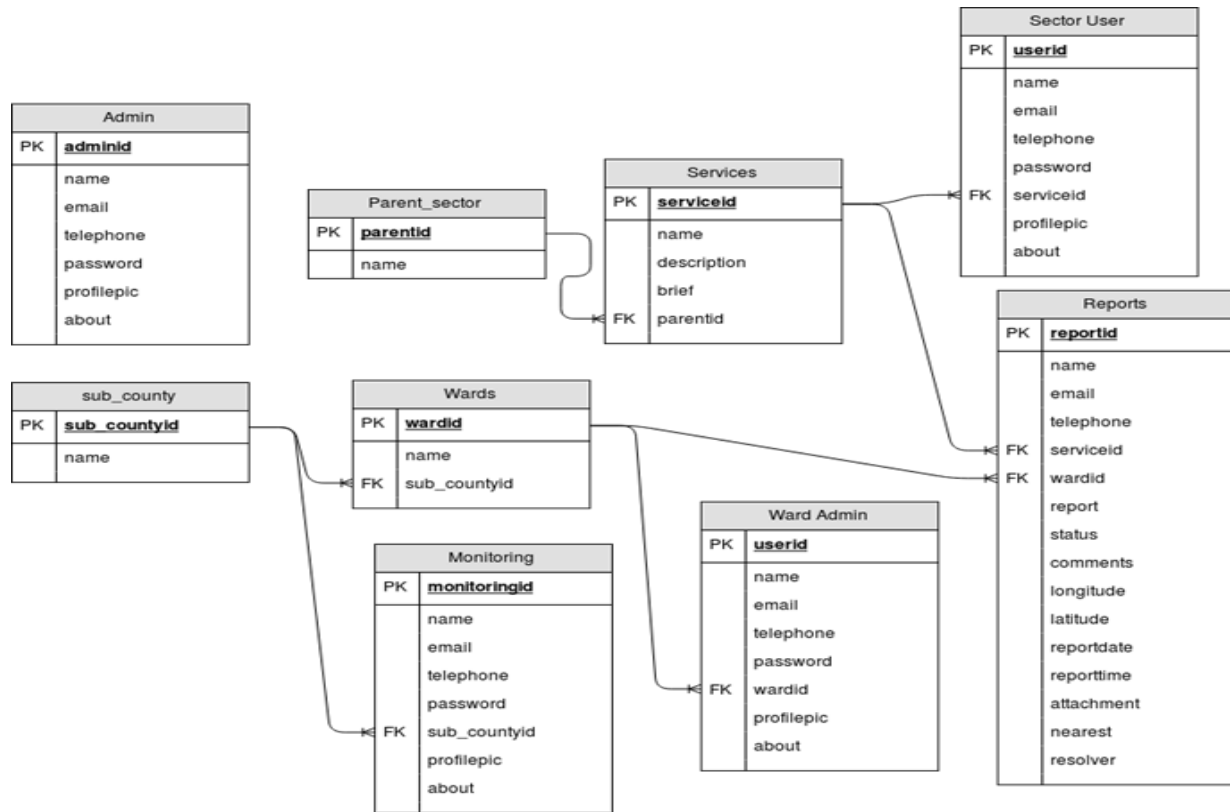


Figure 11: Entity relationship model

3.3.1.3.3 Architectural components descriptions

The web server was used to host all web applications which were developed using PHP language. Apache web server was used to host all web applications. MySQL database management system was used as database server.

Ozeki SMS Gateway was used to send and receive SMS messages; the messages would be transferred to or received from any mobile network in different ways. In this project a setup of a wireless connection was used where GSM Modem with SIM card was installed on PC making it possible to attach to the GSM network.

The HTTP client user on OzekiNG SMS Gateway passes incoming messages in an HTTP GET or an HTTP POST request to external web servers which host the system. The HTML page returned by the external webserver contained response SMS messages or any other outgoing SMS messages which was delivered by Ozeki NG SMS Gateway.

The citizens used mobile phone; SMS, application or web application to report an event, receive notification message, or view status of reported event and download report through appropriate RESTful user designed interface.

The system offered services to service provider; county government sectors, administrative leaders to view reported issue to either resolved or forwarded or rejected events. It was possible through web server which runs a web application where such users were able to access the services over standard interface of HTTP using the unique uniform resource identifier (URI).

3.3.1.4 Construction Phase

It comprised development of web based service oriented monitoring system; implemented and defined services interfaces and it descriptions. All services were defined so as to obey the principles of service-orientation which is an autonomous, loosely coupled, and stateless unit of functionality that is made available by a defined interface.

3.3.1.4.1 The Services Architecture

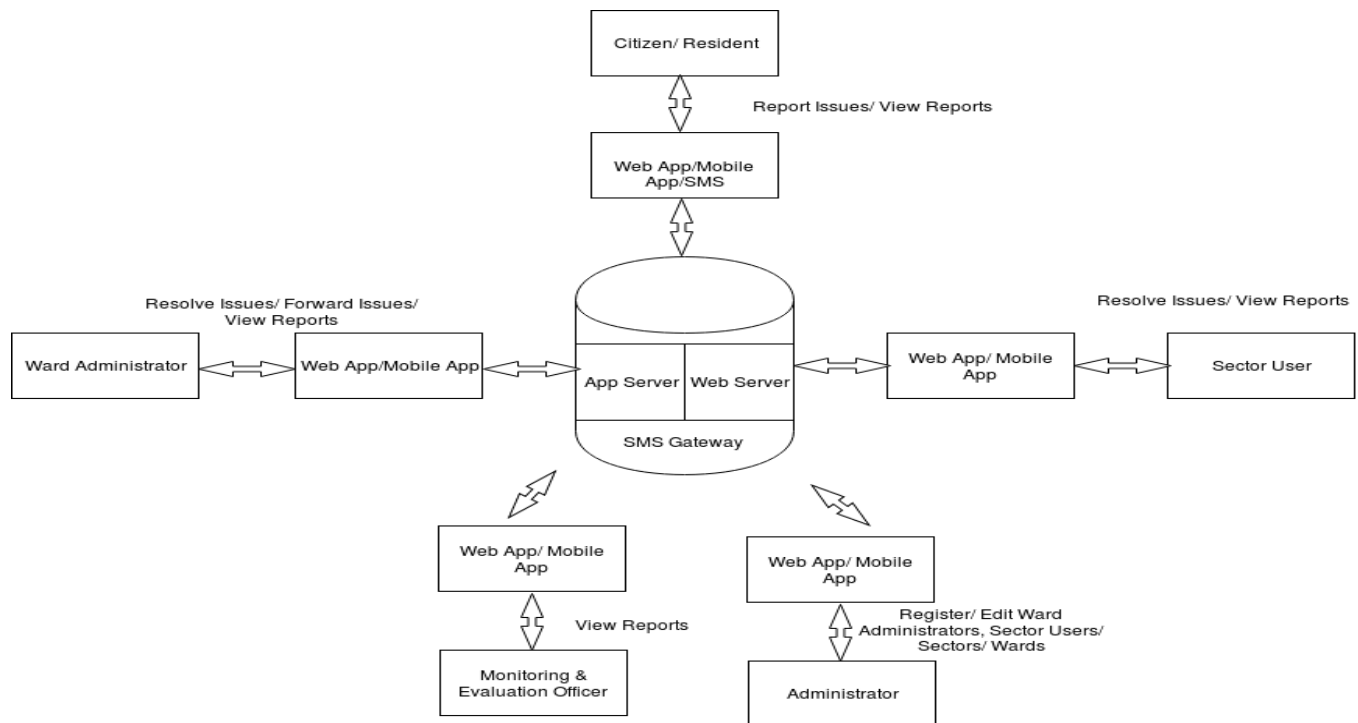


Figure 12 : Services Architecture Model

3.3.1.4.2 Services use description

A three tier model consisting of a mobile app, SMS based system and a web application was used in this project. The different stakeholders were able to interact with the system through these modes.

