

SMS Location Based Services: A Case of Beyond Zero Campaign Mobile Clinic

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Abstract: The Beyond Zero campaign initiative complement the existing health services providers to improve access to and quality health services to a zero state of maternal and child mortality, and zero new HIV infections, these mobile clinics provide free services on prenatal, antenatal and postnatal care. However, limited resourceful information of where a mobile clinic is located inconveniences most patients.

This paper studies the existing mobile clinics and proposes a Location Based Services application to locate the beyond zero campaign mobile clinic via a SMS inquiry, scheduled activities and supplementary information as an outreach program for beyond zero campaign patients. A web based prototype application was developed using several web technologies: HTML, JavaScript, XML, PHP and MySQL.

The results obtained from the testing phase showed that 75% of the participants were satisfied with the application ease of use from its simple Short Message inquiry of the location using any kind of phone, regardless of whether the phone is a smart phone or a feature phone, timely message reply, and real time location with street name and route. 83.3% of the participants were satisfied with the structuring, the location inquiry and patient enrolment with Short message reminders of scheduled clinic appointments.

It is recommended that a pilot application should first be tested with a given sample participants especially in counties where low turnout of patients was recorded at beyond zero campaign mobile clinics. Afterwards a viable production application should be implemented to test its viability in locating the mobile clinic.

Keywords: Beyond zero campaign, Location based services, Open Location Services Platform, SMS.

I. INTRODUCTION

Kenyan women, many of who deliver at home face various challenges. A research conducted by Africa Population Health Research Center [2] estimated that, approximately 68% of surveyed women said it was not necessary to go to a health facility. Poor road infrastructure and insecurity often prevented women from delivering in a health facility. Women who went into labor at night often felt it was unsafe to leave their homes for a facility and risked their lives, giving birth at home away from the support of skilled medical personnel and health facilities [16].

While, approximately 92% of women giving birth have received antenatal care in 2010, only 47% had more than four antenatal. 56% of Kenyan women deliver at home, with home births being more common in rural areas and only 44% of births were assisted by a health care professional ([25]; [27]), to improve the maternal and child health in Kenya, the First lady Margaret Kenyatta launched the Beyond Zero Campaign in January of 2014.

The initiative aims to fast-track Kenya's plan towards the United Nations Millennium Development Goals, number four - Reduce Child Mortality, five - Improve Maternal Health and number six - combating HIV/AIDS, malaria, and other diseases ([34]; [35]) by the year 2015, and goal number three in line with the sustainable development goals adopted in September 2015. The beyond zero mobile clinics are being used to deliver essential health services. The mobile clinics are also used to transport important health commodities such as mosquito nets to serve Kenyans who have limited access to static health facilities, to strengthen referral and emergency services [27].

The Beyond Zero campaign initiative intends to complement existing initiatives to improve access and quality of health services to a zero state of maternal and child mortality, and zero new HIV infections, these mobile clinics provide free services on prenatal, antenatal and postnatal care. However, there is limited resourceful information source on where the beyond campaign mobile clinics are located at any given time, particularly to the underprivileged in the rural and urban areas. The clinic offers low cost and quality health care is, mis-guided information inconveniences the patients, hence the patients finds themselves in a health facility or hospital, which they were not expecting to or cannot afford, causing the patients to change from one hospital to another within the course of the treatment, others are retained in the hospital due to failure of clearing their hospital bills hence increasing the costs of treatment.

II. RESEARCH OBJECTIVES

The study evaluates other existing mobile clinics and their methodologies with an aim to propose a location based system that can provide the location of the beyond zero campaign mobile clinic, supplementary information and outreach to enrolled patients.

Therefore, the specific objectives are;

- Review other existing mobile clinics and their methodologies
- Design and develop a beyond zero campaign clinic prototype
- Test the beyond zero clinic locator prototype
- Evaluate and report results

III. LITERATURE REVIEW

3.1 Review of some of the existing mobile clinics:

Community Health Africa Trust, works with scattered, nomadic populations in the Laikipia region of Kenya, it uses an integrated model, including trucks, bicycles or foot travel to nearby communities, African Impact, 2011 [16]; and also camel convoys in areas without road network. CHAT also currently is providing services in other counties in Kenya namely; Baringo, Marsabit, Nyeri, Meru, Nyandarua, Kitui, Narok and Nakuru counties.

The most identified Mobile Health Units such as CHAT operating in low income or developing countries provide services and treatment free of charge.

