



UNIVERSITY OF NAIROBI
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GIS DRIVEN WEB REPORTING: A Case Study of Nutrition and HIV Program

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Declaration

I, Wilfred A. Achilla, hereby declare that this project is my original work. To the best of my knowledge, the work presented here has not been presented for a degree in any other Institution of Higher Learning.

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Signature

.....2ND AUGUST 2022.....

Date

Abstract

Nutrition is a fundamental factor in managing the HIV/AIDS pandemic. This study focused on the Nutrition and HIV program mainly due to the delicate, bi-directional relationship between nutrition and HIV. The program targets, pregnant and lactating mothers, adults (above 15 years) and Children (below 15 years). It also largely depends on Ante-Retroviral Treatment (ART) sites as the main Nutrition, Assessment, Counselling and Support (NACS) centres. The fundamental success factor in this program squarely rests in the ability of the program to provide a consistent and uninterrupted supply of nutrition commodities to the NACS centres.

Current data in the Kenya Health Information System (KHIS) –MOH FORM 731- Care and Treatment Summary Tool, indicates that out of 3650 Anti-Retroviral Treatment (ART) sites, only 1900 report nutrition data at a rate of 65% compliance. Some of the challenges contributing to this poor reporting can be attributed but are not limited to; lack of a reporting system and structure at the at the NACS centres, low motivation, and a manual or bulky reporting process. This largely affects management and distribution of nutrition commodities in the program.

This study aims to establish the main contributors to reporting challenges in NACS centers actively participating in the Nutrition and HIV program and use these findings to develop a GIS driven web reporting system to overcome the main challenges within the program.

A study was done to establish these challenges in the Nutrition and HIV program and the main issues identified were used to develop a system that would streamline reporting, monitoring and distribution within the program. The methodology involved interviewing all the program actors. Data from the interviews was analysed to highlight the challenges in the program. One of the outstanding challenges found was lack of an efficient reporting tool which pointed to the need for the development of a GIS driven web reporting system. A system was thus developed with near real-time reporting and monitoring capabilities and web routing functionality. With this system, near real time reporting on nutrition commodities is possible at facility level and real time nutrition commodities monitoring can be achieved. The study came up with recommendations based on challenges faced during the study including multiple user sign in and reporting.

Dedication

I dedicate this report to God Almighty, my Mom Sarah Wambogo Achilla in heaven, Connie my lovely wife and my family both nuclear and extended, for being my key pillars of patience, dedication, support, encouragement and prayers throughout the study.

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List of Acronyms and Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
AJAX	Asynchronous JavaScript and XML
AMPATH	Academic Model Providing Access for Healthcare
ART	Anti-Retroviral Treatment
API	Application Programming Interface
ART	Antiretroviral Therapy
BMI	Body Mass Index
DBMS	Database Management System
FBF	Fortified Blended Foods
FHI	Food for Hunger International
FNSP	Food and Nutrition Security Plan
GIF	Graphics Interchange Format
GIS	Geographic Information System
GNSS	Global Navigational Satellite System
HiNi	High Impact Nutrition Interventions
HIV	Human Immunodeficiency Syndrome
HTML	Hyper Text Mark-up Language
JPEG	Joint Photographic Experts Group
KEML	Kenya Essential Medical List
KEMSA	Kenya Medical Supplies Authority
KNAP	Kenya Nutrition Action Plan
KHIS	Kenya Health Information System
MDG	Millennium Development Goals
MOH	Ministry of Health
NACS	Nutrition, Assessment, counselling & Support

NACC	National Aids Control Council
NASCOP	National Aids and STI's Control Program
OGC	Open Geospatial Consortium
OVC	Orphaned Vulnerable Children
PDA	Personal Digital Assistant
RUTF	Ready to Use Therapeutic Foods
RUSF	Ready to Use Supplementary Food
SDE	Spatial Data Engine
SDG	Sustainable Development Goals
SOAP	Simple Object Access Protocol
UNICEF	United Nation Children's Fund
USAID	United States AID
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
WMTS	Web Map Tile Services
WPS	Web Processing Service
XML	Extensible Mark-up Language

1 INTRODUCTION

1.1 Background

Nutrition is a fundamental factor in managing the HIV/AIDS pandemic. Nutrition Programs in a broad sense cut across very many areas. The guiding principle of nutrition programs is embedded in the definition of the term nutrition. The fourth edition of the American Heritage Dictionary of the English Language gives three definitions of Nutrition as;

1. The process of nourishing or being nourished, especially the process by which living organisms assimilates food and uses it for growth and replacement of tissues.
2. The science or study that deals with food nourishment, especially in humans.
3. A source of nourishment; food.

1.1.1 Nutrition and HIV in Africa

Several nutrition programs and studies have been conducted across Africa through various funding agencies including USAID, PEPFAR, Feed the Future, Global Fund and Save the children among many others. According Dr. Temitope K. Bello, Human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) are still global problems, with Africa remaining as the most affected continent in this region of the world at almost 500,000 deaths in 2018. This is despite the investment in highly active antiretroviral therapy and the collective efforts of health care workers. Without incorporation of quality diets, the therapy may not actually help to reduce HIV related morbidity and mortality rates.

1.1.2 Nutrition and HIV in Kenya

The government of Kenya identified nutrition as one of the key components of the national response to the HIV/AIDS epidemic according to the Kenyan National HIV/AIDS Strategic Plan 2005 – 2010. This gave way to Kenya Aids Strategic plan (KASP III) which was concluded in June, 2014. The promulgation of the 2010 constitution and the vision 2030 then gave birth to the Kenya Aids strategic framework (KASF) 2014-2019 whose main aim was to take lead in implementing HIV/AIDS initiatives. Kenya is currently running KASF 20/21–24/25 which aims to among other things ensure equitable intervention measures to all Kenyans. The Ministry of Health, nutrition and dietetic unit currently runs a total of 15 programs. Out of these, the clinical nutrition program was started with an aim of achieving objective 5 of the National Food and Nutrition Security Plan (FNSP) 2008 which had 14 objectives. Objective 5 focuses on improved access to quality curative nutrition services. The

clinical nutrition program has 4 programs namely; Nutrition in HIV, Nutrition in Management of Diabetes, Nutrition in Tuberculosis, and Management of Severe Under-Nutrition. The Nutrition in HIV program which is the area focus in this study is among 4 clinical nutrition programs. This focus is mainly due to the delicate, bidirectional relationship between nutrition and HIV. In a report titled *a Qualitative Study on Perceived Factors Affecting Feeding Practices among Adult People Living with HIV/AIDS in Kigali, Rwanda, 2019*, Poor nutrition has been associated with unsuppressed viral loads among People Living with HIV/AIDS (PLWH) while HIV infection leads to poor nutrition. HIV treatment, care and support efforts should thus incorporate nutrition management. According to the Nutrition in HIV program, HIV infection increases patient's nutrient requirements, and at the same time impairs nutrient intake and uptake. In turn, poor nutrition increases the risk of opportunistic infections and accelerates the progression of HIV to AIDS. Malnutrition and HIV/AIDS are synergistic and creates a vicious cycle that actively weakens the immune system. The unfortunate fact is that if this delicate nutrition balance is not streamlined the situation could lead to fatalities.

The Kenya National Nutrition Action Plan (KNAP) 2018-2022 is currently being used to implement the National Food and Nutrition Security Policy 2012 and its implementation framework, (NFNSP-IF) 2017-2022. KNAP 2018-2022 also identifies optimal nutrition as a key driver in achieving all sustainable development Goals (SDG's). In September, 2015 the transition from Millennium Development Goals (MDG's) to Sustainable Development Goals (SDG's) was adopted. This occasioned the transitioning of the USAID funded FHI 360, Nutrition and Health Program (NHP) to the Nutrition and Health Program Plus (NHPplus) program. Two key changes took place in the (NHPplus) program. First was the incorporation of SDG 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture and SDG3: Ensure healthy lives and promote well-being for all at all ages. The second change was the incorporation of the current governance structure in Kenya that recognised the 47 counties. Other changes were to increase the scope of Nutrition, Assessment and Counselling Services (NACS) beyond PLWHIV. The program thus aimed at providing technical support to provide High Impact Nutrition Interventions (HiNi). This was also concluded and handed over to National Aids and STI's Control Program (NAS COP) which falls under the Ministry of Health Nutrition and Dietetics Unit. NAS COP is tasked to oversee provision of technical assistance to strengthen nutritional care and support for PLHIV and improve food assistance and food security programming in the context of HIV.

The Program is designed to improve the nutritional status of patients who are malnourished at different severity levels. Disadvantaged and vulnerable groups receive supplemental nutritional support in the form of nutrient-dense fortified blended, therapeutic foods also known as nutrition commodities. In order to expand their reach, nutrition programs work through Nutrition, Assessment and Counselling Services (NACS) centres like, local health centres, community groups, churches and religious organisations. It also largely depends on Ante-Retroviral Treatment (ART) sites as the main NACS centres. The program targets, pregnant and lactating mothers, adults (above 15 years) and Children (below 15 years).

1.2 Problem Statement

Current data in the Kenya Health Information System (KHIS) –MOH FORM 731- Care and Treatment Summary Tool, indicates that out of 3650 Anti-Retroviral Treatment (ART) sites, only 1900 report nutrition data at a rate of 65% compliance. Some of the challenges that contribute to the poor reporting can be attributed but not limited to; lack of a reporting system and structure at the at the NACS centres, low motivation due to stretch tasks and the manual or bulky nature of the reporting process. This largely affects management and distribution of nutrition commodities in the program.

It is critical to maintain the correct stock levels of nutrition commodities in a nutrition and HIV program. Failure to do so would result in stock outs which can interfere with the patient's progress and even lead to fatalities due to the already established delicate relationship between nutrition and PLWHIV. The problem faced by nutrition programs point to operational, management and planning challenges met in reporting on program participants and stock levels at the comprehensive care centers, in order to facilitate timely efficient and cost effective ways of replenishing stocks. Sustaining stock levels is a very critical component in stock management and efficient service delivery. If there is a lapse in taking nutrition commodities, the negative impact to patients is very difficult to reverse. The main problem therefore is that the Nutrition and HIV program lacks a centralized system that can synchronize and streamline operations and reporting between different stakeholders in the program.

1.3 Objectives

1.3.1 General objectives

This study aims to establish the main contributors to the reporting challenges in NACS centers actively participating in the Nutrition and HIV program and use these findings to develop a GIS driven web reporting system to overcome the key challenges within the program.

1.3.2 Specific objectives

The specific objectives of this study are to:

- a) Establish the challenges faced in reporting across the value chain within the Nutrition and HIV program
- b) Develop a GIS driven web reporting system with functionality to address the main challenges to be identified in objective one in order to streamline reporting, management and distribution of nutrition commodities within the program

1.4 Justification for the Study

As highlighted earlier, the program is aimed at delivering on SDG 2 and 3 by ensuring that PLWHIV get access to the much needed nutrition commodities. With interrupted supply of these commodities the patients in the program stand to suffer from severe malnutrition and even fatalities owing to the bidirectional relationship between nutrition and PLWHIV.

The study therefore aims to take advantage of challenges identified in the previous programs and surveys done across the value chain in order to establish a terms of reference TOR for developing a relevant and effective application to mitigate the same.

With this application, the study aims to achieve consistent availability of nutrition commodities stocks within ART sites. This will be achieved by streamlining, reporting, ordering and delivery through the entire value chain. The program thus aims to eventually achieve positive outcomes with patients in the program.

1.5 Scope of Work and Limitations

Nutrition and food programs are spread all over the country and currently devolved to the 47 counties. Depending on the program, delivery points can be based within community groups, religious centres or health facilities. This study will focus on the nutrition and HIV program

that is led by NASCOP within the Ministry of Health housed within the Nutrition and dietetics unit. This is due to the fact that most of the data and preliminary analysis on the study was done based on previous projects which were eventually handed over to them for sustainability and continuity upon the project periods lapsing. This program focuses on NACS centres targeting; pregnant and lactating mothers, adults (over 15 years) and children (under 15 years.)

The study will only focus on nutrition commodity tracking and management as well as routing to enhance efficiency in distribution. These came out clearly as the key challenges during preliminary research on the study.

The study will only work with a sample of 24 sites within Nairobi County as a representative sample of all centres spread all over the country. The results may therefore not be applicable to the entire country due to different parameters like geography, distance between health facilities and lifestyle of participants.

This study will also only focus on selected nutrition commodities that cut across the board in most nutrition and HIV programs. This is mainly because these commodities are produced by one supplier within the nutrition and HIV program hence it would be justifiable to use this as pilot. The proposed system should however be scalable in order accommodate more commodities and should be customizable to fit into any nutrition program.

1.6 Organization of Project Report

This project report has been organized into five chapters. Chapter one provides background information on nutrition programs in Africa and Kenya. It also provides the problem statement and justification of study as well as the objectives for the study. The scope and limitations are also highlighted in this chapter.

Chapter two contains the literature review that focuses on the Nutrition and HIV program as well as similar projects and projects where GIS web technology has been used. It also focused on emerging web mapping technologies that can bridge identified gaps within the nutrition and HIV program.

Chapter three focuses on the methodology, looks at the study area, data collection, GIS web reporting design, implementation and deployment. Chapter four goes ahead and tackles the results, analysis and discussions of the study. Chapter five being the last chapter of the report gives the study conclusions and recommendations, highlighting challenges faced during the study.

2 LITERATURE REVIEW

2.1 Nutrition and infectious diseases

Ministry of Agriculture, (2011) highlights that; inadequate nutrition results in an impaired immune system. The high disease burden of HIV/AIDS, malaria, tuberculosis and other infections threatens food and nutrition safety. This is mainly because they deplete household resources and decimate economically productive individuals.

Ministry of Public Health and Sanitation, (2012) among the key strategic objectives of the national nutrition action plan is to strengthen nutrition monitoring and surveillance systems.

2.1.1 Nutrition Commodities

Nutrition Commodities are supplementary foods issued to malnourished patients upon diagnosis. These foods are normally prescribed based on the level of malnutrition. Within the Nutrition and HIV program, patients across the three categories will be diagnosed as severely malnourished or moderately malnourished. Appendix B gives national treatment guidelines for the same.

Nutrition commodities made it to the Kenya Essential Medical List (KEML), 2019 having been included by The Ministry of Health. This was mainly done to enable KEMSA to procure and stock them and facilitate easy access by county governments. This strategic direction was taken in order to address challenges linked to nutrition commodities supplies and accommodate the changing demands from the donor community. This has been aligned with implementation of the multisectoral Kenya Nutrition Action Plan (2018-2022) where priority interventions in promoting good nutrition and addressing the persistent acute malnutrition have been outlined.

2.1.2 Challenges in nutrition commodity management

According to USAID/Kenya, (2012) the essential development challenge facing Kenya's health program is how to develop and maintain a sustainable, strong and responsive health system given the shortages in financial resources, human resources, infrastructure, technical capabilities and governance systems.

The needs outlined in the plan include the necessity to:

1. Develop equitable financing mechanisms to increase resources to marginalised, poor and underserved populations, including women, girls and youth.

2. Improve the Health Management Information System (HMIS) to provide timely and comprehensive data for decision making

The fundamental success factor in the Nutrition and HIV program squarely rests in the ability of the program to provide a consistent and uninterrupted supply of nutrition commodities to the NACS centres. This is owing to the fact that an interruption of nutrition commodity provision will lead to severe outcomes to the patients including fatality. In order to achieve this, there is a need for a secure reporting and ordering structure that would allow for proper planning and delivery of the commodities. Further to this, monitoring and accountability in distribution of stocks has been a challenge. There is therefore a need to understand the operations, planning and delivery of nutritional commodities to participating NACS centres. It is also important to understand the gaps and challenges faced and come up with ways of mitigating the risk of lacking commodities in the NACS centres.

The program setup can be summarised as follows;

1. **NASCOP:** The headquarters, who provide strategic and Technical input in the nutrition and HIV program within the Ministry of Health, nutrition and dietetics unit
2. **ART Sites:** These are all the NACS centres, majorly ART sites that are taking part in the Nutrition and HIV program where the patients (PLWHIV) visit.
3. **KEMSA:** The central store and distributor has been selected to currently oversee the storage and distribution of the nutrition commodities
4. **Equatorial Foods:** The manufacturing firm won the bid and has been tasked by the program with the responsibility of manufacturing and delivering nutrition commodities to the central store, KEMSA
5. **Global Fund:** This is the funding agency currently funding the nutrition and HIV program

A conceptual framework depicting the coordination and roles between the program actors is illustrated in Figure 1.

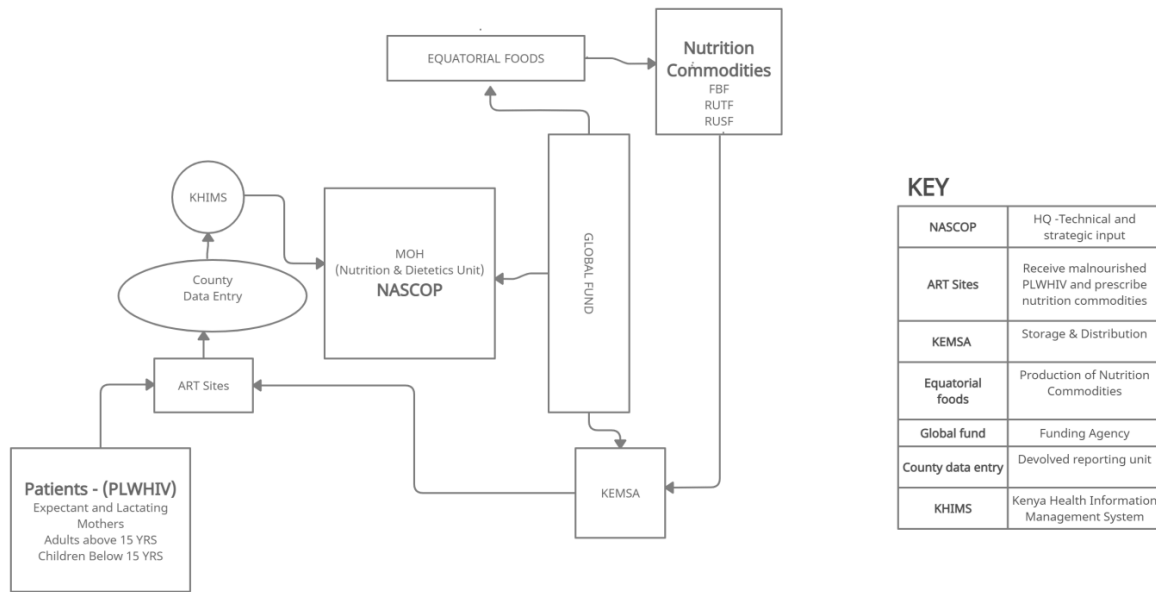


Figure 1: Nutrition and HIV Program Conceptual Framework

Web GIS reporting has successfully been used in the past to perform monitoring, evaluation, and reporting (MER) in the U.S. President’s Emergency Plan for AIDS Relief (PEPFAR). The program agreed on essential indicators for programs involving orphans and vulnerable children (OVC). The selected outcome indicators were a reflection of internationally accepted developmental milestones that collectively measured the holistic well-being for children and their families over time. The agreed upon indicators are used to track how OVC programs gain from and contribute to the broader in response in HIV and child protection. These indicators are further regarded as “essential survey indicators,” which essentially means that PEPFAR will require participating countries to collect these indicators biennially. These outcome data will support improved, evidence-informed strategic portfolio development, programming, and resource allocation decisions both at the country level and the headquarters level. It is prudent to note that the success of the program was dependant on the ability of the participating countries to effectively report on the agreed upon outcomes. This was in order to improve allocation and evidence based decision making both at the country level and the headquarters level. PEPFAR is currently funding a project within the Nutrition and HIV program whose main purpose is to centralize data collection at facility level and share the same to MOH in a synchronised manner. The system is still not geo-enabled but plans are underway for the same.