The different stakeholders were:

- 1. Users (citizens)** – The Citizens were able to interact with the system by use of the three modes. They were able to report events that have occurred using the three modes. Using the mobile web application, they could simply fill a form using the online web portal provided. Filling this form would trigger the information being directed to Apache server for processing and storage. Once the issue has been resolved, they were able to get feedback via SMS or Email. The citizens were also able to view reports and insight of all the reported events and also download reports in PDF format in both the mobile app and the web application.
- 2. The Ward Administrators** – The ward administrators were able to view the reported events in their respective wards through the web portal and the mobile app. They were able to take action on the reported events through the three platforms or they could resolve or forward the events to the respective concerned sector users. They were also able to generate reports and view insights of their respective wards. Apart from that, they were able to view reports of all other wards and sectors, but they could take no action.
- 3. The Sector Users** – The sector users were responsible for resolving issues forwarded to them by the ward administrators. They were able to do so using their respective mobile and web portals. Once resolved, the message would be sent to the respective sector users. They were also able to generate and download reports in PDF format.
- 4. The monitoring and Evaluation team** – The monitoring and evaluation team were responsible for seeing if the issues being reported by the citizens were real and if action was taken by the ward administrators and the sector users. They had their own web portal and mobile page where they could view the reported issues and confirm if the issues were resolved. They were able to generate reports and download them in PDF format.

3.3.1.4.3 Service Interfaces

The interfaces are essential for providing a link between the system users and the system itself. They provided a platform for sending input to the system and relaying output to the user.

Below are the interfaces that were created.