3.1.1 Mozambique Mobile Clinic Project:

The Mobile Clinic vehicle/Mobile Health Units, custom built as a mid-sized truck and provides an extremely versatile and flexible platform to provide primary health care services, education and counseling. Since its inception in 2008, the Mobile Clinics have been hugely successful and remains the only mobile clinic in all of Mozambique, Lindgren, et al, 2011 ([13]; [23])

The main aim of the clinic is to improve the quality of life and provide access to health services, particularly access to maternal-child health care and anti-retroviral therapy for people living with HIV and AIDS, Tuberculosis and other diseases. The clinics provide access to healthcare in remote areas of Zambézia Province. The Mobile clinics are most commonly used on a temporary basis such as before the opening of a more permanent health facility, in settings where health services are absent or dysfunctional, or in emergency relief settings, Schell, et al [32].

3.1.2 Mobile health clinics and mobile phone technology to promote safe motherhood initiative in Tanzania:

Non-governmental organization - Voluntary Services Overseas Tanzania [37], initiated a project in two district hospitals in Pemba Island, Wete and Micheweni to increase the coverage on maternal, newborn and child health services through the following activities: community maternal health promotion; mobile health clinic services delivered by trained health workers and a gynecologist in villages providing pre and post natal care; an innovative referral system using mobile phones enabling women to access health services and training in maternal, newborn and child health for community health workers; and traditional birth attendants.

3.2 An overview of the beyond zero clinic:

The Beyond Zero campaign initiated by the First Lady, Margaret Kenyatta, intends to complement existing health services providers to improve access to and quality health services to a zero state of maternal and child mortality, and zero new HIV infections, these mobile clinics provide free services on prenatal, antenatal and postnatal care. The Beyond zero campaign initiative has launched 47 mobile clinics spread across all the counties nationwide that complements the existing health systems at the county and national level on by providing health services to the less privileged women and children in Kenya;

- Maternal and child health,
- Curative services,
- De-worming of the children,
- Administration of Vitamin A,
- HIV Counseling and Testing/ Elimination of HIV among children while keeping their mothers alive,
- Cervical cancer screening.

By December 2015, 37,807 Kenyans from 15 counties had benefited from the Beyond Zero mobile clinics across the country as explained by Ministry of Health Kenya in Kenya Demographic and Health Survey 2013-2014 ([22]; [29]). The Ministry of Health statistics on beyond zero campaign, 2015 estimate 11,401 women, 9,193 children between 0-5 years, 5,984 children between 5-14 years old, 1,255 adolescents between 15-24 years and 1,577 pregnant women had been treated at the facilities.

The data was collected from Kwale, Kilifi, Taita-Taveta, Marsabit, Isiolo, Tharaka Nithi, Kiambu, Turkana, Samburu, Uasin Gishu, Elgeyo Marakwet, Baringo, Bomet, Narok and Homa-bay counties. Kiambu, Homabay and Elgeyo Marakwet counties recorded the lowest turnout of patients was recorded compared to other counties by recording 299, 195 and 413 patients respectively.

3.3 Location based services:

Location awareness refers to applications or services that make use of location information provided by suitable devices or software; location need not be the primary purpose of the application or service, while location sensitivity refers to location-enabled mobile devices that can be used by location aware applications and services such as mobile phones, personal digital assistants and pagers. Such devices rely on GPS - Global Positioning System or mobile phone related technologies ([21]; [30]).

3.3.1 The Components of Location Based Services:

Mobile tools:

A terminal that is used by the user to request for specific information; it is both an output and input entity. The mobile device can have a positioning component for the position of the user to be determined so that he or she can be provided with context aware information of which is dependent on the user's geographical location.

Communication link:

Mobile link which communicates between the user and the service provider of the system, activities are such as data, user requests and content delivery. This is reiterate by Ficco et al [9] that the communication network component is composed of the wireless communication networks and is classified into network range and network topology.

Positioning:

The system often provides positioning information of the user. Positioning of user could be done by methods such as wireless link or by using GPS. Dao, Rizos and Wang, 2002 [8] in their paper proposed that there are three ways or techniques of determining positions namely, non-GPS positioning techniques, GPS and Assisted GPS. Cell of Origin, Time of Arrival, Angle of Arrival and Enhanced Observed Time Difference are all non-GPS positioning techniques.

Service provider:

LBS providers usually provide different services to use in the result of processing her/his request. This service is includes positioning, user's address, lining/routing a way to distinction point, returning interested information of users.

Data and content provider:

This entity stores the geographic base data and location information. This can include a GIS server to provide access to location data source. The data is stored in different formats ([30]; [36]).

SMS gateway:

SMS gateway application will enable the application to send/receive SMS messages to mobile devices from the computer. The application will use a GSM technology on the GPS component with IP SMS technology to transmit and receive the messages.

3.3.2 Mechanism of Location Based Services Architecture Components:

The components are grouped into three categories; the mobile positioning system, the telephony network and the location-based service application. Dao, Rizos, & Wang, 2002 [8] demonstrated in detail how components on an LBS system work together through the diagram in figure 1.