2.2 Web Mapping Technologies

The study is going to rely largely on web mapping technologies to deliver the GIS based web reporting and monitoring system. A look at the available web mapping technologies and advancement of web mapping was there for necessary in order to pick the best fit web maps for the study. Web mapping started off as the simple art of sharing maps on the internet. This could be achieved by easily uploading Tiffs or Jpegs and pointing people to where they can find them. This type of map sharing however exciting at that time eventually could not satisfy the user needs as time went by. Users wanted to be able to zoom, pan, query and be more interactive with the maps. This paved way to more advanced that allowed more interactivity, through technological advancements that gave rise to programing languages and models that would avail these features on web maps. Currently we have moved to web based GIS, where maps are not only for visualization and simple queries. Whole GIS systems are now being served on the web with functionality and features that even allows one to build their own application through application programming interfaces (API's).

Web GIS can now be looked at as combining the web and Geographic Information Systems (GIS). Over time GIS has become such a relevant application in day to day life that has resulted into many people taking advantage of the web to leverage it, Longley, (2005).

Kraak MJ and Brown A, in their book titled, *Web Cartography –Developments and concepts* (2000), reviews different classes and uses of web maps.in his book. This classification method however not conforming to everyone's requirements in terms of grouping and definition sets a good foundation for understanding the various types of maps that are available today. Web maps have evolved over time and an analysis was done in order to settle on the best fit map for this study. The matrix in table 1 below broadly outlines the strengths and weakness or various web maps.

Table 1: A web maps matrix showing comparison of strengths and weaknesses

No.	Map Type	Advantages	Disadvantages
1.	Static web maps	Simple to create and easy to share. Mostly useful in publications and printed materials.	Has very limited functionality. It covers only the area within its margins in terms of features, is not interactive hence cannot be queried and can it be updated
2.	Dynamically created web maps	They can be availed upon request and data can be updated. Quite useful especially when you take advantage of its capacity to update data on the fly upon request	It can take very long for these maps to load. This is especially when there are a lot of layers involved. This doesn't make it a good choice for complex map queries
3.	Distributed web maps	A key advantage it has is the ability to produce a map from different data sources and the fact that it can use different standards from OGC to produce user specific maps.	Cannot handle complex queries and analysis since it has limited client side functionality.
4.	Animated web maps	They are able to incorporate technologies and multimedia formats like; Adobe flash, QuickTime, SVG and Java among others to perform time laps analysis	Are generally a bit slow due to sever side technology that cannot support complex queries
5.	Real-time web maps	Real time maps can be used to ensure quick, accurate and efficient evidence based decision making.	They are limited in terms of the nature of analysis they can perform. They rely on data from more complex analysis in order to get the near real-time results. Data hungry and requires a strong network infrastructure to perform well
6.	Personalized web maps	One can choose how to arrange, depict and color the different features and elements in the map through Standard Layered description (SLD) OGC standard.	One needs to have a clear understanding of the OGC SLD standard. Can easily be misleading if one has no advanced cartographic skills.
7.	Interactive web maps	Allows users to take advantage of advanced client side technologies. Some of these technologies include; Network requests, document object model (DOM), Java support, ECMA script support, events support, and web browser plug-ins. Users have the ability to	Complex analysis models like network analysis cannot be performed unless specialized extensions are plugged in to extend its functionality

		explore different data relationships and patterns through dynamically linked tools.	
8.	Analytic Web Maps	Due its strong server side capability, it has enabled GIS analysis to be performed on web maps. Considered the major turning point of web GIS	Use and creation of these maps requires a strong GIS background and long customization curves in most instances.
9.	Collaborative Web Maps	It uses the power of many to map large areas within a short time through collaborative tools. In many instance is has helped to access data from unauthorized areas through locally accepted initiatives	Due to its collaborative nature, quality issues will arise as a result of individual initiatives an no clear control measures

For the purpose of this study, interactive web maps with analytical capabilities will be used to handle network analysis based queries and to show the distribution of the health facilities offering the nutritional supplements in Nairobi. This is because dynamic inputs and user queries will be implemented

2.3 From Web Maps to Web-Based GIS Technology

Web based GIS involve a 3 step process of planning and design, production and sharing of maps through the wide world web (www) or internet. Web GIS as opposed to web mapping adds an element of GIS functionality. The term web mapping and web-based GIS can easily be used interchangeably. The true position however is that they aren't the same technologies despite the similarities at face value.

As we drew closer to the millennium, numerous technological advances were realized which resulted in the possibility of developing web-GIS technology. Among the key advances were;

1. Internet browsers could support vector graphics
2. JavaScript and JAVA programming languages added web functionality
3. Leading geospatial software development companies, started to embrace web mapping as opposed to the traditional GIS.

A major drawback to the pace of development was that only large organizations were able to invest in this technology due to its complex nature and the huge investment required in research and development (R&D). In most instances, delivering map-based information on

the web was facilitated by producing the maps as JPEG or GIF images and then implementing a mix of HTML and JavaScript to allow users to click on features to query and retrieve other map output, or access data download, Waller and Sharpe, (2006)

Web GIS technologies have since changed this position and users can now enjoy most of their desktop GIS functionality on the web and enjoy almost similar functionality to desktop GIS. Web GIS users are now able to pan and zoom, query different features in the form of (point, line, and polygon), add and remove layers, perform path distance calculations, as well as buffer queries and area estimations among others.

Ideally due to these technological advancements, it would suffice that web-based GIS should achieve spatial analysis and complex spatial statistics functionality similar to that available in desktop GIS. This is however not yet the case. Desktop GIS due to its structure will benefit from the processing power of the host computer, leverage access to disk storage, and robust graphics visualization. On the contrary in web-based GIS, factors such as bandwidth capability, network reliability and choice of browsers must be taken into consideration. Web users also expect near to instantaneous responses from information systems Waller and Sharpe, (2006). For this reason only medium to lightweight queries (simple queries whose responses can be delivered in close to real-time) are usually processed. Large queries are redirected to more powerful processing environments, performed off-line and then the results shared. These results aren't real time but with more robust development, can meet the threshold of near real time. The advancement of web technologies will thus deliver more of this functionality in due course.

2.3.1 Technologies Driving Web-based GIS

There are two main developments that have immensely contributed to driving web GIS globally among others;

- 1.) The Open Geospatial Consortium (OGC)
- 2.) Asynchronous Java Script and XML (AJAX)

a. The open Geospatial Consortium - OGC

One of the many influences in the progression of web based GIS technology is basically the proliferation of stakeholders, key players and users. On the one end we have different firms developing GIS web applications to serve several client and server needs, requests and queries. On the other end there is a need to regulate, evaluate, and align these applications to allow for interoperability, access, and re-use. The formation of the Open Geospatial Consortium (OGC) was thus mainly driven by the need to provide Geographic Information Systems that are findable, accessible, interoperable and re-usable (FAIR). The OGC is a voluntary based international consortium with a varying membership of 500, including government and research agencies, universities and business. The OGC membership has over time put together a set of standards and resources including; registries, best practices, engineering reports, discussion papers, white papers, community practices and the OGC reference model. These standards are continuously reviewed, updated and new standards introduced as the needs, technology and situations change.

OGC standards are segmented into three groups namely;

1. Abstract Specification topics
2. Member developed standards
3. Community developed standards

The most commonly used OGC standards across all GIS web based platforms are:

1. **WMS** – Web map services
2. **WFS** – Web feature services
3. **WCS** – Web coverage services
4. **WMTS** – Web map tiles services
5. **WPS** – Web processing services

OGC has contributed a lot to ensuring that researchers, firms and individuals develop systems, produce data and share content that is standard, has been reviewed and meets the minimum threshold of globally accepted standards that have been set out.

b. Asynchronous Java and XML - AJAX

AJAX is a web based technology or technique in application development, that enables information to flow seamlessly between the client side and the server side of a web GIS. Ajax supports the development of web pages that allow for interactivity without a need for have it refreshed in order to get a result. This technology proves to be valuable especially when dealing with map interfaces which are embedded into web-based GIS applications. Ajax specifically comes out as a very powerful application model as it incorporates already well known technologies in its formation. Technologies used in the Ajax model like Java script, XML, HTTP, XHTML have been widely used in the past. Another key strength that can be leveraged is that both AJAX and web services share the same XML based structure. This structural advantage allows them to benefit from each other's strong points.

Google Maps and Virtual Earth are some of the products that have benefited from the AJAX application development model. This approach made it very easy for users with limited or no GIS background to interact effectively with browser based applications. Another breakthrough is that developers can be able to access web application API (Application Programming Interfaces) and develop their own applications customized to their specific needs and requirements. Developers, researchers or organizations no longer have to bear the cost and resource burden of managing in-house web based GIS services. They only need to tap into the rich resources base already provided by Microsoft, Google and the other big data companies in the market.

This approach by Google and Microsoft has exposed the deficiencies of traditional GIS by tapping into what GIS end users really want: simplicity, accessibility, immediacy, responsiveness, and low cost development of web mapping services, Sharl (2007).

The major components of a web GIS system mainly comprise of the database, web services and a web application. These 3 major components ensure that data is stored and updated effectively, made shareable on the internet and allows users to interact with the shared maps in various ways. In order for all these processes to work seamlessly, there are various technologies that are used. Below is a list of the 3 major components within the web GIS architecture:

1. A database
2. Web services

3. A web application

Web-GIS applications fall under two broad classes. Server side systems give access to numerous users at the same time while client side systems are more confined to single user access at any given time.

2.3.2 Key web-based GIS server software tools

Geospatial data is usually stored on a server machine in order to make it ready for Internet access. In order to provide spatial query functionality, cartographic visualizations, and spatial data exchange special GIS software must be running on these server machines. This software is referred to as GIS Server Software.

2.3.3 Web-based GIS client Software tools

There are a large number of software tools available which offer easy-to-use client-side web mapping application development and access to geospatial data services. This section provides an overview of three of the most commonly used tools. Web-based GIS clients normally connect to publicly accessible WMS, WFS, and WCS offered by data provider organizations running web based GIS server technologies. WMS are also offered by Google (through Google Earth and Google Maps) and Microsoft (through Windows Live and Virtual Earth).

2.3.4 Other related technologies

The following is a brief description of the system technologies and components used in the study. The components include;

a) ArcGIS for Server – Publishing interface

- a. This is a server-based implementation of ArcGIS and was used to serve/publish the project map, geo database, analysis models, and other elements of geographic information that were created using ArcGIS for Desktop.

b) The Web Interface (JavaScript API)

- a. This was used to develop a responsive and an interactive web interface of the resulting application. JavaScript is a programming language used to add interactivity to web pages and web maps.

c) **Data base and database Technologies**

The choice of database used was based on several criteria including tables being to relate with each other. This influenced the decision to use a relational database. In this type of database, data is stored on rows and columns within tables. The data structure follows a specific type of schema. A Relational Database Management System (RDBMS) allows an administrator create and update the database. This data base has a structured query language (SQL) which is among the most widely used to create, delete read, and update data. Relational database are required to be ACID (Atomicity, Consistency, Isolation, Durability) complaint. The data base system of choice in this study will be PostgreSQL

PostgreSQL - PostgreSQL is the best fit for a database management system due to the following functionalities: -

1. It is open source hence very convenient in this study as it would have been difficult to acquire a commercial off the shelf RDBMS like; IBMdb2, Microsoft SQL server or Oracle database
2. It is a centralized and scalable data base and management system.
3. It has better data security for individual datasets, though its features such as permission and access control
4. It is ACID compliant
5. Enables a multiuser editing and multiuser access environment
6. It has a geo database toolset (GDBT) that monitors geo database performance
7. Provides data backup and recovery mechanisms, rollback, and failover.

PostgreSQL was used in storage of facilities data. New facilities could be added to the database due to the scalability of the application.

Geo database - A geo database offers the capability to have a centralized storage for GIS data especially in the ArcGIS environment. It can be single or a multiuser geo database. The multiuser geo database workflow provided three key functionalities, namely;

1. Geo database replication

Data replication is a method of data distribution that is built on top of a versioning environment. Building on the versioning capabilities, replication allows for all or part of a dataset to be replicated and distributed across related geo databases. This functionality is accessible within an ArcGIS environment and allows for the replicated datasets to be synchronized across the related geo databases. Synchronization is achieved through a process

where one replica will reside in the original database while the other replicas will be distributed across the other databases. If changes are made in one replica during an edit session, the changes are synchronized and available across all the other replicas. Geodatabase replication can be used in both connected and disconnected environments and it supports the full database model like relationships, topologies and networks. Figure 2 illustrates synchronization of changes made between a parent and replica geodatabase. Geodatabase replication will enable the various facilities to synchronize the HIV and nutrition program data with the main database residing at NASCOP offices.

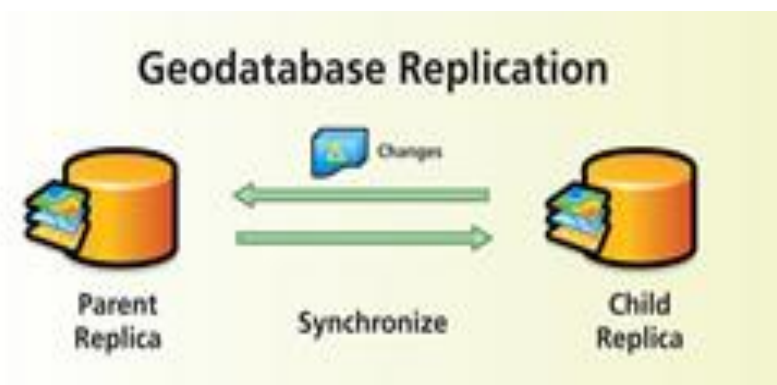


Figure 2: Geodatabase Replication

2. Geo database Archiving

In the typical English meaning, archiving will equally provide in GIS system the ability to store and retrieve changes made to a data set in whole or just a part of it within a versioned geo database. This feature will enable the GIS system to capture, manage and analyze changes within data. Nutrition Programs need to preserve the changes made to their data in order to answer common historical questions.

Through Geodatabase archiving functionality, organization be able to answer historical questions by preserving the data changes. It is therefore important to note that the key feature in geodatabase archiving is the ability to maintain a historical record of changes made from the moment archiving is enabled until archiving is disabled.

3. Versioning

This is a feature that is available in geo databases that enables several users to edit without necessarily having to lock features and services to other users. It is important to note that versions are not separate copies of the geo database but are versions whose transactions are tracked within the system tables. As users work during an edit session can therefore be isolated and be uniquely identified with them in during multiple edit sessions involving different users. It can therefore be defined a snapshot of the entire database at a particular that contains all the updated datasets in the geo database. An illustration of two users working on two projects in separate edit sessions within the same geo database (versioning) is depicted in Figure 3.



Figure 3: Versioning

Versioning will enable various edits to be made regarding the nutrition and HIV program with no risk of interfering with already existing program data.