1. Web application

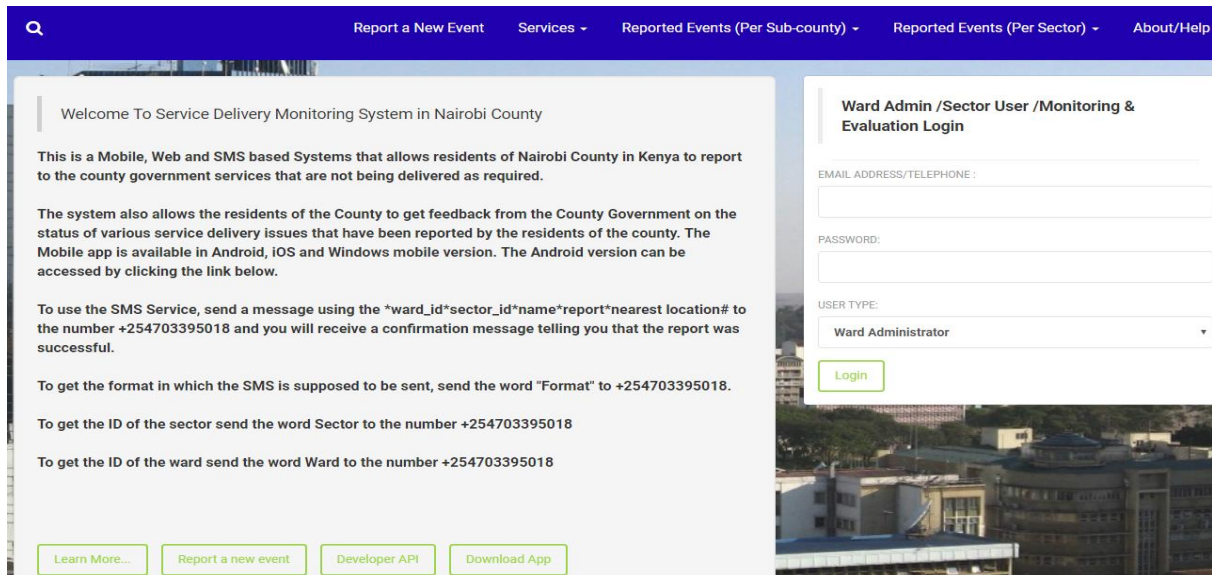


Figure 13: Web application

2. Mobile Application

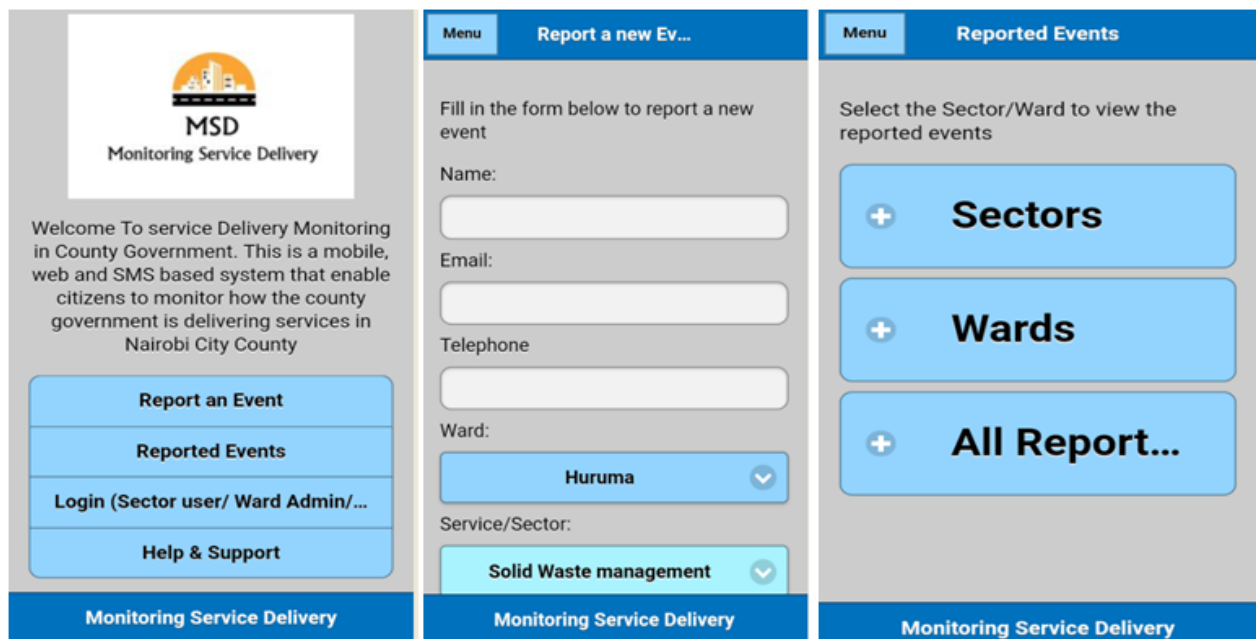


Figure 14: Mobile application

3. SMS based system

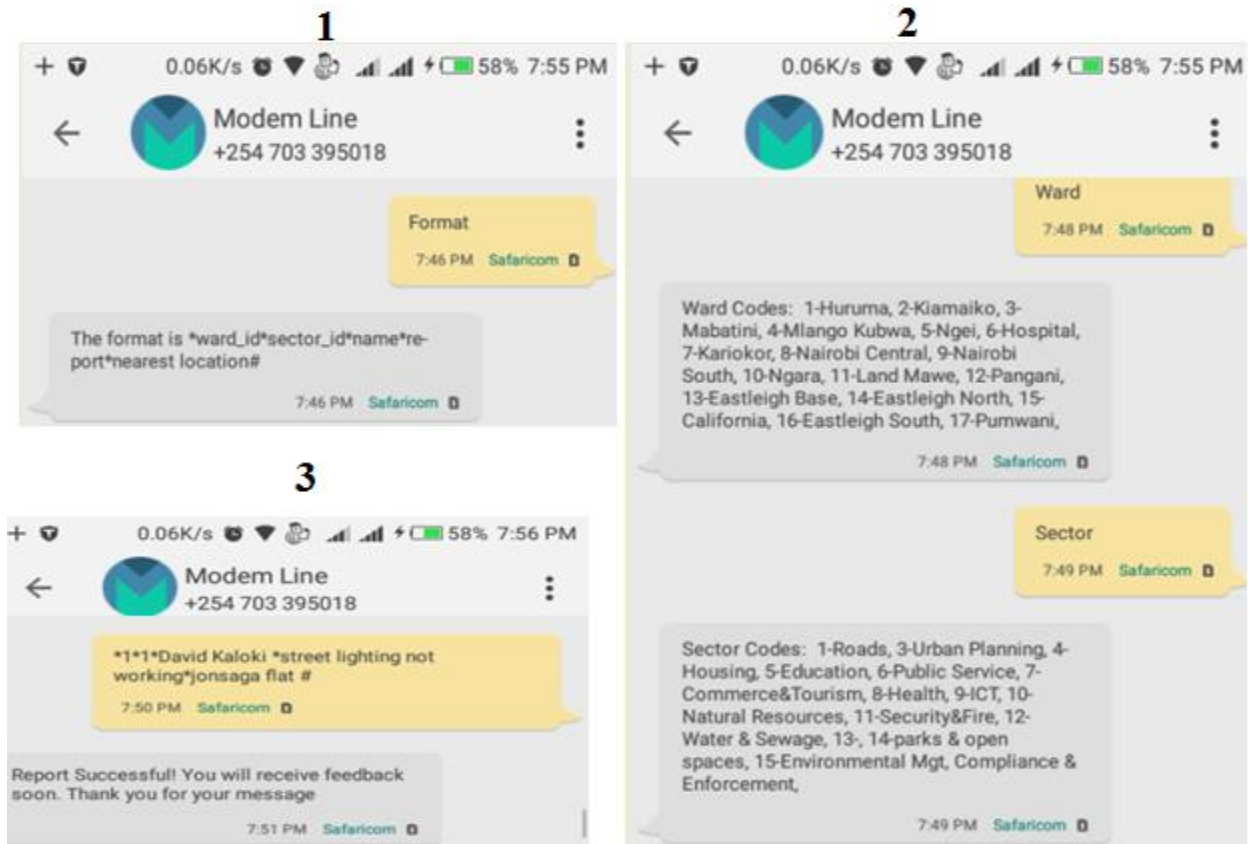


Figure 15 : Example of SMS

3.3.1.4.4 Construction tools

3.3.1.4.4.1 Hardware Resources

1. Laptop
2. Modems for the SMS gateway
3. Phones (a smartphone and normal phone for testing)

3.3.1.4.4.2 Software Resources

The success of this project relies on several software applications.

- 1) **Sublime Text** -A light-weight text editor that is custom made for web and software development
- 2) **Bootstrap** – It is open-source front-end application used in constructing websites and web applications.
- 3) **PHP Version 7**– This is a server side web programming language that was used for creating web based applications that run on apache server.
- 4) **JavaScript** It is a lightweight web scripting language that can be embedded into HTML. It is used to make websites to be interactive.

- 5) **Jquery Mobile** this is a platform that is used to create mobile applications using CSS 3, HTML 5 and JavaScript. It creates light weight and responsive mobile based application that can run on various platforms.
- 6) **Cordova/Phonegap** -This is an app for converting jquery mobile or angular JavaScript mobile apps to be native.
- 7) **JSON** - JavaScript Object Notation it's a minimal, readable format for structuring data. It is used to transmit data between a server and web application.
- 8) **Ozeki SMS Gateway** – This is a gateway that enables the interaction between SMS users and other application. It uses and API.
- 9) **Apache** – This is a web server that is able to run PHP.
- 10) **MySQL Database** – This was used for storing data. The data can be retrieved using PHP or other programming languages.

3.3.1.5 Testing Phase

Its validation process that ascertains that the needed requirements of the system have being met and the outcomes are acceptance with standards of analysis, design and implementation phases of the proposed system. It provided needed feedbacks that helped in improving expected users' needs in reporting, notifications and accessing to monitoring of service delivery in system. I performed the following testing in this system (Shelly & Rosenblatt, 2012)

- **Unit testing** – it's testing of individual program or module and will be performed after development in iterative manner to ensure expected standards are meets. It's done to ensure correct data input and output in each module is expected.

Each unit was tested individually starting from the web application, the mobile app and SMS based system. This was to ensure that each module was working accurately as required as unit. The result of the test showed that all the modules were working as required. All this modules were tested with wards citizens.

- **SMS**

It was tested based on the following functionality analyzed using IBM SPSS;

SMS is easy to use.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	30	37.5	37.5	37.5
	Agree	45	56.3	56.3	93.8
	Strongly Agree	5	6.3	6.3	100.0
	Total	80	100.0	100.0	

Table 37: SMS is easy to use

From the table 38 above, out of 80 participants, slightly agree was 37.5%, agree was 56.3% and strongly agree was 6.3%. It was found that, participants agreed SMS was ease of use with highest percentage of 56.3%.

The use of SMS is effective and efficient.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	34	42.5	42.5	42.5
	Agree	36	45.0	45.0	87.5
	Strongly Agree	10	12.5	12.5	100.0
	Total	80	100.0	100.0	

Table 38: SMS is effective and efficient

From the table 39 above, out of 80 participants, out of valid options; slightly agree was 42.5%, agree was 45% and strongly agree was 12.5%. It was found that, participants rated use of SMS was effective and efficient with highest percentage 45%.

Do you consider acceptability of SMS if deployed to all citizens?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agree	6	7.5	7.5	7.5
	Slightly Agree	27	33.8	33.8	41.3
	Agree	31	38.8	38.8	80.0
	Strongly Agree	16	20.0	20.0	100.0
	Total	80	100.0	100.0	

Table 39: Acceptability of SMS to citizens

From the table 40 above, out of 80 participants, Not Agree was 7.5%, Slightly Agree was 33.8%, Agree was 38.8% and Strongly Agree was 20%. It was found that, participants agree use of SMS will be accepted by all citizens if deployed to them.

SMS performed well.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agree	3	3.8	3.8	3.8
	Slightly Agree	28	35.0	35.0	38.8
	Agree	33	41.3	41.3	80.0
	Strongly Agree	16	20.0	20.0	100.0
	Total	80	100.0	100.0	

Table 40: SMS Performance

From the table 41 above, out of 80 participants, Not Agree was 3.8%, Slightly Agree was 35%, Agree was 41.3% and Strongly Agree was 20%. The general output on SMS performance was agreed by participants.

- **Mobile Application**

It was tested based on the following functionality analyzed using IBM SPSS;

Use of the mobile application is effective and efficient

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	17	21.3	21.3	21.3
	Agree	34	42.5	42.5	63.7
	Strongly Agree	29	36.3	36.3	100.0
	Total	80	100.0	100.0	

Table 41: mobile application effective and efficient

From the table 42 above, out of 80 participants, slightly agree was 21.3%, agree was 42.5% and strongly agree was 36.3%. The output of testing mobile application effective and efficient was agreed.