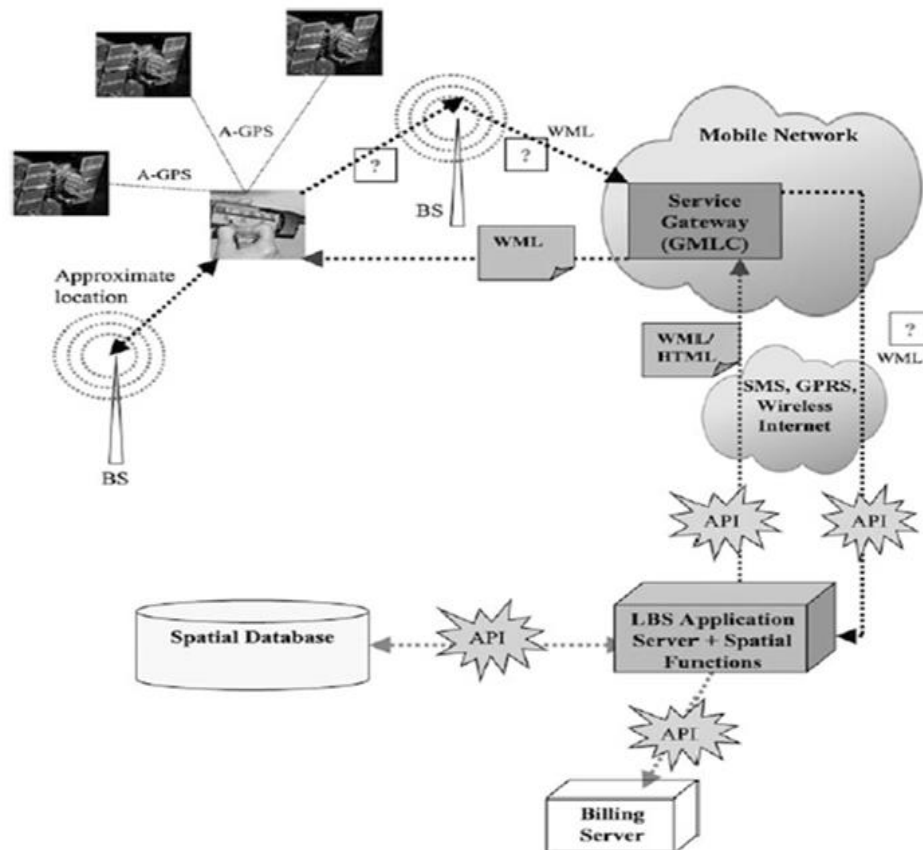


Figure 1: LBS components mechanism (Dao, Rizos & Wang, 2002)

The mobile telephony network delivers the services to mobile device users through service gateways that connect the positioning systems with the wireless network of the mobile operator and the Location Based Services application [8]. The Location Based Services application consists of an application server and a spatial database. The application server operates the user interface functions and communicates with the spatial database via APIs. This Component therefore integrates location-based services with the mobile telephony networks. The GeoMobility server is a Web Service-enabled middleware piece that operates common/core LBS functionality. It has six services and Google Maps provide most of these services; these services include directory service, gateway service, location utility service, presentation service, routing service and tracking service [8].