2.4 System Architecture

The system architecture diagrams described below are;

1. High level system architecture diagram
2. Deployment architecture diagram
3. Integration architecture diagram

2.4.1 High Level System Architecture diagram

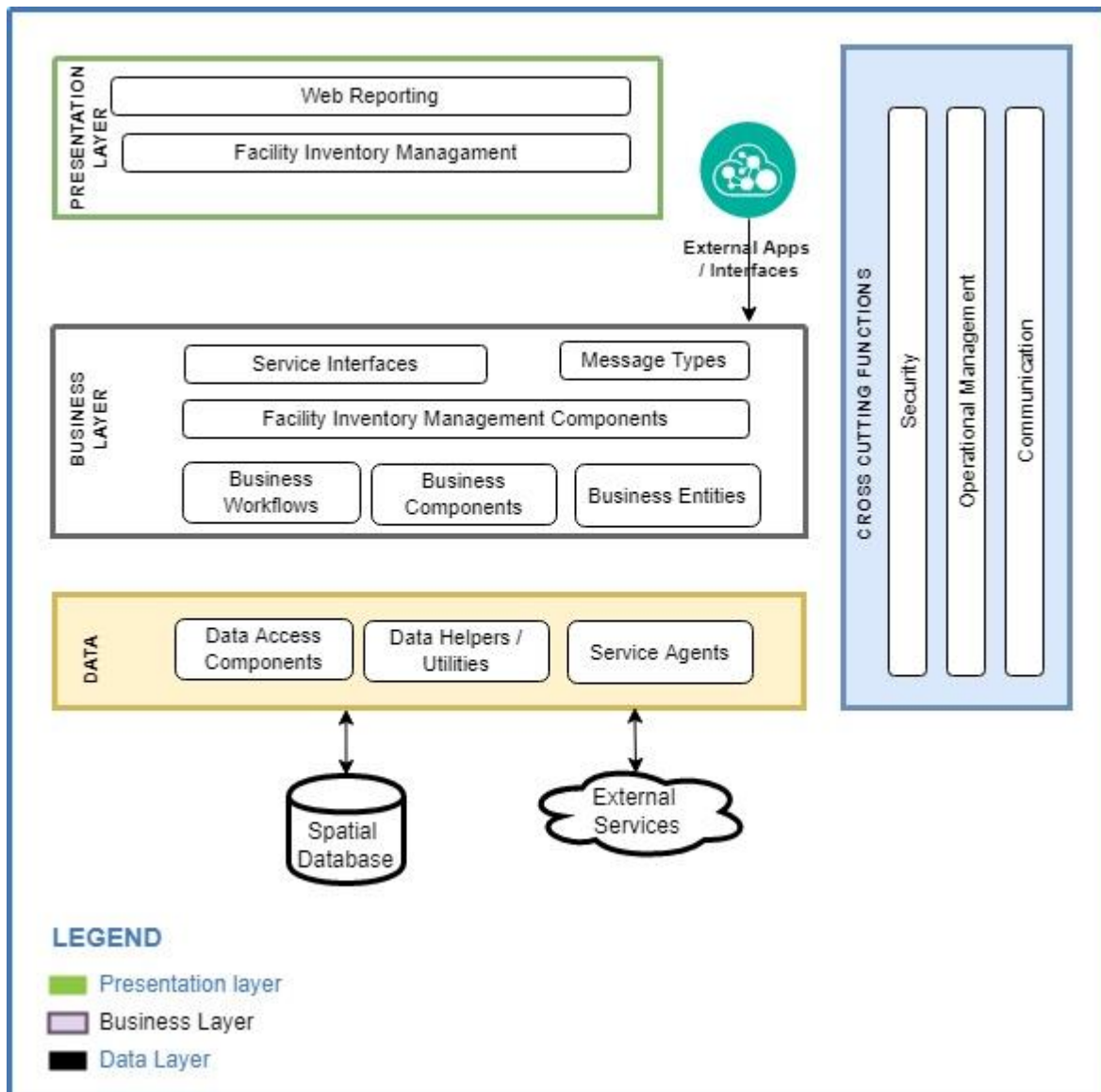


Figure 4: High Level System Architecture diagram

The high-level system architecture diagram is layered into three components:

- i. **The presentation layer.** This is the front-end layer that is handling the user views. The front-end layer is implemented as
 - i. Web Reporting Application based on HTML 5(Dojo JS Framework, ArcGIS JavaScript API, ArcGIS Server Web REST web mapping services.
- ii. **The business services layer.** This is the facility management back-end system that handles processing requests of the users. It is a set of back-end web services that implement the features and functionalities of the rangeland monitoring tool.

- iii. **The data access layer.** This is the persistent layer that stores all the data that support the Web reporting platform and user supplied data (Facility Inventory Management System). This data access layer is based on PostgreSQL +PostGIS RDBMS.

2.4.2 Deployment Architecture diagram

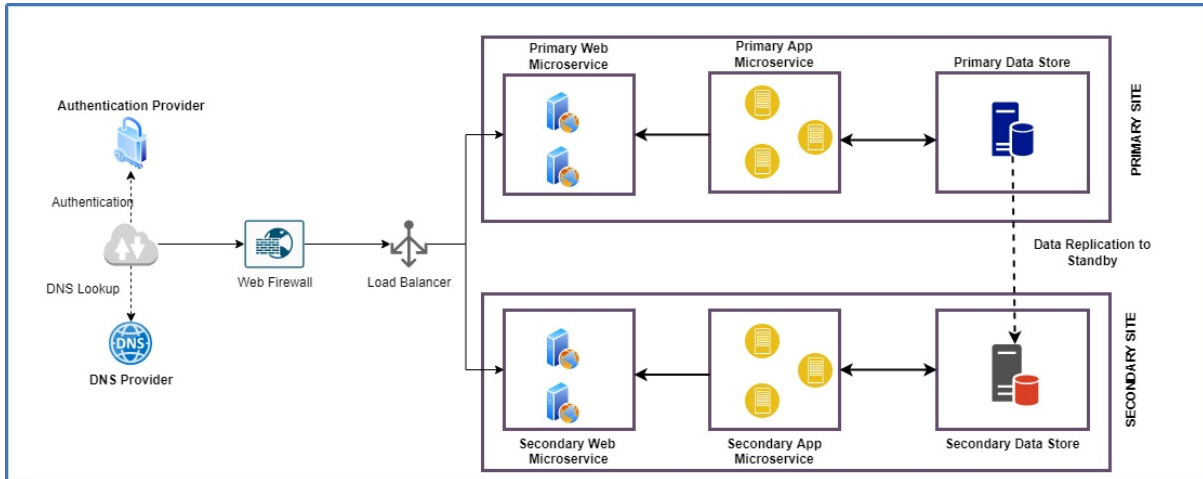


Figure 5: Deployment Architecture diagram

2.4.3 Integration Architecture diagram

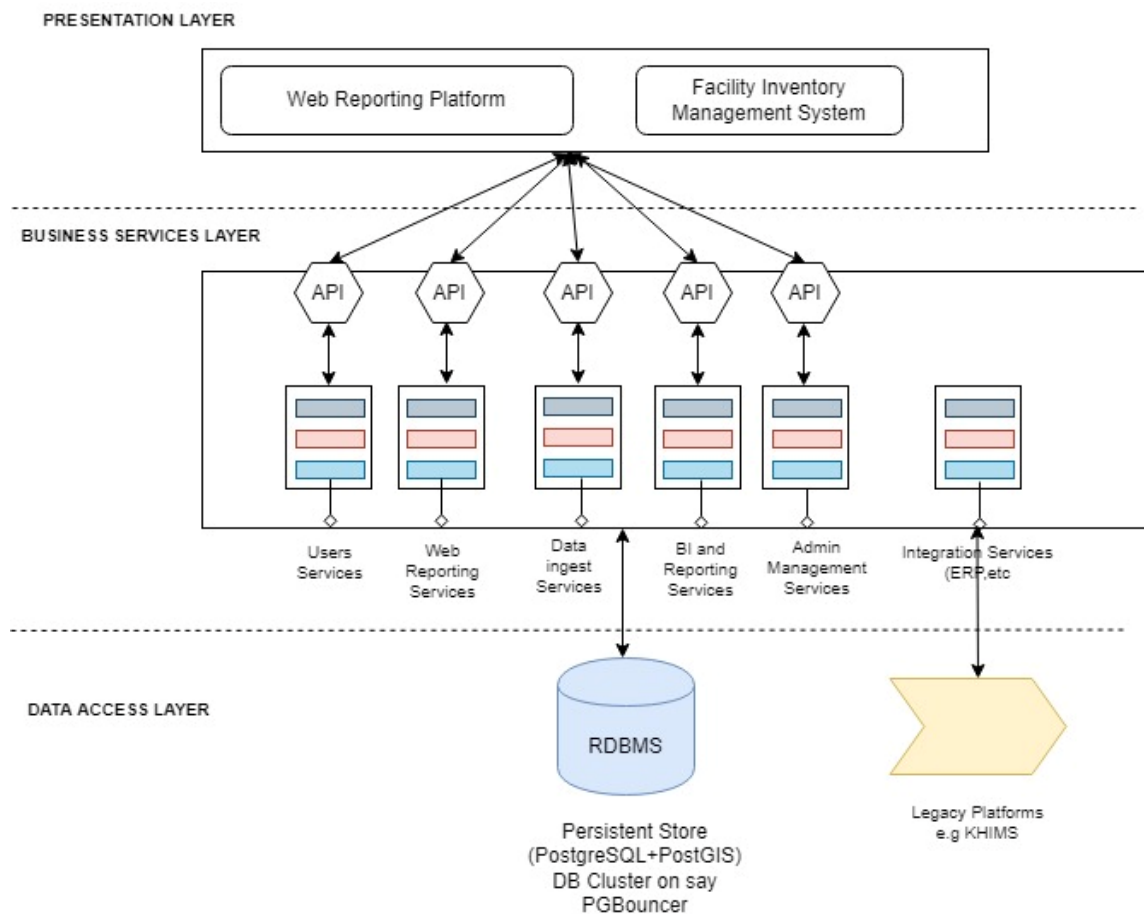


Figure 6: Integration Architecture Diagram

The architecture diagram can be decomposed on a 3-tier architecture composing of presentation, business and data access services layers. Predominantly, the architecture diagram indicates that the business layer is architect on the service-oriented layer. The service-oriented layer is architected on the docker and Kubernetes philosophy

This decomposition allows having separation of concerns between how the data is presented and how the data is accessed. This helps in ensuring that the application is built to allow ease of extension, loose coupling of the application, and solution manageability.

The business services layer is further broken into independent pieces of product features. This allows for flexibility of the solution, portability of the solution and manageability of the solution, since the services can each be worked on independently of each other.

2.4.4 Communication Interfaces

The communication interfaces that require being included into the platforms are as follows: Hyper Text Transfer Protocol (HTTP)/ Secure Hyper Text Transfer Protocol (HTTPS) used for communication between the Web client (browser) and NGINX Web Server/Apache web server etc.

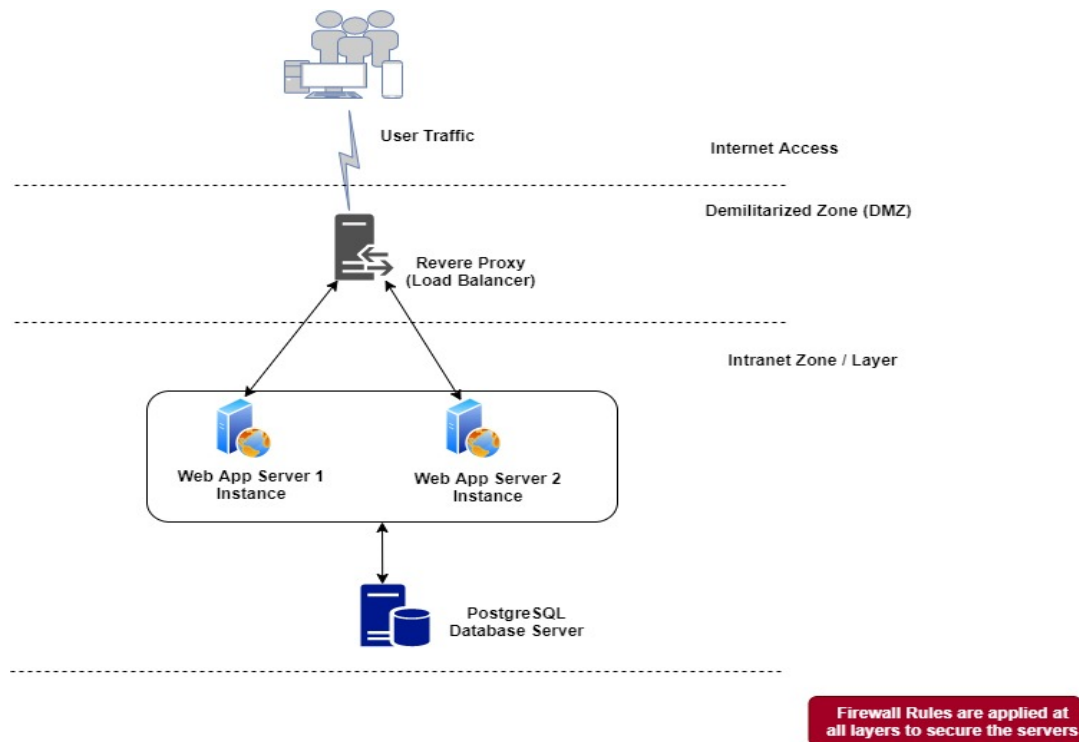


Figure 7: Physical Architecture Diagram

The physical architecture of the solution is composed of:

- One Reverse proxy server. To handle traffic routing from the client machines to the internal application servers. This provides an additional layer of security.
- Multiple Web servers. The multiple web servers are used to host the web applications (web app and web services) for the solutions, both the business services and the front-end application. They are scaled on demand to provide redundancy hence high availability and improved performance.
- Multiple DB servers. This will be used to create the databases used to support the platform. Multiple database instances will be created to support the various product features as exposed by the business services.

3 MATERIALS AND METHODS

3.1 Study area

Nairobi County is located at 1°17'S, 36°49'E and occupies 696 square kilometers. It is surrounded by three neighboring counties namely; Machakos, Kiambu and Kajiado. With a population of over 3 million, Nairobi ranks as one of the most populous cities in Eastern Africa. Nairobi County was picked as an area of study due to the nearness of facilities participating in the program. Due to cost and time constraints, it would be difficult to cover the entire country or travel to other counties. Figure 1 shows the map of Nairobi detailing the area of study.

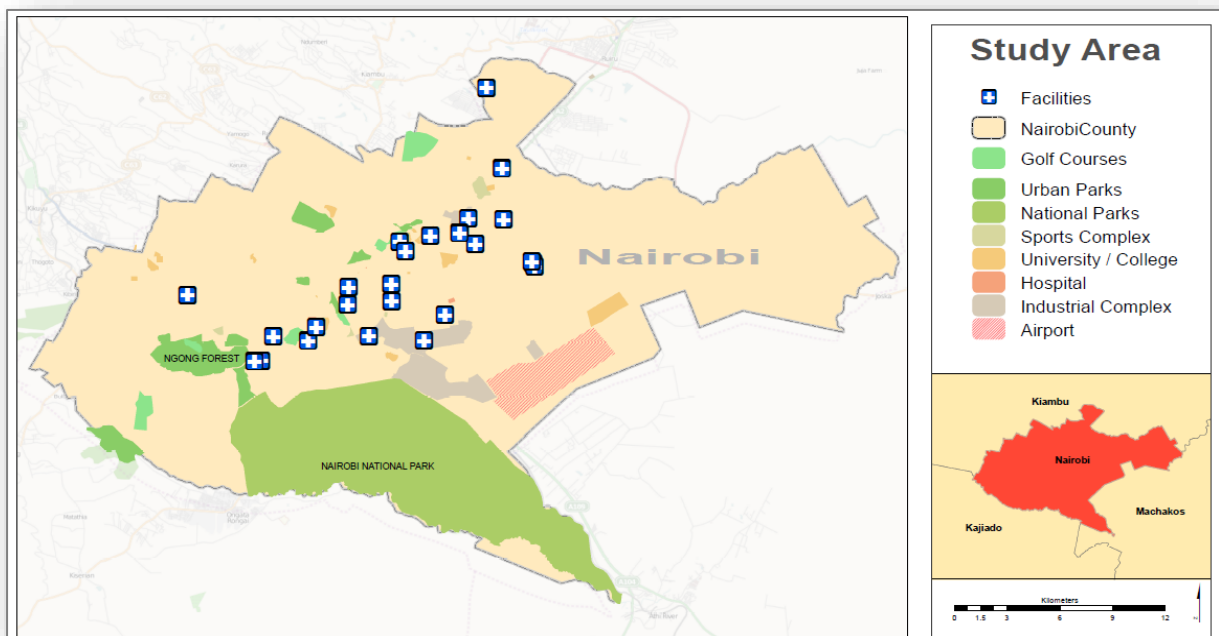


Figure 8: The study area showing health Facilities

3.2 Research Type and Design

Upon gathering initial information on the study, it was imperative that a survey needed to be done in order to establish the extent to which operations were affected and the challenges being faced. This would establish if and which type of solution would be proposed. Preliminary indications pointed towards a GIS web based application being developed, however the features and functionality were largely dependent on the survey outputs. This type of research is best described as applied research as it aims to find a solution to an

immediate problem facing nutrition programs. C. Kothari in his book intimates that applied research is used when among the key objectives is to find a solution to immediate problems. These problems could be affecting industries, organizations or the society. This research aims to thus find the nature and extent of problems faced and develop a best fit interactive web map for commodity tracking and management (re-supply, re-order) to ensure availability of adequate nutrition commodities for malnourished HIV+ patients (Lactating mothers, Adults & Children). A summary of the project design flow diagram is illustrated in Figure 5 below.

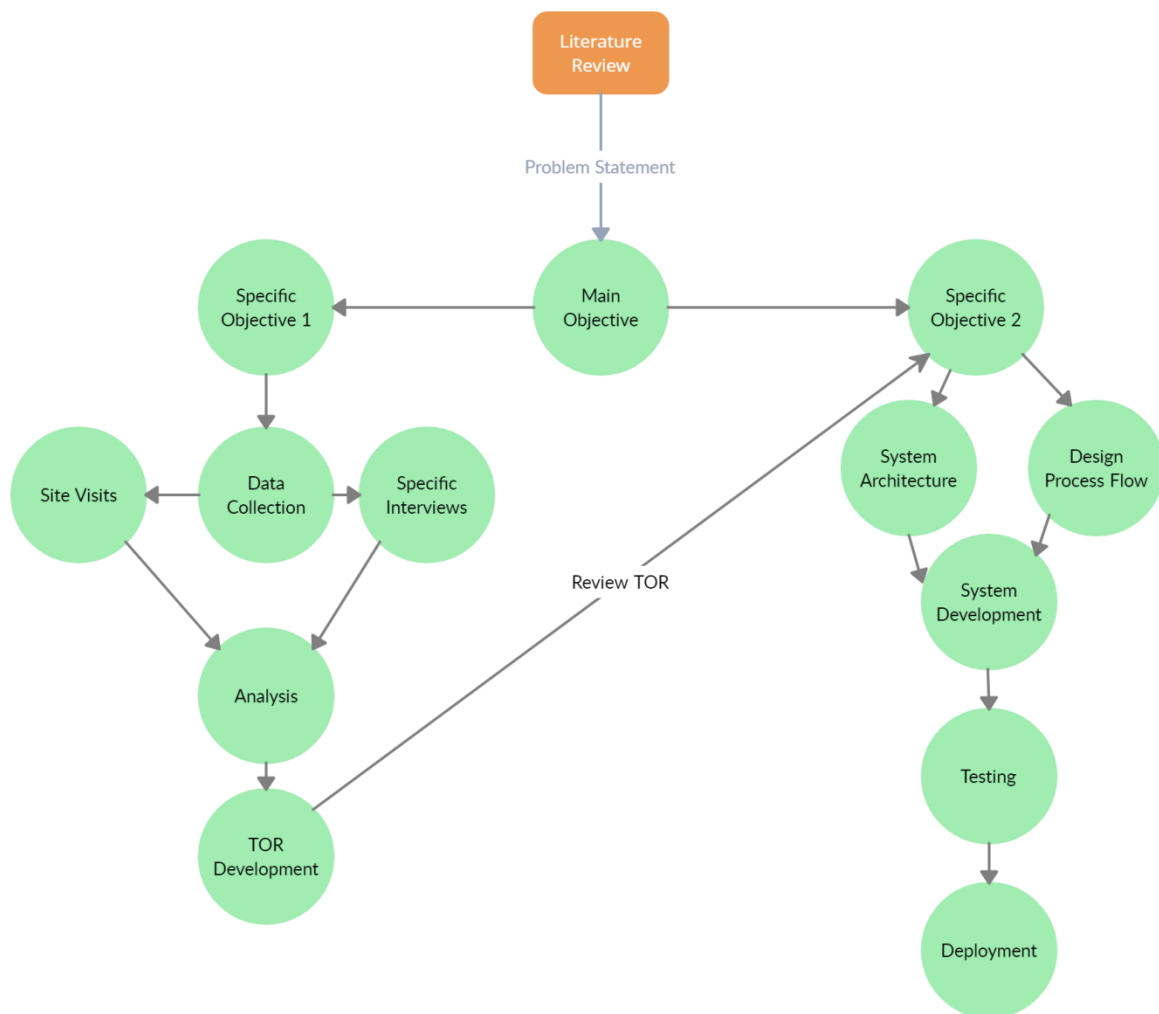


Figure 9: Project Design Flow

3.3 Analysis

3.3.1 NASCOP

Following the interview at NASCOP several gaps were realized within the nutrition program.