The mobile application is easy to use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	20	25.0	25.0	25.0
	Agree	42	52.5	52.5	77.5
	Strongly Agree	18	22.5	22.5	100.0
	Total	80	100.0	100.0	

Table 42: mobile application ease of use

From the table 43 above, out of 80 participants, slightly agree was 25%, agree was 52.5% and strongly agree was 22.5%. The output of testing mobile application ease of use was highly agreed in valid option given.

Do you consider acceptability of this mobile application if deployed to all citizens?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agree	5	6.3	6.3	6.3
	Slightly Agree	23	28.7	28.7	35.0
	Agree	38	47.5	47.5	82.5
	Strongly Agree	14	17.5	17.5	100.0
	Total	80	100.0	100.0	

Table 43: Acceptability of mobile application to citizens

From the table 44 above, out of 80 participants, Not agree was 6.3%, slightly agree was 28.7%, agree was 47.5% and strongly agree was 17.5%. The output of testing mobile application acceptability if deployed to all citizens in their county was highly agreed.

The use of the mobile application performed well.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agree	3	3.8	3.8	3.8
	Slightly Agree	27	33.8	33.8	37.5
	Agree	32	40.0	40.0	77.5
	Strongly Agree	18	22.5	22.5	100.0
	Total	80	100.0	100.0	

Table 44: Performance of mobile application

From the table 45 above, out of 80 participants, Not agree was 3.8%, slightly agree was 33.8%, agree was 40% and strongly agree was 22.5%. The output of testing performance of mobile application was highly agreed.

▪ **Web application**

It was tested based on the following functionality analyzed using IBM SPSS;

The use of web application provides efficiency and effectiveness

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Slightly Agree	8	10.0	10.0	10.0
Agree	33	41.3	41.3	51.2
Strongly Agree	39	48.8	48.8	100.0
Total	80	100.0	100.0	

Table 45: web application efficiency and effectiveness

From the table 46 above, out of 80 participants, slightly agree was 10%, agree was 41.3% and strongly agree was 48.8%. The output clearly demonstrated the use of web application was highly efficiency and effective.

The web application is ease to use.

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid Slightly Agree	19	23.8	23.8	23.8
Agree	47	58.8	58.8	82.5
Strongly Agree	14	17.5	17.5	100.0
Total	80	100.0	100.0	

Table 46: Ease of use of web application

From the table 47 above, out of 80 participants, slightly agree was 23.8%, agree was 58.8% and strongly agree was 17.5%. The output clearly demonstrated the use of web application was ease of use having 58.8% agreed.

Do you consider acceptability of this web application if deployed to all citizens?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Not Agree	2	2.5	2.5	2.5
Slightly Agree	10	12.5	12.5	15.0
Agree	39	48.8	48.8	63.7
Strongly Agree	29	36.3	36.3	100.0
Total	80	100.0	100.0	

Table 47: Web application acceptability to citizens

From the table 48 above, out of 80 participants, Not agree was 2.5%, slightly agree was 12.5%, agree was 48.8 and strongly agree was 36.3%. The output of acquiring the acceptability of web application if deployed to all citizens within the county was agreed.

The use of web application performed well.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Slightly Agree	21	26.3	26.3	26.3
Agree	45	56.3	56.3	82.5
Strongly Agree	14	17.5	17.5	100.0
Total	80	100.0	100.0	

Table 48: Performance of web application

From the table 49 above, out of 80 participants, slightly agree was 26.2%, agree was 56.3% and strongly agree was 17.5%. The output clearly demonstrated the performance of web application was highly agreed.

- **Access testing**

The system users were authenticated before gaining access to the system. The authentication was done as follows: the users (sectors, ward admin, M & E officers) entered their usernames and passwords before gaining access to the system. If the username and password matched the ones in the database, the user was granted access to the system. If the two did not match, there was an error message that was given and the user was given another chance to try to login again.

- **Data Entry Testing**

Test data was entered into the fields to ensure that the system was able to capture data and save it into the database. If the data is not entered into the database, an error is displayed. If the data is entered, a success message is displayed.

- **Integration testing**

It's testing where modules depend on each other's. It was done to ensure smooth integrated modules and in iteratively manner in the system. It checked whether the system interfaces links has integrated well with other systems and data sharing. The user simply enters the URL that has the API and he/she is able to access data in JSON format.

3.3.1.6 The Service Provisioning Phase

It's a complex combination of technical and business aspects for supporting service client's activities and involves choices for service governance, service enrolment and managing operations that control the behavior of services during its use. In service governance it aligned the selected county government sectors processes into system components. In service enrolment; it transformed the selected sectors, wards into services via published and discoverable interfaces. In managing operations that control the services, it involved enrolment of sectors users, wards user to the services and having control authentications.

3.3.1.7 Deployment Phase

It's rolling out the system to wards citizens, wards administrators and sectors users. Some of the tasks in this phase include publication of services interfaces and services implementation descriptions. All these tasks were performed using RESTful services architectural style.

All the components of the system (mobile, web and SMS) communicates through interfaces, which have clearly defined methods and dynamic code. The communication consisted of independent pairs of request and responses. Thus each module or component of the system platform (mobile, web and SMS) was treated independently though the three modules were integrated.

3.3.1.8 Execution Phase

This phase ensured deployment and operationally of web services of system. The service requester was finding the service definition and invoking all defined service operations. The run-time functions included static and dynamic binding, service interaction of RESTful service architectural style, messaging and interactions with back-end legacy systems. The system executed different reports in PDF for different services of wards and sectors. An example of report generated by ward administrator of Nairobi central ward

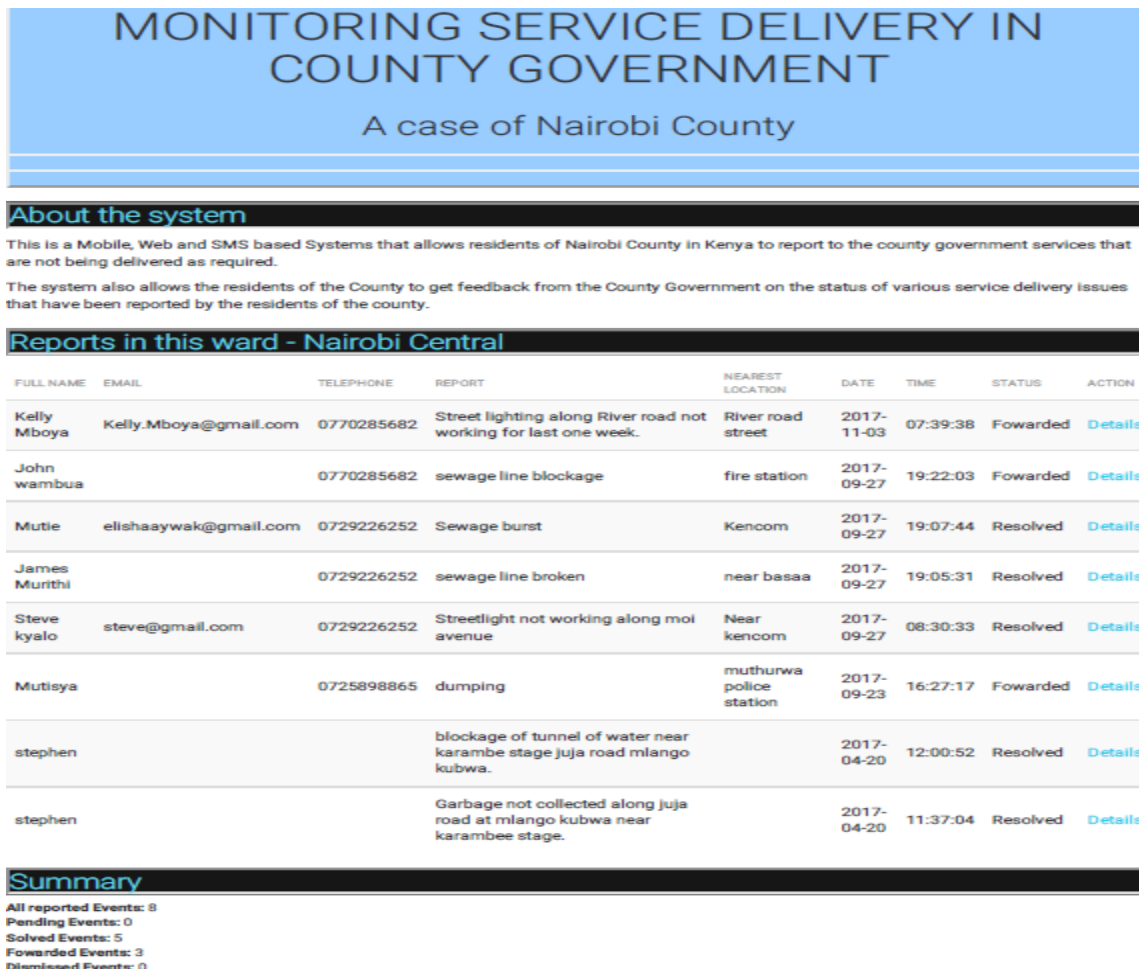


Figure 16: Report of Nairobi central ward

3.3.1.9 Monitoring Phase

This phase was concerned with service level measurement and monitoring which is continuous and closed-loop way of measuring, monitoring, reporting, improving the quality of service of systems and applications delivering by the service- oriented solution. It's a methodology for establishing acceptable levels of service that addressed business objectives and processes. It was done through sectors user's feedbacks on functionality performance of the system.

3.3.1.9.1 System Evaluation

The following was evaluated from the sectors users (Ward administrators, ICT, Environment, Road and lighting and M & E). They evaluated functionality performance of the service oriented monitoring system, on a five point Likert scale (1-5). I used IBM SPSS to analyze the data.

The system provides efficiency

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Agree	7	43.8	43.8	43.8
Strongly Agree	9	56.3	56.3	100.0
Total	16	100.0	100.0	

Table 49: Efficiency of System

From the table 50 above out of 16 respondents, those agree was 43.8% and strongly agree was 56.3%, It was found out that the system was very efficiency in monitoring service delivery.

The service oriented monitoring system is responsive.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Slightly Agree	4	25.0	25.0	25.0
Agree	6	37.5	37.5	62.5
Strongly Agree	6	37.5	37.5	100.0
Total	16	100.0	100.0	

Table 50: Responsiveness of service oriented monitoring system

From the table 51 above, out of 16 respondents, slightly agree was 25%, agree was 37.5% and strongly agree was 37.5%, It shown that the system was very responsive in monitoring service delivery.

The system gave information for solving reported problems.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't Agree	1	6.3	6.3	6.3
	Slightly Agree	2	12.5	12.5	18.8
	Agree	1	6.3	6.3	25.0
	Strongly Agree	12	75.0	75.0	100.0
	Total	16	100.0	100.0	

Table 51: Provision of information by system

From the table 52 above, out of 16 respondents, don't agree was 6.3%, slightly agree was 12.5%, agree was 6.3% and strongly agree was 75%, It was found out that the system provided information on reported problems concerning service delivery to various sectors user.

The system improves service delivery monitoring processes.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't Agree	1	6.3	6.3	6.3
	Slightly Agree	1	6.3	6.3	12.5
	Agree	3	18.8	18.8	31.3
	Strongly Agree	11	68.8	68.8	100.0
	Total	16	100.0	100.0	

Table 52: System improves processes of service delivery monitoring

From the table 53 above, out of 16 respondents, don't agree was 6.3%, slightly agree was 6.3%, agree was 18.8% and strongly agree was 68.8%, It was found out that the system highly improved the process of service delivery monitoring in the sectors.

The system improves transparency.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	6.3	6.3	6.3
	Agree	8	50.0	50.0	56.3
	Strongly Agree	7	43.8	43.8	100.0
	Total	16	100.0	100.0	

Table 53 : System improved transparency

From the table 54 below, out of 16 respondents, slightly agree was 6.3%, agree was 50% and strongly agree was 43.8%, It was found out that the system improved transparency in various sectors.

The system provides user dependence.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't Agree	1	6.3	6.3	6.3
	Slightly Agree	3	18.8	18.8	25.0
	Agree	4	25.0	25.0	50.0
	Strongly Agree	8	50.0	50.0	100.0
	Total	16	100.0	100.0	

Table 54 : Users dependence on system

From the table 54 above, out of 16 respondents, don't agree was 6.3%, slightly agree was 18.8%, agree was 25% and strongly agree was 50%, It was found out that the system highly provided users dependence in the process of service delivery monitoring in their sectors.

The output information from system improves public service delivery and decision making processes.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	3	18.8	18.8	18.8
	Agree	2	12.5	12.5	31.3
	Strongly Agree	11	68.8	68.8	100.0
	Total	16	100.0	100.0	

Table 55 : System improves public service delivery

From the table 55 above, out of 16 respondents, slightly agree was 18.8%, agree was 12.5% and strongly agree was 68.8%, It was found out that the system would improve public service delivery and decision making processes.

The system improves accountability

From the table 56 below, out of 16 respondents, slightly agree was 6.3%, agree was 31.3% and strongly agree was 62.5%, It was found out that the system improved accountability in various sectors.

Table 56 : System improve accountability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Slightly Agree	1	6.3	6.3	6.3
	Agree	5	31.3	31.3	37.5
	Strongly Agree	10	62.5	62.5	100.0
	Total	16	100.0	100.0	

Chapter Four: Results and Discussions

4.1 System functionality testing

The system after the development was tested by various stakeholders. The researcher issued questionnaires to various stakeholders upon testing it to evaluate the functionality performance of the system.

The testing was done to users of sectors (Ward administrators, ICT Officers, Environmental Officers, officers in Road and lighting and M & E) and wards citizens. The testing results indicated that;

The system was efficiency on service delivery monitoring; it provided accessible, understandable, relevant and timely information to sectors users which was rated 56.3%. The system was able to analyze reported problems and generate report in PDF to different sector users.

The system was responsiveness on service delivery monitoring; the reported problems was directed to concern ward administrator or sector user contributing to citizen's demand for better service delivery, It also taken short time to report problem to sector users by use of SMS, mobile Application or Web application or got respond from them and the citizens were able to track the progress of reported issues on the system. The result indicated that by majority rating of 75% of sectors users, the system was responsive.

The system was able to improve current service delivery monitoring process which from data analysis was not easy; the integration of county government service in the system made the process easier for citizens to interact to them by use of three modes of communication (SMS, Mobile application and Web application). The results found that 87.6% overall rating by sectors users the system improved the current processes.