1) Some nutrition commodities were totally lacking at the ARTS sites. These included FBF for P&L mothers and children. FBF stocks for adults were almost running out too. This is depicted in Figure 7, the nutrition stock status report as at February, 2022 tabled in the HIV Commodities Security Committee Meeting on March 29, 2022. This was mainly due to the long turnaround time in manufacturing of nutrition commodities. It takes 6 months to deliver nutrition commodities upon order placement. This highlighted the need for standard stocks threshold analysis.

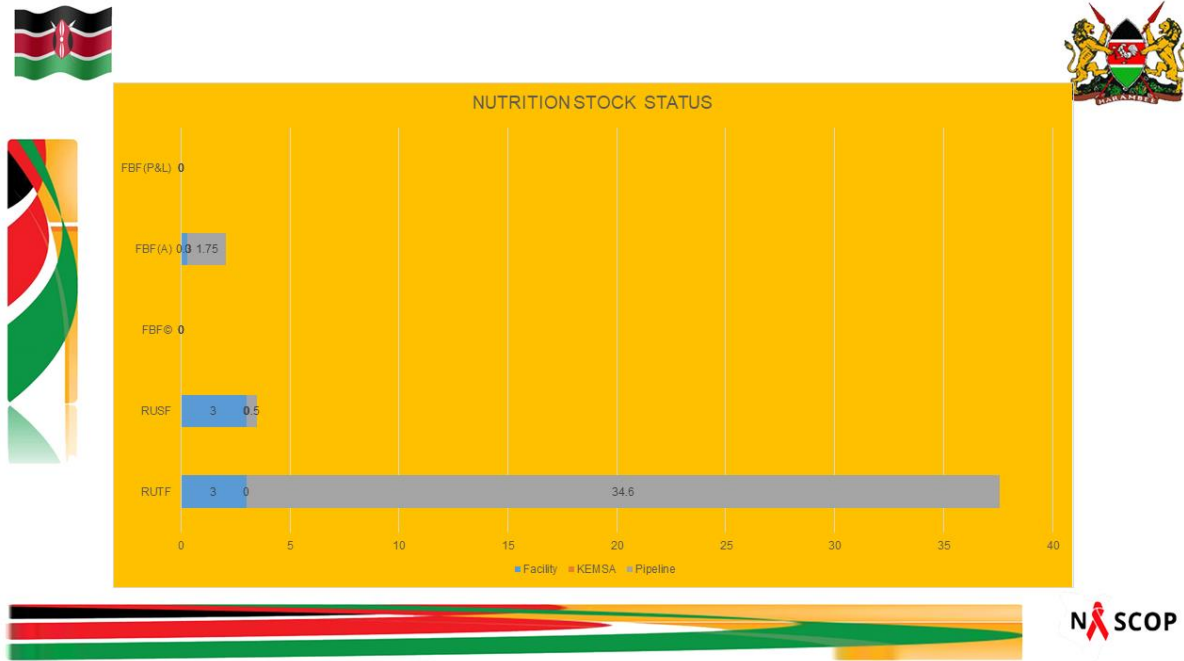


Figure 10: Nutrition Stock Status

2) There was a significant difference in the number of malnourished PLWHIV vs. those receiving nutrition. This is depicted in Figure 8 below.

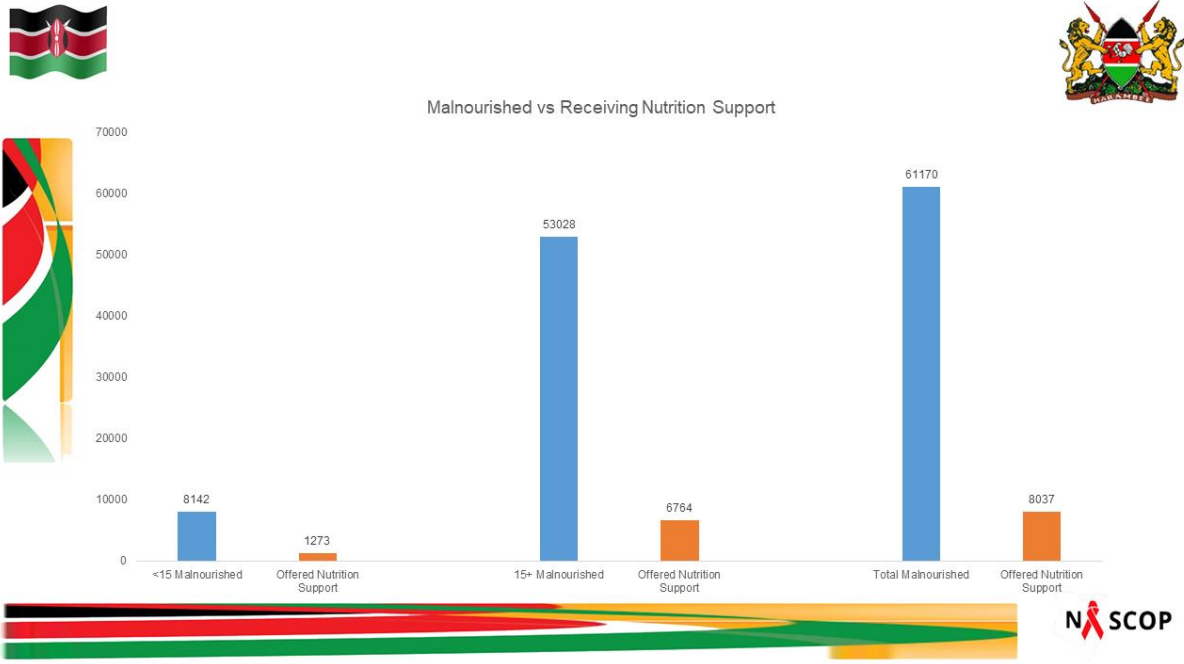


Figure 11: Malnourished vs. Receiving Nutrition

3.) There was also a noticeable gap in reporting from facilities that received nutrition. This is highlighted in figure 9

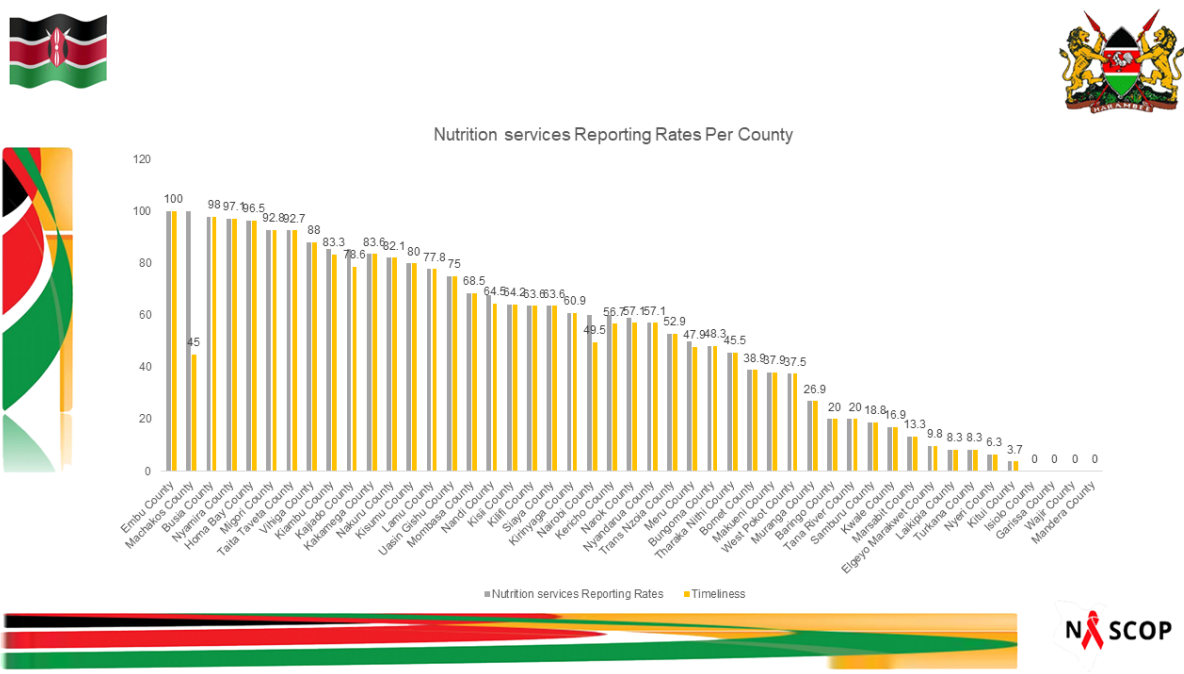


Figure 12: Facilities Reporting on Nutrition Commodities Status

3.3.2 NACS Centers - ART Sites

- 1.) **Storage capacity:** Out of the 5 NACS centers interviewed, 3 had storage capacity for nutrition commodities to last up to 6 months. 2 had the capacity to store Nutrition commodities up to 12 months. This was sufficient to meet the required thresholds to maintain stocks in between re-order and delivery cycles.
- 2.) **Data capture and Reporting:** Out of the 5 sites visited. 4 sites were capturing nutrition data using form MOH 731 – Care and Treatment Summary Tool in hard copy form. 1 site was using the ERM system to automatically update information to the KHIS. (Appendix A) shows the patient registration forms used in previous NHP programs and (Appendix B) shows Nutrition guidelines for the different patient categories.
- 3.) **Other Challenges:**
 - a. Fear of stigmatization led to low adherence by patients in the program
 - b. Poor staff to patient ration in the facilities led to low adherence in reporting

3.3.3 KEMSA

- 1.) **Storage Capacity:** KEMSA have up to 12 months (1 year) storage capacity to supply all NACS centers in the country.
- 2.) **Shelf life of nutrition commodities:** FBF in all patient categories have a shelf life of 6 months whereas RUTF/RUSF have a shelf life of 12 months
- 3.) **Ordering process:** KEMSA currently depends on data from KHIS and technical input from NASCOP in order to place an order. There is currently no SOP for allocated standard stock thresholds hence there is a big chance of experiencing stock outs
- 4.) **Logistics and distribution:** There currently exists an Ordering Management and Planning (OMP) System at KEMSA. This system is however being used only for ARV drugs. This can be extended to accommodate nutrition commodities however some key functionalities that would help streamline OMP were identified as;
 - a. Geo-enabling the application for more efficient logistical planning
 - b. Creating web based application for easier access
 - c. Broadening the scope of access to the system through training and delivery through mobile platforms

3.3.4 Equatorial Foods

- 1.) **Manufacturing and delivery:** The cycle for ordering and delivery of nutrition commodities to KEMSA central store is 6 months. This was a very critical detail in setting the re-order thresholds at KEMSA

3.4 System Technologies

The following is a brief description of the system technologies used. The components include; ArcGIS for Desktop; ArcGIS for Server; Spatial Database (PostgreSQL); and JavaScript API (Application Programming Interface).

i) Spatial Database (PostgreSQL)

The database design was used based on multiuser geodatabase which leverages ArcSDE technology. ArcSDE was implemented on a relational database management system (RDBMS).

ii) Data Model: - A data model was developed and used to guide in how data will be represented and accessed logically. The initial data schema provided the structure of the data to be collected including attribute information. Workflows were designed to guide data loading and migration, and updating procedures. This was aimed at automating and enhancing GIS processes.

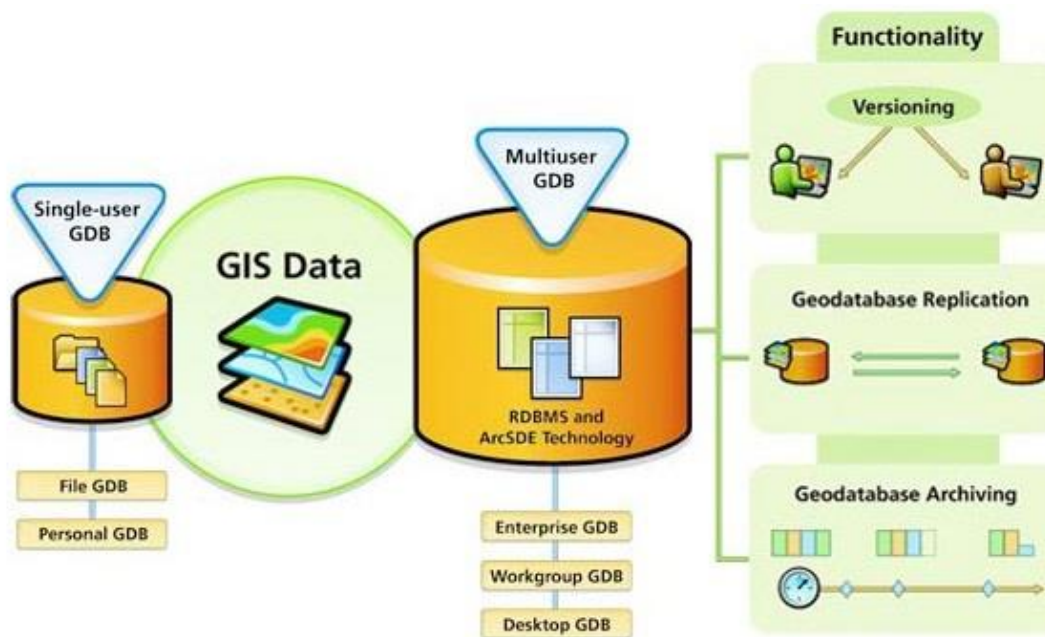


Figure 13: Multi-user Geodatabase

The multiuser geodatabase workflow (see figure 14) provided three key functionalities, namely; versioning, geodatabase replication, geodatabase archiving. Versioning aims at creating a version that gives the false impression that a copy of the entire geodatabase is

being created. As the user edits a feature class or table in a version, the edits are not directly applied to the parent version unless reconcile and post procedures are carried out.

Each health facility had its own version mainly because all the institutions are required to update information on commodity stock, recruitments and drop out numbers in the system. Multiple users are thus able to edit the same version at the same time via the web application through geodatabase replication. Archiving in ArcGIS provided the functionality to record and access changes made to all or a subset of data in a versioned geodatabase to enable capturing, managing and analyzing data change. Nutrition Programs need to preserve the changes made to their data in order to answer common historical questions.

iii) System users

Different system users are divided to the three groups, Administrator, Supervisor, and Editor User groups. These groups have different access levels which are configured at the server level. Each user is capable of accessing the web application via the web on different clients such as desktop computers, tablets, smart phones or GPS devices. The Administrator user has full access rights to the database and the web application. The administrator is responsible for adding users and assigning them roles in the database.

The Supervisor user controls the quality of data being posted from different institutions. He/she has read/write access rights to the database to ensure that the correct information is registered in the default geodatabase which is eventually used to make critical decisions on commodity supplies.

The Editor is stationed in each health facility to ensure that current information regarding recruitments, drop outs and stock levels is recorded in the system. The editor user has read/write access rights only to one feature class – the facility.

i) ArcGIS for Desktop – Mapping interface

ArcGIS for Desktop was used to compile, use, and manage facility information before publishing to the web. This included comprehensive professional GIS applications that support a number of GIS tasks, including mapping, data compilation, analysis, geodata and image management, and geographic information sharing.

This study used ArcGIS for Desktop for mapping, data compilation and management, spatial analysis, and creating maps and geographic information to be served and consumed by authorized service providers/institutions in the Nutrition Programme. For the purpose of this research, ArcGIS for Desktop Standard license level was used. This license has the capabilities of concurrent editing and performing standard analysis workflows that accomplished the goals stated for this research.

ArcGIS for Desktop (see figure 15) was thus used to create geographic information from different sources, which were then shared and served to a range of users through the web application interface. This application has powerful spatial analysis capabilities that were used to generate reports regarding commodity consumption and stock levels. Publishing of the map document was accomplished using ArcGIS for Server.