The system provided information for solving reported problems by citizens; the ward administrators were able to view the reported events in their respective wards through the web portal and the mobile app. They were able to take action on the reported events through the three platforms or they could resolve or forward the events to the respective concerned sector users. The sector users were responsible for resolving issues forwarded to them by the ward administrators. They were able to do so using their respective mobile and web portals. It was rated overall 81.3% by sectors users in solving reported problems by citizens.

The system provided reliance for users; the citizens were able to track reported issues by use mobile application or web application. The ward administrators were able to resolved or forward or rejected issue. Once they forward the issues, they were able to track the progress through use of mobile application or web application. The sectors users were able to track issues reported by citizens in wards and see the progressive measures taken by the ward administrators in order to ensure better service delivery to citizens. The monitoring and evaluation team were able to get notification of issues being reported by the citizens and counter check if action was taken by the ward administrators and the sector users, and if no action taken they query on behalf of citizens to ensure action is taken on reported issue. It was rated 75% overall by sectors users on user dependence.

The **system improved accountability** by providing way of addressing and acknowledging issues reported by citizen and resolved through acknowledgement receipt in both SMS, mobile and web application. The wards administrators and sectors users were provided with decision actions (forward, resolve or rejection). They were able to generate summarized report of issues reported. The results found that 93.8% overall rating by sectors users the system improved accountability.

The **system improved transparency** since it was hosted where ward citizens can access information. Administration officers of county government were able to have access and monitor the reported issues by citizens. The resolving decisions taken by wards administrators or sector users were published on system and decisions actions notifying or accessible by citizens. It was rated overall 93.8% by sectors users in improving transparency.

4.2 Module usability testing

In the table 57 below summarize functionality usability of SMS, mobile and web application based average performance. The values was sum of agree and strongly agree results in unit testing as described in chapter three, testing phase.

From the table 57 below, the overall performance of SMS was 59%, mobile application was 68% and web application was 76%. It was found that the best average results were from web application, mobile application and SMS.

Table 57 : Module usability testing

Functionality	SMS (%)	Mobile Application (%)	Web application (%)
Effective and efficient	67.5	78.8	90.1
Easy to use	62.6	75	76.3
Easy navigation	42.6	56.3	55.1
Acceptability if deployed to all citizens	58.8	65	85.1
Performance	61.3	62.5	73.8
Overall rating (%)	59%	68%	76%

4.3 Service Integration Testing

The service functionality integration testing was done to ascertain whether integrated mobile and web application services through service request and response were working well. These was through both citizens and sectors users. The execution was successful.

Service Requestor	Service response	Other service messages to citizens	Other service actions
Citizen mobile app	Notification of Problems	Sms, email alert	Ward administrator alerted/View issue
Citizen SMS	Notification of Problems	Email, SMS alert	Ward administrator alerted/View issue
Citizen Web App	Notification of Problems	Email alert	Ward administrator alerted / View issue
Ward Admin verification	Problem reported verified	Email, SMS alert to citizens	- Resolve/forward /Reject - Pdf generated report -Sector user alerted
Sector user notify	Event notified	-Citizens receives SMS / email alert - Ward admin receives email alert	- Resolve /Reject action - Pdf generated report/ -View status of reported issues.
M & E Officers	Event notified	Email alert	Pdf generated report/ View status of reported issues.
Report services	View reports	-	Print / export reports
External data users	Generate reports	-	Export Jason format

Table 58: Integration testing

Chapter Five: Recommendations and Conclusions

5.1 Reviewing of objectives in relation to the prototype

The first objective was to investigate service delivery monitoring process in the Nairobi county government. We managed to do thorough investigation and found that the current service delivery monitoring processes in wards and sectors were not easy. These were evidenced from data collected and analyzed from sectors officers and wards citizens. Further investigation found that, by use of an integrated information system improved processes which were not easy in both wards and sectors on service delivery monitoring. They acknowledged that use of technologies innovation such as web application, mobile application and SMS improved service delivery monitoring process.

Our second objective was to evaluate the existing service delivery monitoring systems and solutions in county government. We found out that there was no automated system that was put in place by the county government for service delivery monitoring. From the study, issues were monitored through daily, weekly, monthly logs and field visit. This proved that the current system and methods was not effective and efficient enough. Further investigation found that introduction of integrated information system provided effective and efficient way to monitor service delivery.

Thirdly was to propose a service oriented model that can monitor service delivery effectively and share information and which can be integrated with other systems. Service oriented monitoring prototype was proposed using the RESTful services architectural style. It had standardized interface such HTTP for transmitting data and the end users can access the services using the unique uniform resource identifier (URI). It integrated use of web platform and mobile; App and SMS who's their components communicated via interfaces independently. Integration was realized through use of Json data format to export data to external user APIs who would use it in their applications.

The last objective was to design and build a prototype that can aid in gaining of important information for county government in monitoring service delivery to improve the public service delivery, decision making processes and for other stakeholders. The prototype was designed based on SOA, built based on RESTful services architectural style and tested with wards citizens, wards administrator and sectors users. The model that was builds included; defined county government sectors services, sector users, ward administrators and integrated

mobile application; App and SMS. Wards administrator and sectors users were notified reported issues by wards citizens and after resolving or forwarding or rejecting they can generate sharable report. Citizens were able to view the status of reported issues, generate report or being notified through SMS or email.

5.2 Conclusions

The findings showed that the current systems, methods and processes were not sufficient and effective to monitor service delivery effectively. The study also discovered that the use of service architecture model improved monitoring of service delivery, its processes and enable data sharing, integration in the county government hence improving responsiveness, efficiency, transparency and accountability.

The model was integrated with mobile technology; SMS and app which provided monitoring of service delivery at platforms access by both wards citizens and sectors users, such innovation revealed that their performance were effective and efficient for users hence facilitation of the service delivery monitoring in real time and enhanced it process.

The study demonstrated that use of service oriented system built based on RESTful services architectural style which was characterized by being platform independent, autonomous, loose coupled and interoperability through designing and integration of different services of Nairobi city county government sectors accessible through standard interface leading to reduced cost, reusability, flexibility and operation efficiency.

5.3 Limitations

On the SMS gateway server it experienced latency in request processing times and bandwidth usage. The system required stable internet when validating occurrence of issues reported using Google map coordinate, but in some wards and had no or low internet connectivity.

5.4 Recommendations

We recommend further work in developing an integrated monitoring and evaluation system where citizens and other stakeholders can appraise the performance of sectors in the county government. Further study should also focus on integration of sectors development plan, budgets allocations and being able provide progressive measures in a centralized system.

The development of SMS platform which uses USSD, where the mobile subscriber dials USSD short code on his mobile to access the app .We recommend use of GPRS for verification of users reporting issue.

The research mainly dealt with studies related to monitoring of service delivery, their system and their processes in county government, other studies should be extended to know their impact of ICT on improving service delivery monitoring, also studies on parameter of evaluating service delivery monitoring of county government leading into development of framework based on technological platform . Other studies can be done by identifying other technology platforms rather than SOA on service delivery monitoring and done to other counties within Kenya.

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Appendices

Questionnaires

Sectors of Roads and Environment

Mutie Stephen Kyalo is a master's student at the University of Nairobi, registration number P53/79083/2015. I kindly request you to participate in filling questionnaire below for my college project. This will enable me to carry out my project in distributed computing technology research. The information being sort is purely and basically for academic purposes and will not be used otherwise.

Kindly do not write your identity on this material.

1. Do you have any information system in place for monitoring service delivery?

- Yes
- No

If yes how do you rate it?