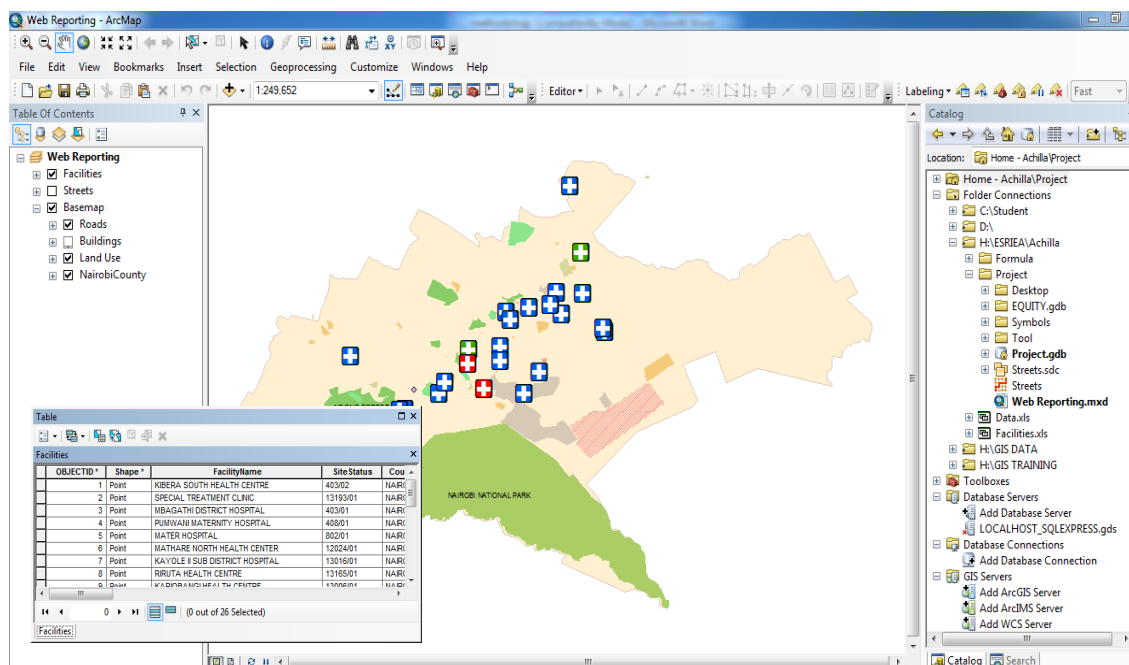


Figure 14: ArcGIS for Desktop - Desktop Interface

ii) ArcGIS for Server – Publishing interface

This is a server-based implementation of ArcGIS and was used to serve/publish the project map, geodatabase, analysis models, and other elements of geographic information that were created using ArcGIS for Desktop.

The map containing health facilities and other reference information published using ArcGIS Server followed widely adopted web standards for access and use. Authorized users at the facilities have different access levels to the system. This includes Administrator who has full access rights, editors who have read/write access rights, and map viewers who can read the information but not allowed to perform any edits on the information presented on the web.

With ArcGIS for Server (see figure 13), users are able to:

- Publish an intuitive Web application tailored to the health facilities. This dramatically strengthened reporting and collaboration in the program thus resource decisions were arrived at with real-time geo-intelligence.
- Geodata is centrally managed; this can now provide better data security and integrity for important information on nutrition programs in the country.
- Extend GIS to its mobile workforce, improving efficiency in delivery of nutrition commodities to the different service points.



Figure 15: ArcGIS Server functionality

iii) Customizing web application

Using the ArcGIS online API for JavaScript, this research pulled a high-performing,

engaging web application that incorporated GIS mapping, editing, and geoprocessing functionality. The web map published from ArcGIS online was used to create custom functionalities that made the application user-friendly. The ArcGIS online API was used to efficiently develop a lightweight application that met the routing needs of the nutrition program. JavaScript applications are stored in simple text files, usually as part of HTML documents. They are developed using a text editor such as Aptana. In order to create and deploy a JavaScript application, the minimum requirements are a text editor, a web server, and a web browser. Figure 14 illustrates the link between the web pages, ArcGIS server and JavaScript (Dojo framework) used to call map services onto the web page and to enhance interactivity on the web application.

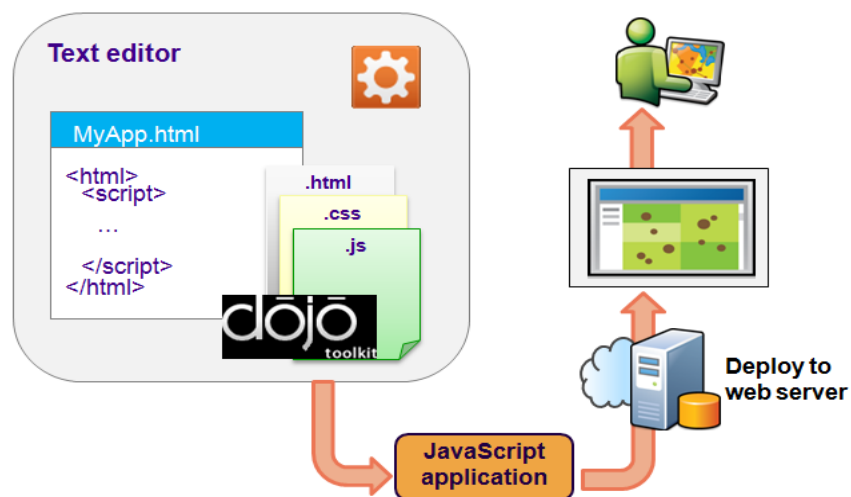


Figure 16: JavaScript Development Environment

iv) Routing Application

Solving a route analysis can mean finding the quickest or even the shortest depending on the impedance you choose to solve for. If the impedance is time, then the best route is the quickest route. This research utilized a network analyst application from ArcGIS online to create a route analysis functionality which guided the delivery crew on the optimal route to taken during delivery of nutrition commodities to the service centers from the central store in Nairobi.

The route analysis functionality was published on the web and made accessible the web application. The delivery crew can now use web enabled devices to improve efficiency in

delivery and also ensure that the patients do not miss out on the important commodities for their day-to-day health. The analysis also provides a summary report on the total distance and time required to cover the deliveries.

3.5 System Development Journey

Figure 15 below, shows a complete description of how business process management, policies, checklists, forms, links to other applications were captured and used for system development.

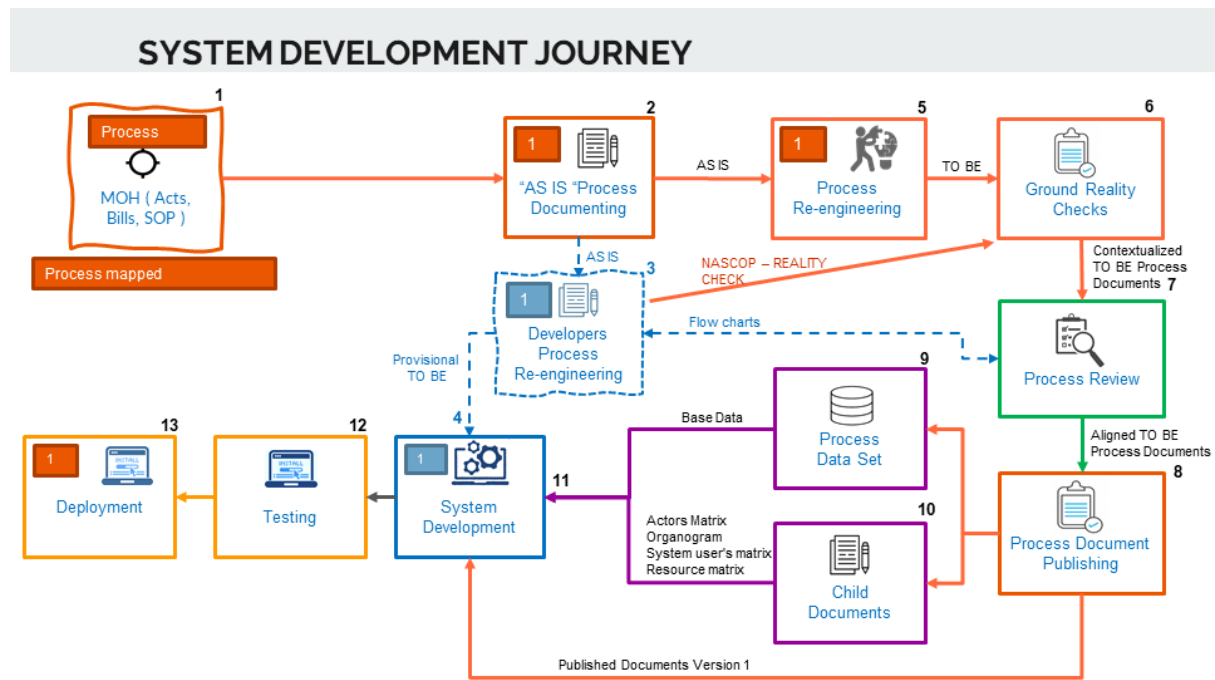


Figure 17: System Development Journey

1. Process mapping
 - a) Business process mapping is conducted to identify which process will be used in the GIS web Driven reporting system
 - b) Requirements gathering through various methods such as interviews
2. As is process documentation
 - a. This involves documentation of the identified process
 - b. Documents the process as is currently conducted manually
 - c. It involves documenting the following detailed documentation;
 1. Current name of process
 2. Process owner
 3. Process improvement (Non-policy change)

4. Process improvement Recommendation (Policy Change)

5. Process Policy/Act

6. Created By

7. Version: version of document

8. Description: A brief overview of the process

9. Actors

10 Process purpose

11. Process Scope

12 Process Input

13. Process Boundaries

14. Process Flow

15 Process output

16 Exceptions to normal process flow

17 Control pins and measurements

3. Process Re-engineering

a. This involves revising process charter timelines

b. Involves optimizing the process flow factoring automation and semi-automation of tasks

4. Ground Reality checks

Verify on ground with actual users on the feasibility of the re-engineered process. for instance, if the process access requires internet access and computers, do we have internet access in the ground? Do we have power/and or safe to connect laptops, tablets? Is the working environment secure? Etc.

5. Process Review

This involves QA/QC process on the re-engineered process factoring in ground realities to develop a TO BE process document

6. Process Data Sets

This informs the base/primary datasets required. For instance, NACS centers, Facility Data

7. Child Documents

- a) Actors Matrix- process actors, roles, rights and permissions
- b) Organogram: Institutional arrangement for the actors, etc.
- c) System User's matrix: Other users of the system other than the process actors.
- d) Resource matrix. These are the resource requirements for the actors and system. For instance, users require laptop, tablet, depending on their roles and responsibilities in the system

8. System Development

Actual coding of the system utilizing the process documents and design documents

9. Testing

- a) UAT testing
- b) System integration testing

10. Deployment

- a) Publishing to AGOL
- b) Configuration and Set-up for the web reporting platform and facility inventory management system

4 RESULTS AND DISCUSSIONS

4.1 Data Collected

4.1.1 Primary data

- A. **NACS Centres:** Interviews were done with questions relevant to the areas of interest in the study. Simple random sampling (SRS) was used to pick facilities where the questionnaire was administered. A total of 5 NACS centres were visited and responses noted. Respondents were the resources involved in issuing of the nutrition commodities within the centres. The data was then analysed and documented.
- B. **NASCOP:** An interview was scheduled with the Nutrition officer who answered a series of questions regarding challenges facing the program. The interview provided relevant program information including; Number of outlets in the program, NACS centres within Nairobi and the 47 counties and compliance by centres within the program
- C. **KEMSA:** An interview was scheduled with the officer in charge of logistics and planning. A series of questions were asked regarding the order reorder systems in place and challenges faced in the process
- D. **EQUATORIAL FOODS:** An interview was scheduled with the officer in charge of logistics and planning. A series of questions were asked regarding the order processing and delivery cycle for the fortified blended foods. This was to identify the period between ordering and actual delivery.
- E. **FACILITY DATA:** This is facility data that was sourced from the Kenya Open Data Initiative (KODI) website. The facility data was downloaded in Excel format then imported into PostgreSQL database. Attribute information included facility name and geographic coordinate defined. This is illustrated in the table 1 below;

Table 2: Facility data

Facility Name	County	Date Started	Lat°	Lon°
Kibera South Health Centre_Kshc (Mbagathi Dh)	Nairobi	1/4/2007	-1.30566001	36.78454
Special Treatment Clinic	Nairobi	1/1/2010	-1.28000998	36.82299
Mbagathi District Hospital	Nairobi	10/26/2006	-1.30792499	36.80224
Pumwani Maternity Hospital	Nairobi	6/27/2006	-1.27849495	36.84484
Mater Hospital	Nairobi	1/4/2007	-1.30539298	36.83348
Mathare North Health Center	Nairobi	3/6/2009	-1.25322998	36.86485
Kayole Ii Sub District Hospital	Nairobi	9/1/2009	-1.26754200	36.91743
Riruta Health Centre	Nairobi	10/1/2009	-1.28404999	36.74052
Kariobangi Health Centre	Nairobi	2/1/2010	-1.25173998	36.87978
Lunga Lunga Health Centre	Nairobi	2/2/2010	-1.30782998	36.86157
Ngaira Rhodes Dispensary	Nairobi	1/1/2011	-1.28893995	36.82251
Langata Health Centre	Nairobi	1/1/2011	-1.31814003	36.7783
Dandora Ii Health Centre	Nairobi	1/1/2011	-1.25760996	36.88775
Kamiti Prison Hospital	Nairobi	1/1/2011	-1.17611003	36.89343
Langata Women Prison Health Centre	Nairobi	1/1/2011	-1.31861997	36.77503
Makadara Health Centre	Nairobi	1/1/2011	-1.29430997	36.87226
Kasarani Health Centre	Nairobi	3/27/2012	-1.21820998	36.90139
Kenyatta National Hospital	Nairobi	4/1/2012	-1.30087602	36.80639
Dandora Clinic (Edarp)	Nairobi	11/1/2009	-1.24474001	36.90223
Babadogo (Edarp)	Nairobi	11/1/2009	-1.24409997	36.88416
Soweto (Edarp)	Nairobi	11/1/2009	-1.26916003	36.91808
Mathare 3a (Edarp)	Nairobi	11/1/2009	-1.25613296	36.84907
Huruma (Edarp)	Nairobi	11/1/2009	-1.26110995	36.85214
Kayole (Edarp)	Nairobi	11/1/2009	-1.26648998	36.91668

F. PATIENT CATEGORIES DATA: Following interviews at NASCOP, it was established that there are 3 patient categories used in nutrition and HIV Program. The three (3) patient categories are Pregnant and Lactating Mothers, Adults (above 15 years) and children (Below 15 years). This is mainly due to the fact that the categories cut across

all the vulnerable patient categories in the program. The selected categories are as follows;

1. Pregnant and lactating mothers
2. Adults above 15 years
3. Children below 15 years

The data can further be illustrated in the tables 2 to 4 below as per the NACS/FBP programming matrix; Input Current patient categories

Table 3: Children 15 years & below

	Patient records
Eligibility	<ul style="list-style-type: none"> • HIV positive • Bilateral pitting oedema + • BMI less than 20 kg/m² • Passed appetite test
Prescription	<ol style="list-style-type: none"> 1. Nutrition counseling 2. 21 sachets of RUTF per week 3. 1 bag (4.5kg) FBF (Advantage) per month 4. One bottle water guard (150 ml) per month
Treatment follow Up	<ul style="list-style-type: none"> • Weekly (7 days)
Treatment end point	<ul style="list-style-type: none"> • No oedema for 10 days • Passed appetite test • Observed weight gain • Steady weight gain after 6 weeks & BMI > or = 20
Treatment period	<ul style="list-style-type: none"> • 30 days • Stop RUTF and continue nutrition counseling and prescribe FBF

Table 4: Adults 15 years & above

	Patient records
Eligibility	<ul style="list-style-type: none">• HIV positive• Bilateral pitting oedema +• BMI less than 16 kg/m²• Passed appetite test
Prescription	<ol style="list-style-type: none">1. Nutrition counseling2. 21 sachets of RUTF per week3. 1bag (4.5kg) FBF (Foundation Plus) per month4. One bottle water guard (150 ml) per month
Treatment follow Up	<ul style="list-style-type: none">• weekly (7 days)
Treatment end point	<ul style="list-style-type: none">• BMI equal to or greater than 16 kg/m²• No oedema for 10 days• Passed appetite test
Treatment period	<ul style="list-style-type: none">• 30 days• Stop RUTF and continue nutrition counseling and prescribe FBF as MAM prescription

Table 5: Pregnant and Lactating Mothers

	Patient records
Eligibility	<ul style="list-style-type: none"> • HIV positive • Bilateral pitting oedema + • BMI less than 20 kg/m² * • MUAC less than 19cm • Passed appetite test**
Prescription	<ol style="list-style-type: none"> 1. Nutrition counseling 2. 21 sachets of RUTF per week 3. 1 bag (4.5kg) FBF (Advantage) per month 4. One bottle water guard (150 ml) per month
Treatment follow Up	<ul style="list-style-type: none"> • Weekly (7 days)
Treatment end point	<ul style="list-style-type: none"> • MUAC equal to or greater than 19 cm • No oedema for 10 days • Passed appetite test • Observed weight gain of above 1 kg/month during pregnancy • Steady weight gain after 6 weeks & BMI > or = 20
Treatment period	<ul style="list-style-type: none"> • 30 days • Stop RUTF and continue nutrition counseling and prescribe FBF as MAM prescription

G. NUTRITION COMMODITIES: Nutrition programs issue about 15 varieties of nutrition commodities to different groups of patients. This study will focus on three (3) nutrition commodities which include;

- i. Fortified Blended Food (FBF):** FBF are used across the board for all patient categories whether severely or moderately malnourished. The nutrients are however varied depending on the patient category. With there for have FBF adult for adults above 15 years, FBF child for children below 15 years and FBF P&L for pregnant and lactating mothers.
- ii. Ready to Use Therapeutic Foods / Ready to Use Supplementary Foods (RUTF / RUSF):** The key functions of RUTF's / RUSF's are the fact that they are energy dense and micro-nutrient enriched. Mostly RUTF's are for severely malnourished while

RUSF's for moderately malnourished PLWHIV. They are made of: dried skimmed milk, oil, vitamin, mineral supplement and sugar.

H. Facility Attribute data

The attribute data for a health facility is where the core functionality for the application will be derived. Field calculators have been applied to specific fields of the data so as to enable various queries which gives the application near real-time analysis capabilities.

This data includes;

- i. **Number of patients:** This is the number of patients either recruited or dropped from the program. The number of patients per program greatly influences the quantity of nutrition commodities consumed. Table 5 in the next page further illustrates this.

Table 6: Patient Numbers per Facility

Facility Name	County	No. Pregnant Mothers	No. Adults Above 15 Years	No. of Children Below 15 Years	Sum Total
Kibera South Health Centre	Nairobi	14	40	16	70
Special Treatment Clinic	Nairobi	8	24	23	55
Mbagathi District Hospital	Nairobi	12	30	12	54
Pumwani Maternity Hospital	Nairobi	10	28	6	44
Mater Hospital	Nairobi	6	20	12	38
Mathare North Health Center	Nairobi	17	25	8	50
Kayole Ii Sub District Hospital	Nairobi	11	24	4	39
Riruta Health Centre	Nairobi	7	18	3	28
Kariobangi Health Centre	Nairobi	12	15	13	40
Lunga Lunga Health Centre	Nairobi	14	24	11	49
Ngaira Rhodes Dispensary	Nairobi	11	18	9	38
Langata Health Centre	Nairobi	8	13	15	36
Dandora Ii Health Centre	Nairobi	6	10	21	37
Kamiti Prison Hospital	Nairobi	14	26	26	66
Langata Women Prison Health Centre	Nairobi	20	28	7	55
Makadara Health Centre	Nairobi	18	31	15	64
Kasarani Health Centre	Nairobi	25	27	9	61
Kenyatta National Hospital	Nairobi	17	29	23	69
Dandora Clinic (Edarp)	Nairobi	15	17	3	35
Babadogo (Edarp)	Nairobi	12	12	5	29
Soweto (Edarp)	Nairobi	16	24	14	54
Mathare 3a (Edarp)	Nairobi	12	28	10	50
Huruma (Edarp)	Nairobi	10	22	4	36
Kayole (Edarp)	Nairobi	9	24	7	40
	Sum Total	304	557	276	1137
	Average	12.67	23.21	11.5	47.38
	Maximum	25	40	26	70
	Minimum	6	10	3	28

- ii. **Quantity issued:** This is the amount of nutrition commodities consumed. The number is affected by quantity of patients in a program and influences the quantity issued and eventually the order tracker. The formula and expression is shown below;

[ready_to_use_supplementary_food]+ [ready_to_use_therapeutic_food] + [Fortified_Blended_Food]

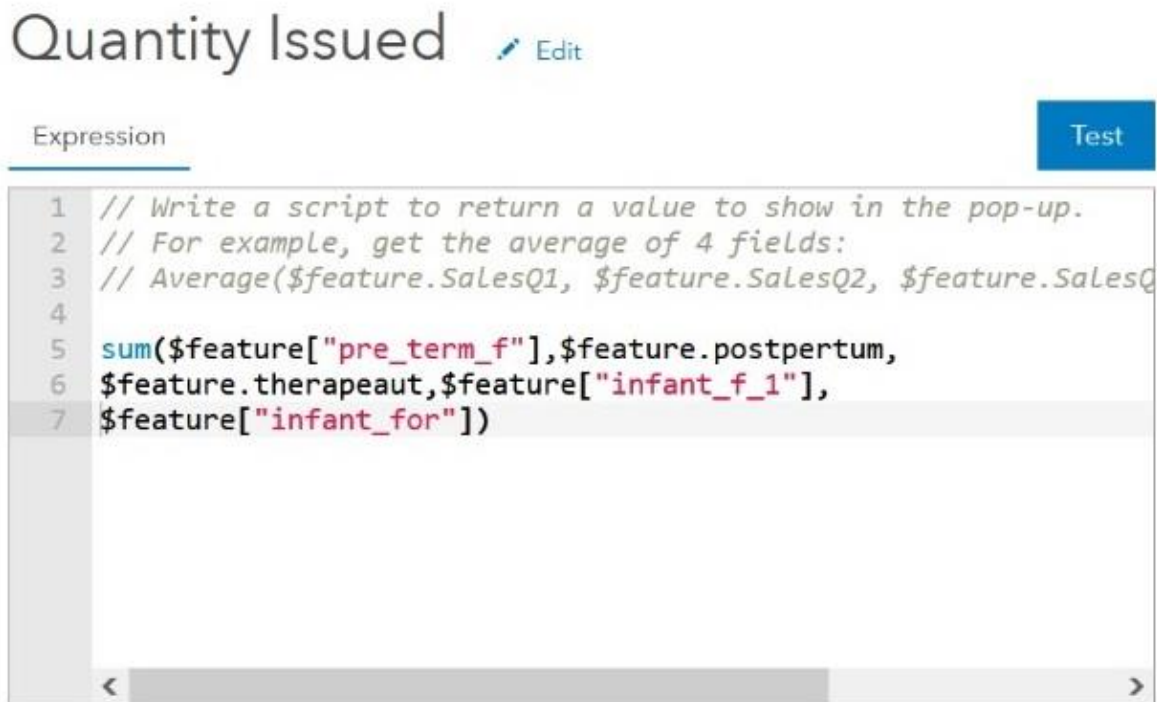


Figure 18: Expression for calculating Quantity Issued

- iii. **Monthly Stocks:** This is a calculation derived from the quantity issued and multiplied by 3 the assumption being that these amounts can cushion the facility against stock outs in case of recruitment through the month. This assumption is derived from verbal interviews with nutrition officers in selected facilities. Most respondents claimed that whenever they order above half more stock than the required, they would make it till the next delivery. The closing stocks of the order tracker at the end of every month become the quantity delivered at the beginning of every month. The formula to automate this is shown below;

*[QuantityIssued]*3*

Monthly Stock [Edit](#)

```
Expression Test  
1 // Write a script to return a value to show in the pop-up.  
2 // For example, get the average of 4 fields:  
3 // Average($feature.SalesQ1, $feature.SalesQ2, $feature.SalesQ  
4  
5  
6 (sum($feature["pre_term_f"],$feature.postpertum,  
7 $feature.therapeaut,$feature["infant_f_1"],  
8 $feature["infant_for"]))*3
```

Figure 19: Expression for Calculating Monthly Stocks

- iv. **Threshold:** Threshold is put at 50% of the quantity delivered. This was established after analysing stock out statistics and establishing the average lead time between order and delivery was between one and two weeks. This figure triggers the ordering process and allows for ample logistical planning thus enhancing efficiency in distribution. The formula and expression is shown below;

$[MonthlyStockDelivered]*0.5$

Threshold [Edit](#)

```
Expression Test  
1 // Write a script to return a value to show in the pop-up.  
2 // For example, get the average of 4 fields:  
3 // Average($feature.SalesQ1, $feature.SalesQ2, $feature.SalesQ  
4  
5  
6 0.5 * ((sum($feature["pre_term_f"],$feature.postpertum,  
7 $feature.therapeaut,$feature["infant_f_1"],  
8 $feature["infant_for"]))*3)
```

Figure 20: Expression for Calculating Threshold

- iv. **Balance:** This is the amount gotten upon subtracting quantity issued from quantity delivered. The formula and expression is shown below;

[QuantityDelivered]- [QuantityIssued]

Balance [Edit](#)

Expression Test

```

1 // Write a script to return a value to show in the pop-up.
2 // For example, get the average of 4 fields:
3 // Average($feature.SalesQ1, $feature.SalesQ2, $feature.SalesQ3, $feature.SalesQ4)
4
5 // Write a script to return a value to show in the pop-up.
6 // For example, get the average of 4 fields:
7 // Average($feature.SalesQ1, $feature.SalesQ2, $feature.SalesQ3, $feature.SalesQ4)
8
9
10 ((sum($feature["pre_term_f"],$feature.postpertum,
11 $feature.therapeaut,$feature["infant_f_1"],
12 $feature["infant_for"]))*3)-(sum($feature["pre_term_f"],
13 $feature.postpertum,$feature.therapeaut,
14 $feature["infant_f_1"],$feature["infant_for"]))

```

Figure 21: Expression for Calculating Balance

- v. **Quantity Delivered:** This is the quantity of nutrition commodity delivered to each facility. The quantity delivered is normally the amount of the order placed on the last day of every month. The formula and expression is shown below;

*Quantity Issued * 3*

Quantity Delivered [Edit](#)

Expression Test

```

1 // Write a script to return a value to show in the pop-up.
2 // For example, get the average of 4 fields:
3 // Average($feature.SalesQ1, $feature.SalesQ2, $feature.SalesQ3, $feature.SalesQ4)
4
5
6 (sum($feature["pre_term_f"],$feature.postpertum,
7 $feature.therapeaut,$feature["infant_f_1"],
8 $feature["infant_for"]))*3

```

Figure 22: Expression for Calculating Quantity Delivered

4.1.2 Secondary data

This research used secondary spatial data from Survey of Kenya, Kenya Roads Board, Open Street Map (OSM), FHI 360, and ArcGIS Online Basemaps. Figure 19 and Table 6 show base maps pulled from ArcGIS Online as well as other data sources used.

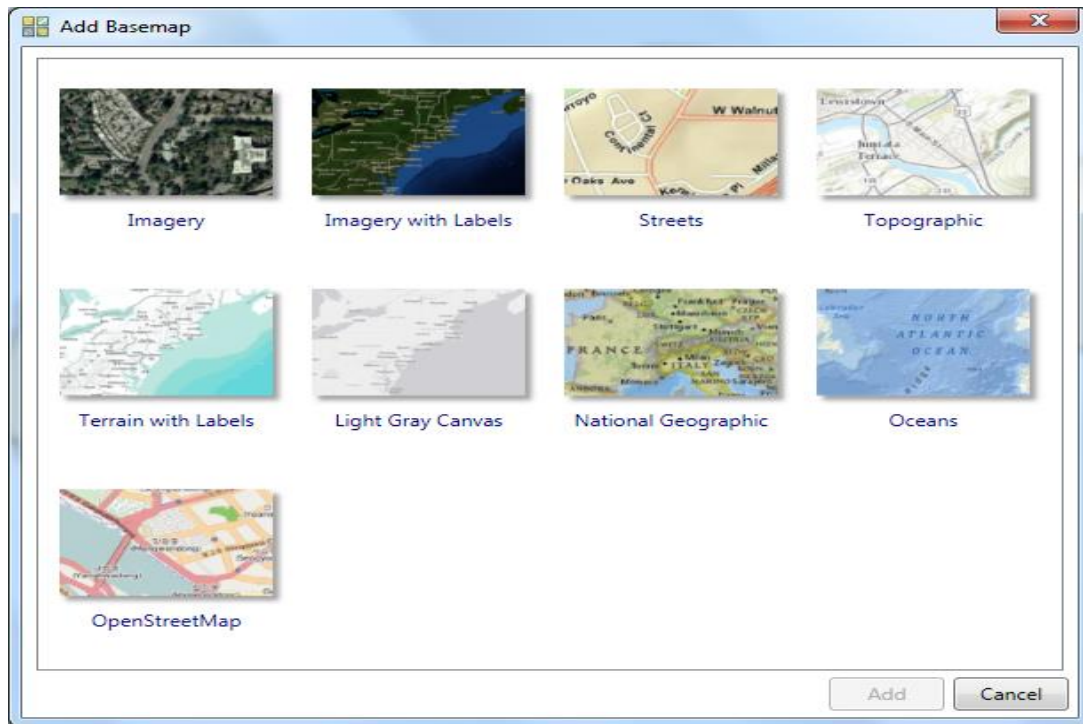


Figure 23: Base Maps from ArcGIS Online

4.1.3 Data Sources

Table 7: Data Sources

Data	Source	Comment
Administration Boundaries	Survey of Kenya	Shows the county boundaries
Major Highways	Kenya Roads Board	Class A
Secondary Highways	Kenya Roads Board	Class B and C
Streets	OSM	Street data
Base Maps	ArcGIS Online	The application pulled the base maps for better visualisation
Health Facilities	Kenya Open Data Initiative	Data in the Kenya open data initiative is accessible to all
Nutrition Program Data	NASCOP	Only sample data on patient category and nutrition commodities was shared

4.2 GIS Driven Reporting, Monitoring and Distribution Web Application

The link to the web application is;

<https://wilarch.maps.arcgis.com/apps/webappviewer/index.html?id=56acf068dc874ddf80b9286d95250038>

The web application has an Interactive web user interface that can be used to input near real time data from facilities. This data is immediately accessible to the assigned resources at the program headquarters in NASCOP offices in Nairobi. This data can be entered from any facility in the program.

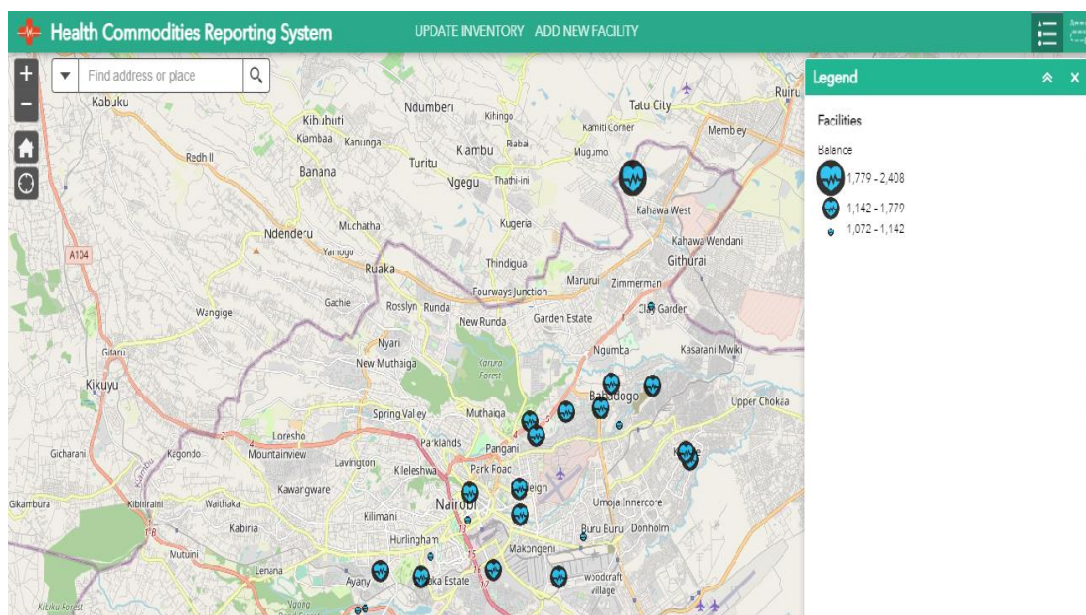


Figure 24: Web Reporting Interface

The visible part of the interfaces (see figure 24), shows several features available on the home page. The feature functionality is summarized below;

4.2.1 Health Commodities Inventory Manager:

The health commodities inventory manager is accessed through the update inventory tab. It is found at the top ribbon next to the add facility tab and gives you access to the facility inventory manager (See figure 25). The system allows each facility to enter program information into the system including; nutrition commodity information as well as patient number per facility by category. As data is entered it updates the centralised system which is accessible at the NASCOP HQ. Versioning protects the main data from being tampered with. As nutrition commodities are issued the stock levels are adjusted using the field calculators input in the application. The end result is

the adjusted stock balances available in the facility accessible both at the facility and the NASCOP HQ.

A level of accountability will be realised as stock balances will tally with issues and number of patients in a program. This information is near real time thus enhancing credibility and accountability within the program.

Facility Code	Facility Name	Site Status	Site Code	Hospitalty
720.00	KASARANI HEALTH CENTRE	13010/01	13,010.00	LOCAL GOVT
504.00	MAKADARA HEALTH CENTRE	13056/01	13,056.00	MOH
503.00	LANGATA WOMEN PRISON HEALTH CEN	13044/01	13,044.00	MOH
502.00	KAMITI PRISON HOSPITAL	13000/01	13,000.00	MOH
501.00	DANDORA II HEALTH CENTRE	12912/01	12,912.00	MOH

Figure 25: Updating Information at the Health Facility

The facility upon issuing nutrition commodities will update the same in the health commodity inventory tab. The bottom left part in figure 25; shows a window labelled manage your facility inventory. Upon selecting a facility, you will be able to edit your facility information as shown in Figure 26 below. Once the information is saved, NASCOP upon refreshing the homepage will be able to access the updated information from the facility. It is important to note that each facility upon logging in will only be able to visualise their facility's information. This is enabled by assigning users rights and roles to users. This was not possible in this study as I was using a developer account that does not allow more than one user. This is further highlighted under the recommendations and possible improvements section.

Figure 26 below, shows the editable inventory management window. The highlighted row in grey colour in the table above the editable window shows the hospital selected. At the bottom right we have a map window highlighting the selected facility. At the bottom left we have an editable cell to update current stock levels.

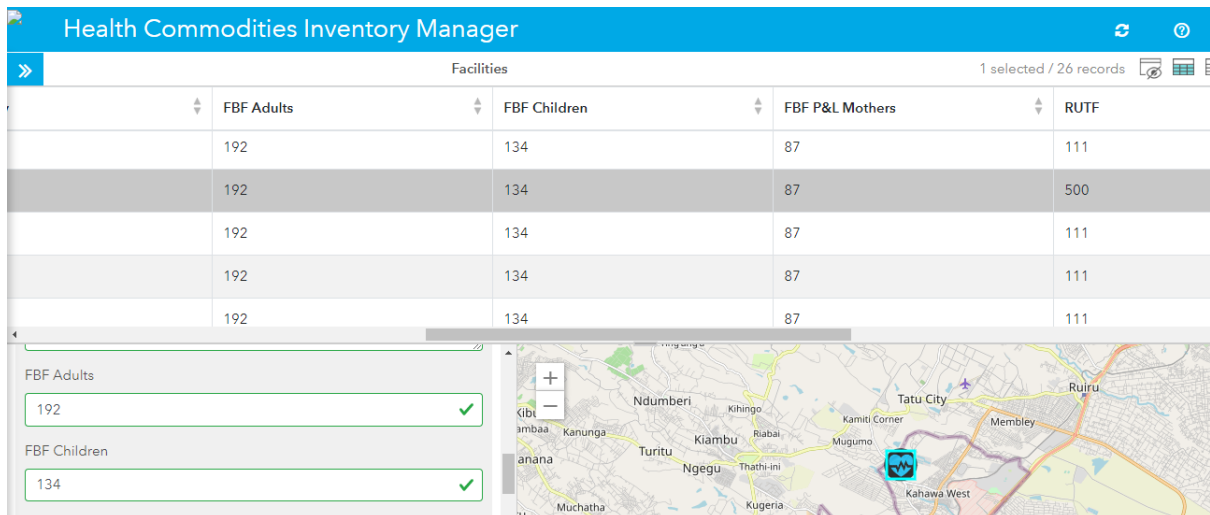


Figure 26: A Hospital accessing the inventory management window to update nutrition commodity data

4.2.2 Near Real Time Monitoring

The data from the inventory management facility window feeds into calculated fields that will help in monitoring facility information in near real time. The calculated fields named as quantity issued, monthly stock, balance and threshold are viewed in a pop up bar upon selecting a particular health facility. This visualization tool will enable the headquarters achieve monitoring in near real time as it is updated in the facilities. Figure 27 below shows facility information on a selected facility.