- Very effective
- Effective
- Slightly effective
- Not effective
- I don't know

2. Do you have any other ways of monitoring service delivery?

Please specify.....

If any how do you rate it or them in monitoring service delivery?

- Very easy
- Easy
- Difficult
- Very difficult
- Not sure

3. What is your experience in knowing new information of issues concerning service delivery monitoring in your county government sector?

- Very easy
- Easy
- Difficult
- Very difficult
- Not sure

4. What are you major challenges in finding new information of issues concerning service delivery monitoring in your county government sector?

- County citizens failure to report
- Lack of enough resource to help in monitoring
- Lack of technology in the monitoring process
- Otherspecify.....
- Not sure

5. Suppose an integrated information system is to be used to monitor service delivery in your county government sector how would you rate it in improving service delivery process?

- Very helpful
- Helpful
- Little help

- Not helpful
- Am not sure

6. Which technology you are likely to use to enhance service delivery monitoring process in your county government sector if made available?

- Mobile application
- Web application
- SMS
- Call
- Others specify.....

7. If an integrated information system was used to monitor service delivery, how helpful will be to your county government sector to respond to issues reported by your county citizens?

- Very helpful
- Helpful
- Little help
- Not helpful
- Am not sure

8. How efficiency will be your county government sector in delivery their service if an integrated information system was used to monitor service delivery?

- Very helpful
- Helpful
- Little help
- Not helpful
- Am not sure

9. Suppose an integrated information system is used to monitor service delivery in _____ county government sector how you would rate it in improving transparency?

- Very helpful
- Helpful
- Little help
- Not helpful
- Am not sure

10. Can you rate how accountability county government sector will be to monitor service delivery if an integrated information system was used?

- Very helpful
- Helpful
- Little help
- Not helpful
- Am not sure

Ward administrator

Mutie Stephen Kyalo is a master’s student at the University of Nairobi, registration number P53/79083/2015. I kindly request you to participate in filling questionnaire below for my college project. This will enable me to carry out my project in distributed computing technology research. The information being sort is purely and basically for academic purposes and will not be used otherwise.

Kindly do not write your identity on this material.

1. How do you rate your current method of monitoring service delivery in your ward?

- Very effective
- Effective
- Slightly effective
- Not effective
- I don’t know

2. How long did ward resident's takes to report service delivery problems in your ward?

- A day
- Week
- A month
- Other specify.....

3. What is your experience in knowing new information of issues concerning service delivery monitoring in your ward?

- Very easy
- Easy
- Difficult
- Very difficult
- Not sure

4. What are you major challenges in learning new information of issues concerning service delivery monitoring in your ward?

- County citizens failure to report
- Distance to cover while investigating the report
- Lack of enough resource to help in monitoring
- Lack of technology in the monitoring process
- Not sure
- Other specify.....

5. Suppose an integrated information system is to be used by your wards citizens to inform you about new report of service delivery problems, how would you rate it?

- Very helpful
- Helpful
- Little help
- Not helpful
- Am not sure

6. If your ward residents were to be given several technologies to use in monitoring process once a problem occurs, which methods do you think would be more suitable?

- Mobile application
- Web application
- SMS
- Call
- Others specify.....

7. What technology interaction listed in No. 6 above you are likely to use to enhance service delivery monitoring process if made available?

- Mobile application
- Web application
- SMS
- Call
- Others specify.....

8. If you received a pre-notification message of problem reported from ward resident, how fast do you think will respond to it?

- One hour
- Half a day
- A day
- A week
- Other specify.....

9. Do you think such prior messages would increase the level of citizen's participations in service delivery monitoring in your ward?

- Yes
- No

10. How would you rate your current system of monitoring service delivery in your county government?

- Very effective
- Effective
- Slightly effective
- Not effective
- I don't know

County Citizens

Mutie Stephen Kyalo is a master's student at the University of Nairobi, registration number P53/79083/2015. I kindly request you to participate in filling questionnaire below for my college project. This will enable me to carry out my project in distributed computing technology research. The information being sort is purely and basically for academic purposes and will not be used otherwise.

Kindly do not write your identity on this material.

1. In what age group are you?

- 19 Years and under
- 20-29 Years
- 30- 39 Years
- 40-49 Years
- 50- 59 Years
- Above 60

2. Kindly specify your gender

- Male
- Female

3. Do you notify your wards of new problems in service delivery?

- Yes
- No

If No what could be the reason

- Distance to ward office
- Process is tedious
- I feel no need
- I don't know the process
- Other Specify

If yes who did you notify the new information?

- Ward Administrator
- Chief
- County department
- Specify any other

If yes how did you notify it?

- Social media
- Call
- SMS
- Website
- Physical going there
- Specify any other

4. How long did you take to notify new information of service delivery problem in your county government?

- A day Week A month other specify

Did you get the response from your county government [Yes or No]

If Yes how long

- A day Week A month other specify.....

5. How do you rate your current process of monitoring service delivery in your ward?

- Very easy Easy Slightly easy Not easy I don't know

6. How do you rate your current process of monitoring service delivery in your county government?

- Very easy Easy
 Slightly easy Not easy
 I don't know

7. Would you consider use of technology to notify service delivery problems if means are made available to you? [Yes No]

If yes which technologies are you likely to use?

- Mobile application
 Web application
 SMS
 Call

8. How effective do you find it looking for ward administrator physically to notify problems in service delivery?

- Very effective
 Effective
 Slightly effective
 Not effective
 I don't know

9. How would you rate your ward administrator effectiveness in attending problems reported concerning service delivery?

- Excellent
 Very good
 Good
 Poor
 I don't know

10. Do you feel the use of technology prior to visiting the ward office or county department would ease service delivery monitoring? [Yes No May be Not sure]

11. If communication methods for service delivery monitoring list below are made available, choose the most preferred methods

- Mobile application
 Web application
 SMS
 Call

Citizen's usability questionnaire

Functionality assessments of SMS, Mobile Application and Web application

From the list below, choose the technology methods that you would like to rate in addressing problems, reported by citizens in the process of Service Delivery Monitoring in the Nairobi County Government.

No.	Please indicate the extent to which you agree with the following statements based on the functionality of SMS, Mobile Application and Web application, on a five point Likert scale (1-5). Please tick (✓) appropriately in the boxes provided.	Strongly Agree	Agree	Slightly Agree	Not Agree	Strongly Disagree
	Functionality of SMS	5	4	3	2	1
1.	The use of SMS is effective and efficient.					
2.	SMS is easy to use.					
3.	SMS provides easy navigation.					
4.	Do you consider acceptability of SMS if deployed to all citizens?					
5.	SMS performed well.					
	Functionality of the Mobile Application	5	4	3	2	1
1.	Use of the mobile application is effective and efficient.					
2.	The mobile application is easy to use.					
3.	The mobile application provides easy navigation.					
4.	Do you consider acceptability of this mobile application if deployed to all citizens?					
5.	The use of the mobile application performed well.					
	Functionality of Web application	5	4	3	2	1
1.	The use of web application provides efficiency and effectiveness.					
2.	The web application is easy to use.					
3.	The web application provides easy navigation.					
4.	Do you consider acceptability of this web application if deployed to all citizens?					
5.	The use of web application performed well.					

Thanks for filling this questionnaire.