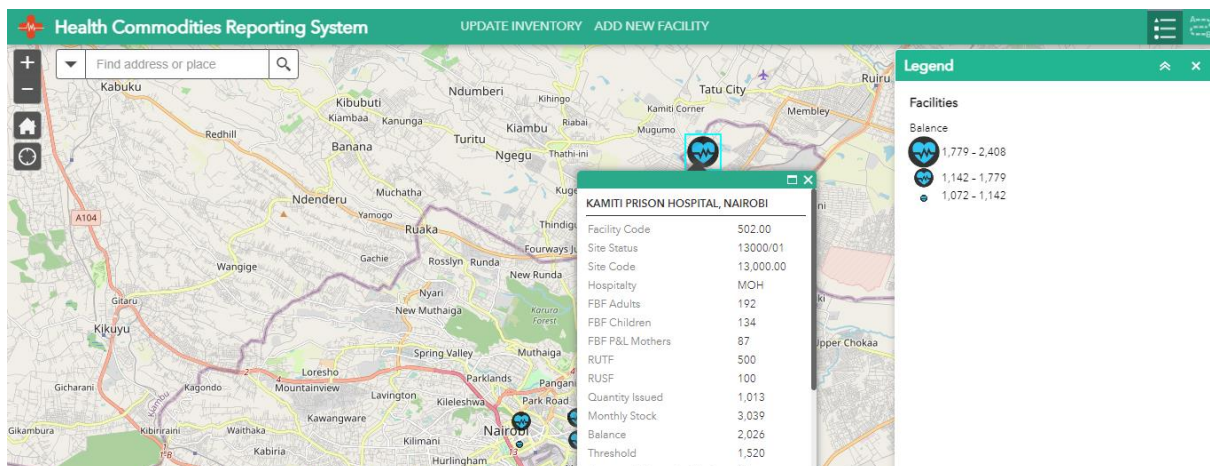


Figure 27: Near real time monitoring at NASCOP Headquarters showing calculated fields and other data

For the data to be accessed by NASCOP headquarters in the reporting window the facility must complete the updating process by saving the changes. NASCOP on the other hand must refresh their reporting window in order to access updated facility information. Figure 28 shows the save button accessed at the bottom of the facility inventory management window.

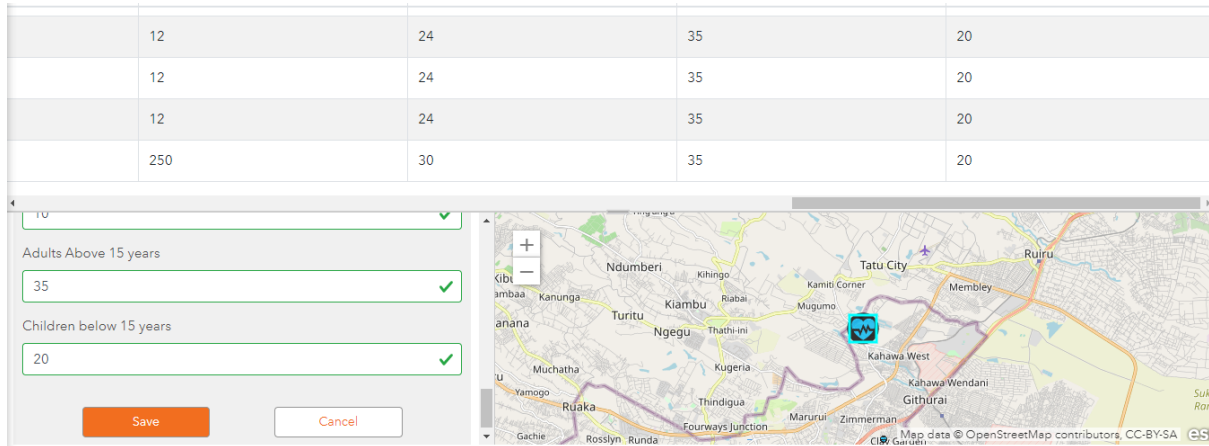


Figure 28: Save button that automatically updates changes to the facility inventory

4.2.3 Analysis on re-order thresholds by facility

This was achieved using the field calculator formulae thus adjusting stock and threshold levels as data on quantity issued is input at the facility level. This empowered the program administrator at NASCOP to make more informed planning and decision making on replenishing stocks. It is also possible to use graduated symbol functionality that allows for visualization of the threshold analysis. This allows for more efficient management of stock balances in the facility. This could have been achieved at the data base design level but limited resource capacity could not allow for the same. The ArcGIS online platform is limited in this functionality. Threshold analysis also triggers timely order placement to the manufacturer so that the nutrition commodities are available at the required times. Figure 29 shows facility threshold analysis data shown in a calculated field. As noted earlier threshold is derived by the formula; $[MonthlyStockDelivered]*0.5$

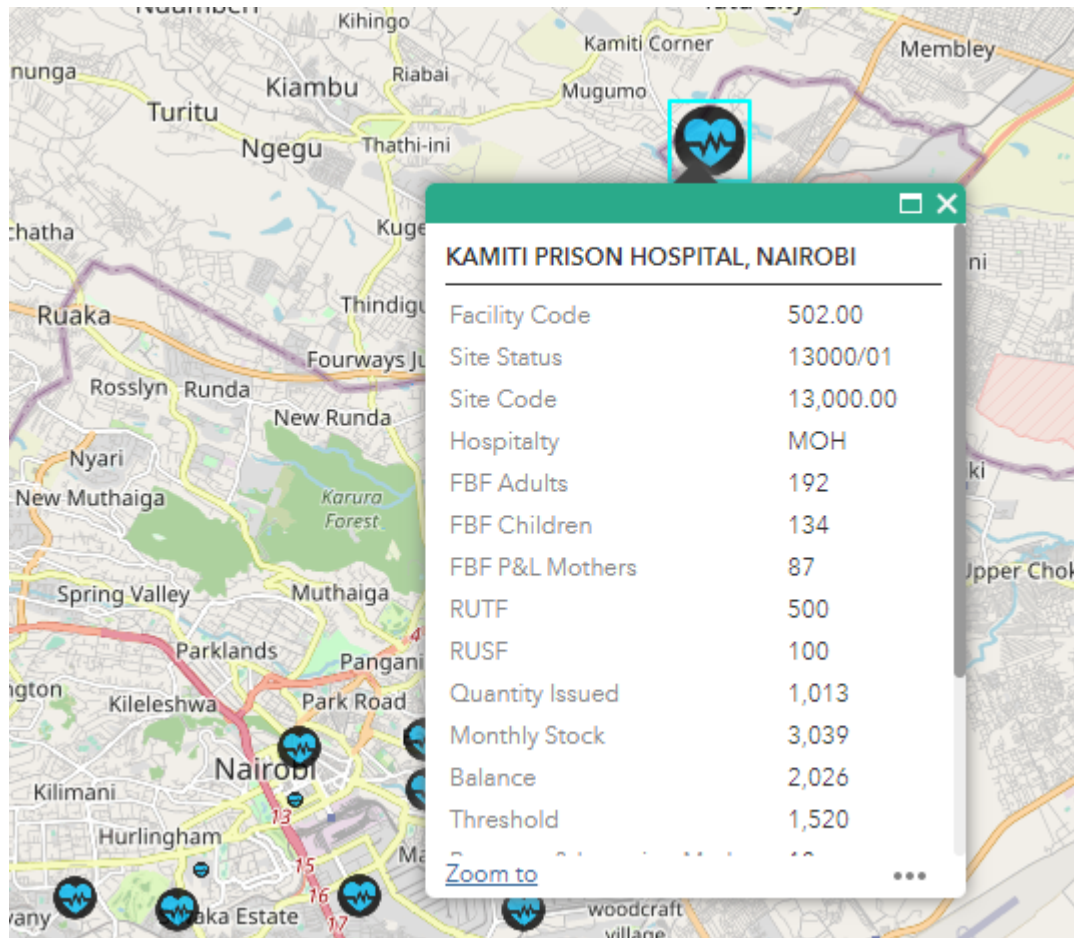


Figure 29: Demonstrating threshold analysis against monthly stocks

4.2.4 Visualisation

The web application allows NASCOP headquarters to visualize of all facilities in the program and their attributes. Attribute information on facilities can be accessed by clicking on any facility. By clicking on the health facility, the system user gets a pop up that will enable them to visualise selected attribute data as required within the program. This is depicted in figure 29 above.

4.2.5 Adding New Facilities

This can be done by accessing the add facility tab that is found next to the update inventory tab at the top ribbon of the home page. The add facility tab will allow NASCOP heady quarters to add new facilities in to the Nutrition and HIV program. This was enabled by using forms which are able to capture attribute as well as location data. Figures 30 and 31 depict these features.

A patient registration form can also be customised into this application. This however is not currently happening in the Nutrition and HIV program. Patient registration has been successfully used in the preceding FHI 360 Nutrition and HIV program and would add to the accountability and quality of stakeholder reporting within the program.

Nutrition Commodities System: Add Facility Form

Drop a pin in the location of your facility.

1. Select Form

2. Enter Information

Facility Code	<input type="text"/>
Facility Name	<input type="text"/>
Site Status	<input type="text"/>
County	<input type="text"/>
Date started	<input type="text"/>
Site Code	<input type="text"/>

Figure 30: Add Facility Form capturing attribute information new facility

Attachment
Select File

3. Select Location

Specify the location for this entry by clicking/tapping the map or by using one of the following options.

Search Lat/Lon
Find address or place



4. Complete Form

Add this information to the map.

Submit Entry View your Entry

Figure 31: Capturing location information in the Add Facility form

4.2.6 Web Routing Application through Optimized Routing

The web routing application can be launched by clicking on the tab on the top left corner of the web reporting system home page. Figure 32 shows the web routing application upon launching. This application will enhance efficiency in distributing the nutrition commodities thus significantly cutting down on the duration, and cost of delivery by KEMSA. Upon receiving the Nutrition commodities, KEMSA which acts as the central stores in the program will be tasked with delivery of the same to NACS centres. It is in their best interest to use the routing application to achieve improved efficiency in delivery.

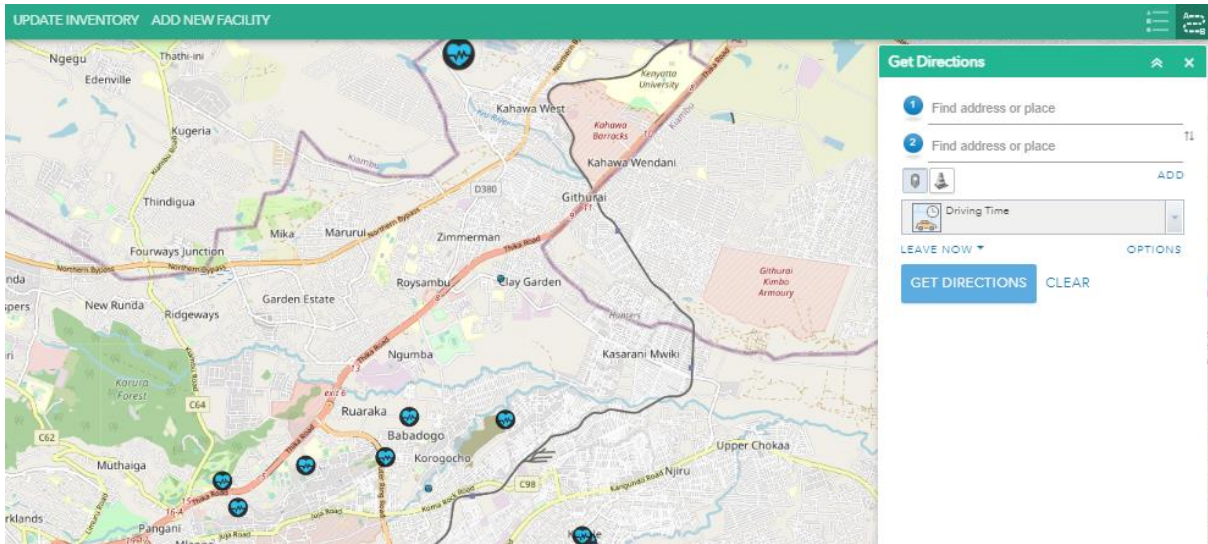


Figure 32: Web Routing Application upon launching

In order to get optimized routing, you have to select the start point from the list of deliveries from the map. Upon adding the second address you click on the add button which will allow you to select all facilities where the deliveries will be done. At this point an optimize order button will appear after clicking the options button. This will allow you to optimize the order of your delivery depending on preferred impedance like, drive time, distance, mode of transport and traffic. Figure 33 depicts the optimised order functionality and figure 34 depicts the available impedances.

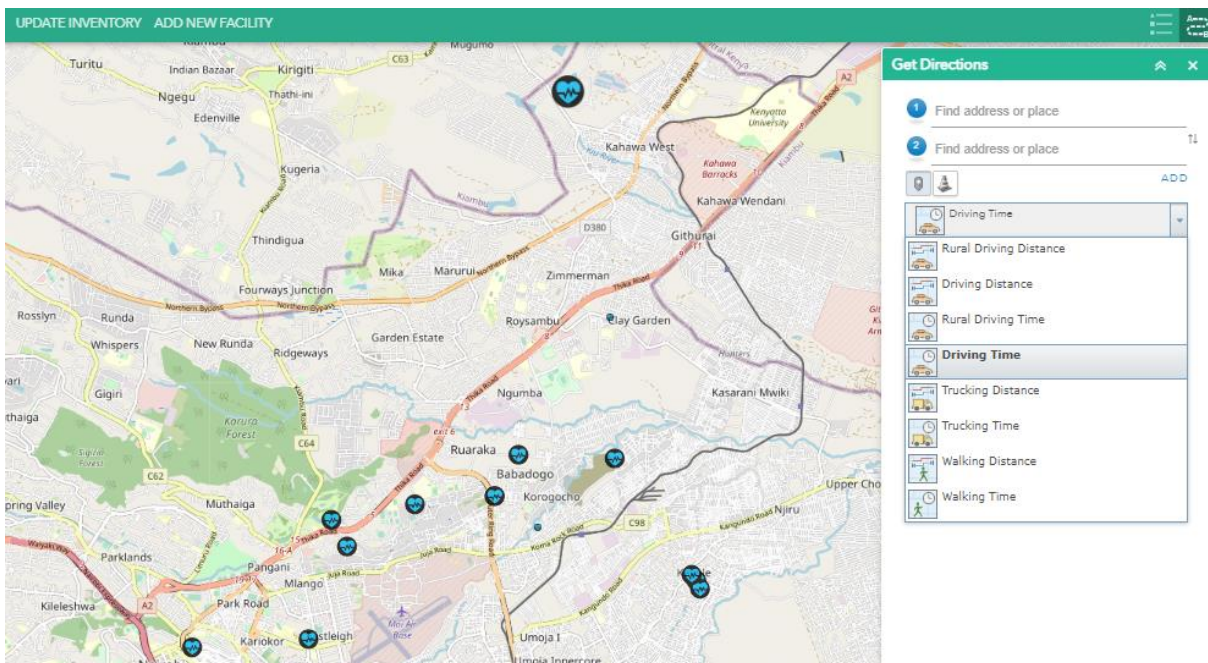


Figure 33: Route analysis by impedance

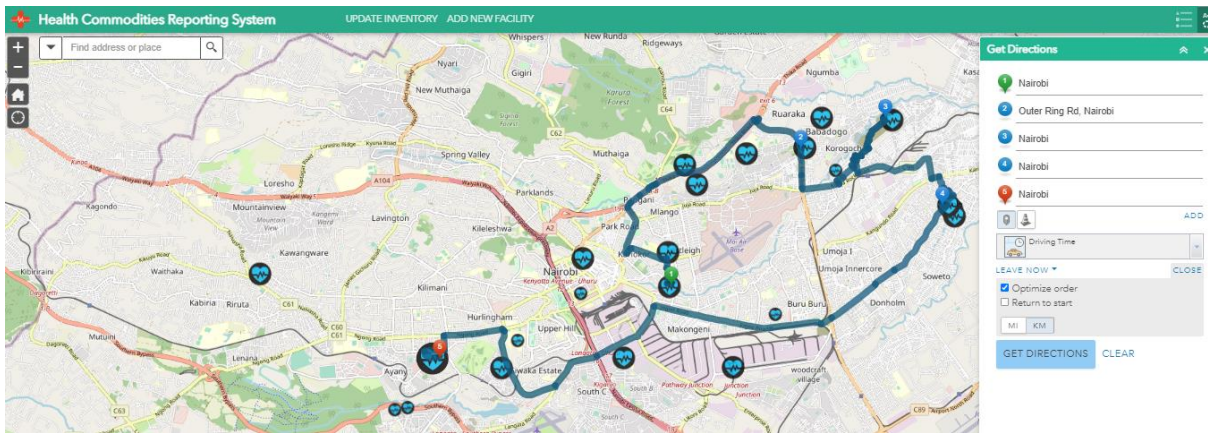


Figure 34: Oder Optimization

Other functionality within the web routing application include printing, saving and sharing, getting total distance and duration of the trip and getting directions within the application. This is depicted in figure 35 below.