Sector user and ward administrator functionality questionnaire

The service oriented monitoring system functionality performance assessment

No.	Please indicate the extent to which you agree with the following statements on functionality performance of the service oriented monitoring system, on a five point Likert scale (1-5). Please tick (√) appropriately in the boxes provided.	Strongly Agree	Agree	Slightly Agree	Don't Agree	Strongly Disagree
	Functionality performance of the service oriented monitoring system	5	4	3	2	1
1.	The system provides efficiency.					
2.	The service oriented monitoring system is responsive.					
3.	The output information generated by system is of good quality.					
4.	The system gives information for solving reported problems.					
5.	The system improves service delivery monitoring processes.					
6.	The system provides user dependence.					
7.	The system improves transparency.					
8.	The system improves accountability.					
9.	The output information from system improves public service delivery and decision making processes.					

Thanks for filling this questionnaire

Sample codes of sector service (<http://www.prisconet.com/apps/county>)

```

<?php
session_start();
//check if the session is set
if (!isset($_SESSION['suserid']))
{
    header("Location:index.php");
}

```



```

//the url to call the json data

$scounty_link=file_get_contents("http://www.prisconet.com/apps/county/getsuser.php?suse
rid=$_SESSION[suserid]");
    error_reporting(E_ERROR | E_PARSE);
    $data = json_decode($scounty_link,true);

        foreach ($data as $sc) {
            $name = $sc['name'];
            $sectorid=$sc['serviceid'];
            $thesector=$sectorid;

        }

//get the name of the sector

$thesector_link=file_get_contents("http://www.prisconet.com/apps/county/getsector.php?se
ctorid=$thesector");
    error_reporting(E_ERROR | E_PARSE);
    $data = json_decode($thesector_link,true);

        foreach ($data as $sc) {
            $sectorname = $sc['name'];

        }

?>
<!doctype html>
<html lang="en">
<head>
    <meta charset="utf-8" />
    <link rel="icon" type="image/png" href="assets/img/favicon.ico">
    <meta http-equiv="X-UA-Compatible" content="IE=edge,chrome=1" />

    <title>Monitoring Service Delivery in County Government</title>

    <meta content='width=device-width, initial-scale=1.0, maximum-scale=1.0, user-
scalable=0' name='viewport' />
    <meta name='viewport' content='width=device-width' />

```

Research Authorization

Letter from Institution



**UNIVERSITY OF NAIROBI
COLLEGE OF BIOLOGICAL AND PHYSICAL SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS**

Telephone: 4447870/4444919/4446544
Telegrams: "Varsity" Nairobi
Telefax: 254-2-4447870
Email: director-sci@uonbi.ac.ke

P.O. Box 30197
Nairobi
Kenya

Our Ref: UON/CBPS/SCI/PHD/STN/2013

18 May 2017

TO WHOM IT MAY CONCERN

Dear Sir/Madam

RE: STEPHEN KYALO MUTIE: REG. NO. P53/79083/2015

This is to confirm that the above named is a bona fide student of the University of Nairobi, School of Computing and Informatics.

He is pursuing M.Sc in Distributed Computing Technology and would like to collect data for his project entitled: ***"A Prototype for Monitoring Service by Citizens in County Government in Kenya based on Service Oriented Architecture: A case Study of Nairobi City County"***. Under the supervision of Dr. Robert O. Oboko.

Any assistance accorded to him will be highly appreciated.

Yours faithfully

Handwritten signature of Dr. Agnes N. Wausi.

**DR. AGNES N. WAUSI
DIRECTOR
SCHOOL OF COMPUTING & INFORMATICS**

**School of Computing & Informatics
University of NAIROBI
P. O. Box 30197
NAIROBI**

ANW/jsn

Letter from National commission for science, Technology and Innovation



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 3310571, 2219420
Fax: +254-20-318245, 318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/60759/17478**

Date: **29th June, 2017**

Stephen Kyalo Mutie
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on *“A Prototype for monitoring service delivery by citizens in county government in Kenya based on service oriented architecture. A case study of Nairobi City County,”* I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **22nd June, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.


PP **GODFREY P. KALERWA MSc., MBA, MKIM**
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nairobi County.

The County Director of Education
Nairobi County.

National Commission for Science, Technology and Innovation ISO9001: 2008 Certified

Letter from Nairobi City county Department of Human resource Development

NAIROBI CITY COUNTY

Telephone: +254 20 2221349
Web: www.nairobi.go.ke



City Hall
P .o. box 30075-00100
Nairobi
Kenya

DEPARTMENT OF HUMAN RESOURCES DEVELOPMENT

Ref: HRD/22/930/HO/ 2017

DATE: 3rd July 2017

Stephen Kyalo Mutie -0729226252
University of Nairobi.

RE: RESEARCH AUTHORIZATION

Reference is hereby made to your application letter dated May 18th, 2017 on the above subject;

The Nairobi city county has approved your request subject to the following:

1. The period of research will be **three (3)** months with effect from **3rd July, 2017** to **30th September, 2017**.
2. You will be allowed to information in specific area in the county.
3. You are expected to adhere to the rules and regulations pertaining to your research.
4. That during your research there will be no costs devolving on the county.
5. That you undertake to indemnify the county against any claim that may arise from your research study.
6. You are required to submit a copy of the final research document to the undersigned one month after completion.
7. Research will be on "A Prototype for Monitoring Service by Citizens in County Government in Kenya Based on Service Oriented Architecture: A Case Study of Nairobi City County".
8. You are expected to pay research fee of five thousand shillings Kshs. (5,000)

The Chief Administrative Officer; Urban Planning and public works Sectors are requested to accord you the necessary assistance.

A handwritten signature in blue ink, appearing to read 'H. Omido'.

HENRY OMIDO
FOR: DIRECTOR HUMAN RESOURCE DEVELOPMENT.

Cc: Pangani Ward Administrator
Starehe Sub-county

- Kariokor Ward Administrator
Starehe Sub-county
- Nairobi Central Ward Administrator
Starehe Sub-county
- Ngara Ward Administrator
Starehe Sub-county
- Huruma Ward Administrator
Mathare Sub-county
- Mlango Kubwa Ward Administrator
Mathare Sub-county
- Mabatini Ward Administrator
Mathare Sub-county
- Ngei Ward Administrator
Mathare Sub-county

Letter from Nairobi City county Department of Environment, Energy and Water

NAIROBI CITY COUNTY



Telephone: 020 344194
www.nairobi.go.ke

City Hall,
P. O. Box 30075-00100,
Nairobi,
KENYA.

ENVIRONMENT, ENERGY & WATER

EMCE/DOE/1/1/057

4th July 2017

TO WHOM IT MAY CONCERN

RE: REQUEST FOR COLLECTION OF DATA – STEPHEN KYALO MUTIE

This is to inform you that **Stephen Kyalo Mutie** is a student at University of Nairobi pursuing a M.sc degree in Distributed Computing Technology and has placed a request to carry out a research on “**A Prototype for Monitoring Service by Citizens in County Government in Kenya based on Service Oriented Architecture**” for one month (1) from **2nd June** to **30th June** 2017.

Besides this research being intended for academic purposes, the study is important to the county government as its findings will provide baseline information for enhancement of effective and quality service provision to the public. We have no objection to his request and therefore recommend him to undertake the research. ✓

The researcher is however, expected to ensure that the research is carried out in an ethical manner. He is also required to provide the county government with a copy of his findings upon completion of his research.

Any assistance accorded to him will be highly appreciated.

A handwritten signature in black ink, appearing to read 'Isaac Muraya'.

ISAAC MURAYA

FOR: CHIEF OFFICER – ENVIRONMENT, ENERGY & WATER