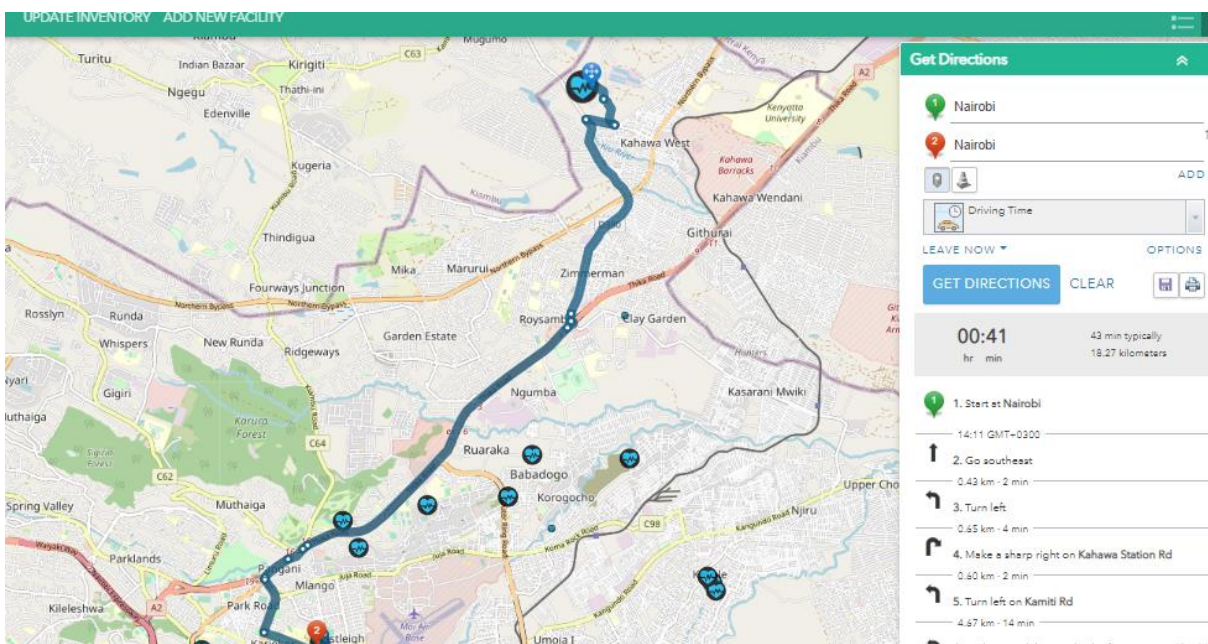


Figure 35: Other Web Routing Application Functionality

5 CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The main goal of the study was to do an assessment of the Nutrition and HIV program with an aim of establishing key challenges in reporting that would lead to interruptions in availability of nutrition commodities at the NACS centres. This was to be followed by developing a GIS driven web reporting application with features that would address the key challenges highlighted during the assessment. This study achieved the same as follows;

5.1.1 Identifying Key Challenges within the Nutrition and HIV Program

This was achieved as per the analysis in chapter 4, which highlighted the three main challenges in the program as follows;

a) Reporting

This was identified as a key challenge at facility level as per HIV Commodities Security Committee Meeting on March 29, 2022 at NASCOP. Lack of an efficient system and reporting structure led to the poor reporting. In most cases data would not be captured at the facility level hence reporting would not be done.

b) Monitoring

The lack of reporting resulted in lack of visibility on nutrition commodity movement and availability at the facility level by NASCOP headquarters. This meant that it would not be possible to monitor stock balances or do threshold analysis which would trigger the ordering process in time to replenish nutrition commodity stocks before the facilities ran out. The lack of monitoring led to crisis ordering which in most cases would not be delivered on time.

c) Routing

Other than reporting and monitoring, a third challenge that was identified involved the distribution of Nutrition commodities. The distributor would mostly fail to optimize route planning that would have given first priority to the outlets with critically low stocks. This could lead to late or no deliveries to these facilities which would in turn result in nutrition commodity stock outs at the health facilities.

5.1.2 Developing a GIS driven Reporting, Monitoring and Routing Web Application

This was achieved through developing a web application that would address the key challenges identified in the program. The features and functionality of the web application are highlighted below;

a) **Health Commodity Inventory Manager - Reporting**

This feature would enable facilities to report information on stock balances and adjust number of patients in near real time. This is depicted in figures 25 and 26. The health commodity inventory manager was also able to demonstrate accountability, through analysing number of patients in the program versus stocks issued.

b) **Near Real Time Monitoring of Nutrition Commodities and Threshold Analysis - Monitoring**

This was achieved by getting near real time information of consumption per facility thus giving operational information to the program headquarters to facilitate timely re-ordering. The program is now able to visualize and added facilities to the program. Facilities can be added at the NASCOP headquarters through the add facility tab displayed at the home page as shown in web reporting interface found in figure 24. This allows for better visibility and monitoring of the program.

Graduated symbols have been used to show the quantitative differences in stock balances for each facility. This way it is easy to note which facilities are at risk of running out of nutrition commodities and those that are appropriately stocked.

Visualization by attributes can now enable NASCOP to identify exact stock balances and identify those below thresholds which will trigger timely ordering of the nutrition commodities

c) **Web Routing Application - Routing**

The study revealed that it is possible to enhance efficiency in delivery of nutrition commodities by applying order optimization through the web routing application. Network analysis based on difference in impedance like time, distance and traffic, can now be achieved hence increasing efficiency in delivery. There is therefore going to be a significant cost reduction in delivery of nutrition commodities. A further advantage is that even new drivers who are not familiar with the routes will manage to do deliveries due to the capabilities of the routing application to give directions as well as printing and sharing of the same. These are portrayed in figures 32, 33, 34 and 35

5.2 Recommendations

During the development of the application two challenges were identified that affected the outcome of the project. As such, further work could be done to overcome the challenges highlighted below;

- 1) One challenge faced was that the application was deployed using an AGOL developer account. This only allows for one user hence I was not able to demonstrate user rights and roles in the developed web application. A key recommendation would be to use a proprietary or student AGOL account, or an open source web server.
- 2) We were not able to configure reports on the fly using AGOL. For the reports to be configured, they needed to be customized within the database. Further developments can be done to the system to introduce reports that can be generated from a user portal. This way it will be easier to follow progress by taking advantage of Preconfigured reports within the system

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APPENDICES

Appendix A: Prescription Form

INSTRUCTIONS FOR USE OF THE PRESCRIPTION FORM FOR HIV NUTRITION COMMODITIES

This data reporting tool is to be used by either Central, Satellite or Standalone sites, at the respective points of service dispensing nutrition commodities. For example, CCC, MCH, Ward, and TB Clinic

WHEN THE PRESCRIPTION FORM SHOULD BE FILLED:

The prescription form should be used to prescribe HIV Nutrition commodities to Clients at designated points of service.

WHO FILLS THE PRESCRIPTION FORM?

The prescription form should be filled in by a Nutrition Officer or designated health worker, who have been trained on NACS/FBP.

HOW TO FILL THE PRESCRIPTION FORM

I. FACILITY INFORMATION

a. Facility Name	Write the full name of your health facility as listed in the MFL
b. Facility MFL code	Write the Master facility list (MFL) code for your health facility.
c. Point of Service delivery	Indicate (tick) the location(s) where HIV Nutrition services are provided in your facility, i.e. CCC, MCH, Ward, TB Clinic
d. Date of Prescription	Write the date of the prescription in day-month-year format
e. New Client	Indicate (tick) whether Client is new, i.e. receiving this service for the first time at the facility
f. Continuing Client	Indicate (tick) whether Client is a revisit , i.e. Client has previously been receiving this service at the facility
g. Pipeline	Indicate (tick) which HIV Nutrition pipeline supplies your facility i.e. KEMSA, WFP, NHP, Other

II. CLIENT INFORMATION

a. Client Unique Number	Write the unique number of the Client.(All Clients receiving treatment and care services should have a unique identification number.)
b. Client National Identification Number	Write the Clients National ID Number for Clients 18 years and above OR Birth Certificate Number OR Passport Number
c. Client Name	Write THREE names of the Client
d. Nutrition Diagnosis	Indicate (tick) nutrition diagnosis based on assessment carried out as either Severe Acute Malnutrition (SAM), or Moderate Acute Malnutrition , HIV Exposed Infant (HEI) and Orphaned Vulnerable Child (OVC)

III. NUTRITION COMMODITY DATA

a. Quantity Prescribed	Write the quantity of commodity that should be dispensed to the Client based on the dose rationale for the nutrition diagnosis.
b. Quantity Dispensed	Write the exact quantity of commodity dispensed to the Client based on the nutrition diagnosis. Refer to the NACS/FBP protocol for standard dosage quantities
c. Prescribing Officer	Write the name of the prescribing officer, signature and designation

For the following sections, when filling in the commodities, please note that all items are in the units of issue indicated, e.g. bags, tins, etc. If the items are in different units, e.g. on the Delivery Notes or Supplier invoices, please convert into the units of issue indicated in the Prescription form.

The unit of issue of the commodity has been calculated as per conversion table below:-

Commodity Name	Example	Unit of Issue	Minimum Quantity Dispensed	Minimum Quantity Issued
Pre-term Formula (80 kcal/ 100 ml)	Cow & Gate®	400g Tin	8 tins	Carton (12 tins x 400g)
Infant Formula 1 (67 kcal/ 100 ml)	Cow & Gate®	400g Tin	8 tins	Carton (12 tins x 400g)
Infant Formula 2 (67 kcal/ 100 ml)	Cow & Gate®	400g Tin	8 tins	Carton (12 tins x 400g)
Therapeutic diet milk F75 (75 kcal/100ml)	F-75	102.5g sachet	1 sachet	Carton (120 sachet x 102.5g)
Therapeutic diet milk F100 (100 kcal/100ml)	F-100	114g sachet	1 sachet	Carton (90 sachet x 114g)
Ready to Use Therapeutic Food – paste (500 kcal/92g)	Plumpy Nut®	92g sachet	1 pouch (7sachets x 92g)	Carton (30 pouches x 644g)
Ready to Use Supplemental Food – paste (500 kcal/92g)	Plumpy Soy®	92g sachet	1 pouch (7sachets x 92g)	Carton (30 pouches x 644g)
Fortified Blended Food (flour) Children (6 mths – 9 yrs) (415 kcal/100g)	First Food®	200g sachet	1 bag (15 sachets x 200g)	Carton (5 bags x 3kg)
Fortified Blended Food (flour) Adults and Adolescents (10-17yrs) (435 kcal/100g)	Foundation Plus®	300g sachet	2 bags (15 sachets x 300g)	Carton (4 bags x 4.5kg)
Fortified Blended Food (flour) Pregnant & Postpartum mothers (450 kcal/100g)	Advantage®	300g sachet	2 bags (15 sachets x 300g)	Carton (4 bags x 4.5kg)
Multiple Vitamin and Mineral mix (1 x RDA ¹)	Liquid	1RDA	As prescribed	Specify

¹RDA = Recommended Daily Allowance

Multiple Vitamin and Mineral mix (1 x RDA)	Tablets/ Capsules	1 RDA	As prescribed	Specify
Multiple Vitamin and Mineral mix	Sprinkles®	1 RDA	As prescribed	Specify
Point of Use Water Treatment Solution 1.2% Sodium hypochlorite(NaOCl) per 150 ml bottle	WaterGuard®	150ml bottle	1 bottle (150ml)	Carton (48 bottles x 150ml)

PRESCRIPTION FORM FOR NUTRITIONAL COMMODITIES

SERIAL No.: _____

1. FACILITY INFORMATION	
FACILITY NAME: _____	FACILITY MFL CODE: _____
POINT OF SERVICE MCH <input type="checkbox"/> CCC <input type="checkbox"/> Ward <input type="checkbox"/> TB Clinic <input type="checkbox"/>	DATE OF PRESCRIPTION: _____ <small>(dd/mm/yyyy)</small>
NEW CLIENT <input type="checkbox"/>	CONTINUING CLIENT <input type="checkbox"/>
PIPE LINE SUPPLY KEMSA <input type="checkbox"/> NHP <input type="checkbox"/> WFP <input type="checkbox"/> OTHER: _____	

2. CLIENT INFORMATION	
CLIENT UNIQUE No. _____	CLIENT NATIONAL ID No./ PASSPORT No./BIRTH CERT. No. _____
CLIENT NAME: _____	
NUTRITION DIAGNOSIS/CATEGORY: SAM <input type="checkbox"/> MAM <input type="checkbox"/> HEI <input type="checkbox"/> OVC <input type="checkbox"/>	

3. NUTRITION COMMODITY DATA			
ITEM DESCRIPTION	UNIT OF ISSUE	QUANTITY PRESCRIBED	QUANTITY DISPENSED
1. Pre-term Formula (80 kcal/ 100ml)	400g tin		
2. Infant Formula1 (67 kcal/ 100ml)	400g tin		
3. Infant Formula2 (67 kcal/ 100ml)	400g tin		
4. Therapeutic diet milk F75 (75 kcal/100ml)	102.5g sachet		
5. Therapeutic diet milk F100 (100 kcal/100ml)	114g sachet		
6. Ready to Use Therapeutic Food (paste) (500 kcal/92g)	Pouch (7 sachets x 92 g)		
7. Ready to Use Therapeutic Food (bar) (500 kcal/ 100g)	100g bars		
8. Ready to Use Supplemental Food (paste) (500 kcal/92g)	Pouch (7 sachets x 92 g)		
9. Corn Soy Blend (flour) (390 kcal/100g)	Bag (15 sachets x 300g)		
10. Fortified Blended Food (flour) Children (6 mths – 9 yrs) (415 kcal/100g)	Bag (15 sachets x 200g)		
11. Fortified Blended Food (flour) Adults and Adolescents (10-17yrs) (435 kcal/100g)	Bag (15 sachets x 300g)		
12. Fortified Blended Food (flour) Pregnant & Postpartum mothers (450 kcal/100g)	Bag (15 sachets x 300g)		
13. Multiple Vitamin and Mineral mix (1 x Recommended Daily Allowance)	liquid (Specify)		
14. Multiple Vitamin and Mineral mix (1 x Recommended Daily Allowance)	Tablet / capsules / Sprinkles (Specify)		
15. Point of Use Water Treatment Solution (1.2% Sodium hypochlorite(NaOCl) per 150 ml bottle)	150 ml bottle		
Others:			
Others:			
Others:			

PRESCRIBING OFFICER: _____ SIGNATURE _____

Appendix B: Standard Treatment Guidelines

Adults 15 years & above

	Severe Acute Malnutrition	Moderate Acute Malnutrition	High Risk Malnutrition
Eligibility	<ul style="list-style-type: none"> • HIV positive • Bilateral pitting oedema + • BMI less than 16 kg/m² • MUAC less than 16 cm • MUAC 16 – 18.5 & WHO stage III • Passed appetite test 	<ul style="list-style-type: none"> • HIV positive • BMI 18.5 kg/m² • MUAC between 16 – 18.5 cm 	<ul style="list-style-type: none"> • HIV positive • BMI 18.6 -21.9 kg/m² • MUAC >18.5 cm
Prescription	<ol style="list-style-type: none"> 1. Nutrition counselling 2. 21 sachets of RUTF per week 3. 1bag (4.5kg) FBF (Foundation Plus) per month 4. One bottle water guard (150 ml) per month 	<ol style="list-style-type: none"> 5. Nutrition counseling 6. Two bags (9kg) FBF – (Foundation plus) per month 7. One bottle water guard(150 ml) per month 	<ol style="list-style-type: none"> 8. Nutrition counseling 9. 14 sachets of RUSF per week
Treatment follow Up	<ul style="list-style-type: none"> • weekly (7 days) 	<ul style="list-style-type: none"> • Monthly (30 days) 	<ul style="list-style-type: none"> • Monthly (30 days)
Treatment end point	<ul style="list-style-type: none"> • BMI equal to or greater than 16 kg/m² • No oedema for 10 days • Passed appetite test 	<ul style="list-style-type: none"> • BMI equal to or greater than 18.5 kg/m² 	<ul style="list-style-type: none"> • BMI equal to or greater than 22 kg/m²
Treatment period	<ul style="list-style-type: none"> • 30 days • Stop RUTF and continue nutrition counseling and prescribe FBF as MAM prescription 	<ul style="list-style-type: none"> • 90 days • Stop FBF and continue nutrition counseling 	<ul style="list-style-type: none"> • 30 days • Stop RUSF and continue nutrition counseling

Pregnant and Lactating Mothers

	Severe Acute Malnutrition	Moderate Acute Malnutrition
Eligibility	<ul style="list-style-type: none"> • HIV positive • Bilateral pitting oedema + • BMI less than 20 kg/m² * • MUAC less than 19cm • Passed appetite test** 	<ul style="list-style-type: none"> • HIV positive • MUAC between 19 – 23 cm <p><u>Pregnancy</u></p> <ul style="list-style-type: none"> ✓ Observed low weight gain of < 1.3kg /month <p><u>Postpartum</u></p> <ul style="list-style-type: none"> ✓ Observed non intentional weight loss of > 0.7 kg/month and BMI < 20 kg/m²
Prescription	<ol style="list-style-type: none"> 1. Nutrition counselling 2. 21 sachets of RUTF per week 3. 1 bag (4.5kg) FBF per month 4. One bottle water guard (150 ml) per month 	<ol style="list-style-type: none"> 5. Nutrition counselling 6. Two bags (9kg)FBF – (Advantage) per month 7. One bottle water guard(150 ml) per month
Treatment follow Up	<ul style="list-style-type: none"> • Weekly (7 days) 	<ul style="list-style-type: none"> • Monthly (30 days)
Treatment end point	<ul style="list-style-type: none"> • MUAC equal to or greater than 19 cm • No oedema for 10 days • Passed appetite test • Observed weight gain of above 1 kg/month during pregnancy • Steady weight gain after 6 weeks & BMI > or = 20 	<ul style="list-style-type: none"> • MUAC = or > 23 cm
Treatment period	<ul style="list-style-type: none"> • 30 days • Stop RUTF and continue nutrition counseling and prescribe FBF as MAM prescription 	<ul style="list-style-type: none"> • 90 days • Stop FBF and continue nutrition counseling

Children 15 Years & Below

	Severe Acute Malnutrition	Moderate Acute Malnutrition
Eligibility	<ul style="list-style-type: none"> • bilateral pitting oedema + • BMI for Age less than – 3 Z score • MUAC less than 16 cm • Passed appetite test 	<ul style="list-style-type: none"> • BMI for Age less than – 2 Z score • MUAC between 16 – 18.5 cm
Prescription	<ol style="list-style-type: none"> 1. Nutrition counselling 2. 21 sachets of RUTF per week 3. 1 bag (4.5kg) FBF (Foundation Plus) per month 4. One bottle water guard (150 ml) per month 	<ol style="list-style-type: none"> 5. Nutrition counselling 6. Two bags (9kg)FBF – (Foundation plus) per month 7. One bottle water guard(150 ml) per month
Treatment follow Up	<ul style="list-style-type: none"> • weekly – seven days 	<ul style="list-style-type: none"> • Monthly (30 days)
Treatment end point	<ul style="list-style-type: none"> • BMI for Age equal or greater than – 3.0 Z score • No oedema for 10 days • Passed appetite test 	<ul style="list-style-type: none"> • BMI for Age equal to or greater than – 1.0 Z score
Treatment period	<ul style="list-style-type: none"> • 30 days • Stop RUTF and continue nutrition counseling and prescribe FBF as MAM prescription 	<ul style="list-style-type: none"> • 90 days • Stop FBF and continue nutrition counseling