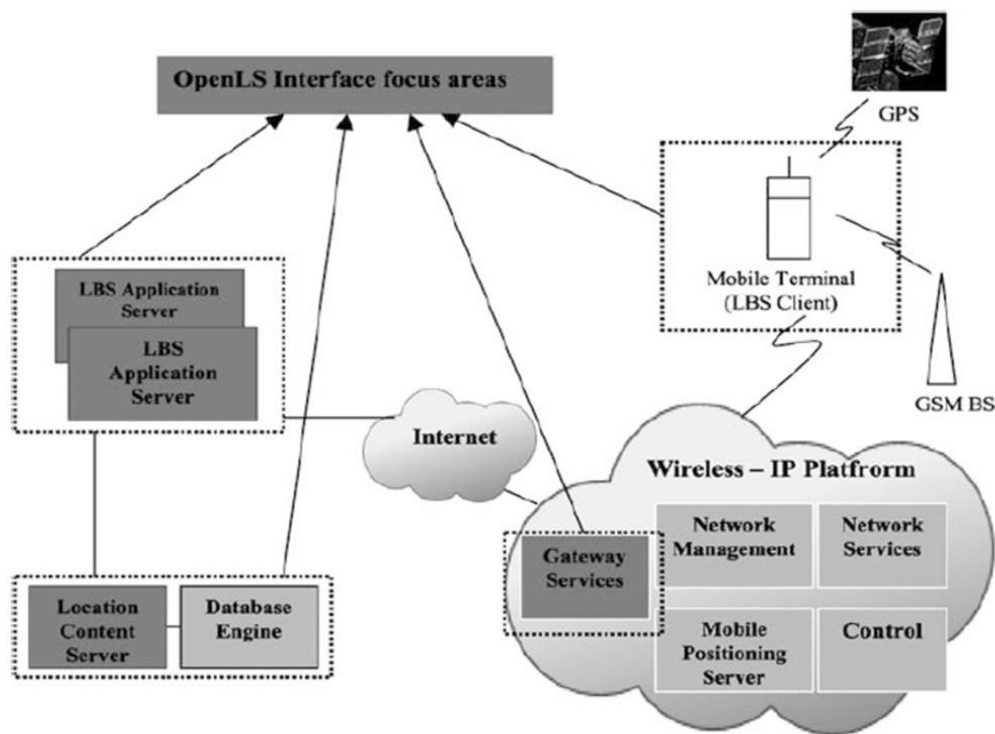


Figure 2: OpenLS focus areas. (Dao, Rizos & Wang, 2002)

IV. METHODOLOGY

In this study, the researchers carry out a comprehensive literature review on the concepts of Location based services and Prototyping [14]: A prototype is a model of a product or a system in part or in whole used to demonstrate various aspects of a product and as a proof of concept. The rapid prototyping approach involving requirements gathering, quick design, development, refining of requirements and testing, was used in the translation of the geo-location to location.

A semi-structured questionnaire and an observation were done to understand a participant knowledge and perspective on the proto-type. This was to understand the participant experience. A sample of 12 participants were selected to use the beyond zero campaign mobile clinic locator system prototype application and willing to give consent to participate in the research study. A final analysis was performed on data from 12 participants who completed a questionnaire after interaction with the prototype. The questionnaires were subjected for analysis to meet the research objectives.

V. RESULTS AND DISCUSSIONS

5.1 Application Development:

The prototype system uses a client/server structure, the client end interface to operate the web application prototype is accessible on a standard web browser, and database used is MySQL and administration done on phpMyAdmin.

SMS gateway	Android Application: SMS Number: 0738388834
Bulk SMS Service	Africa is Talking
GPS (TK110 Model)	Gadget fitted with a GSM SIM card
Development Environment	PHP (Lavarel framework), Java, MySQL and phpMyAdmin
Url	bzcl.jirani-link.co.ke

Figure 1: Description of prototype development tool

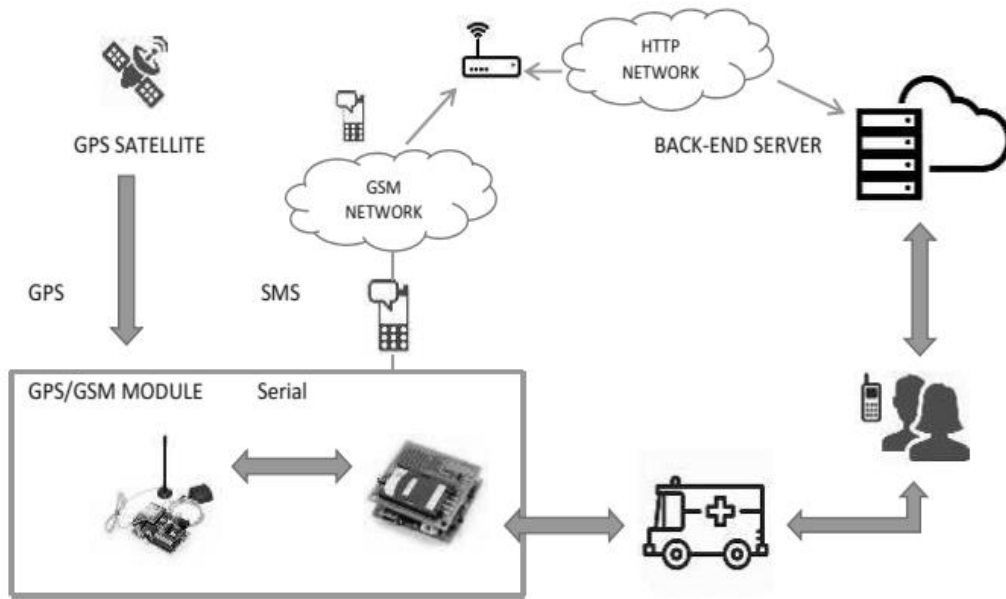


Figure 2: Prototype system structure

Location data is provided by open Google Maps API, the prototype application connects to the Google Maps API using an Android SMS gateway which relays the SMS to the prototype application domain.

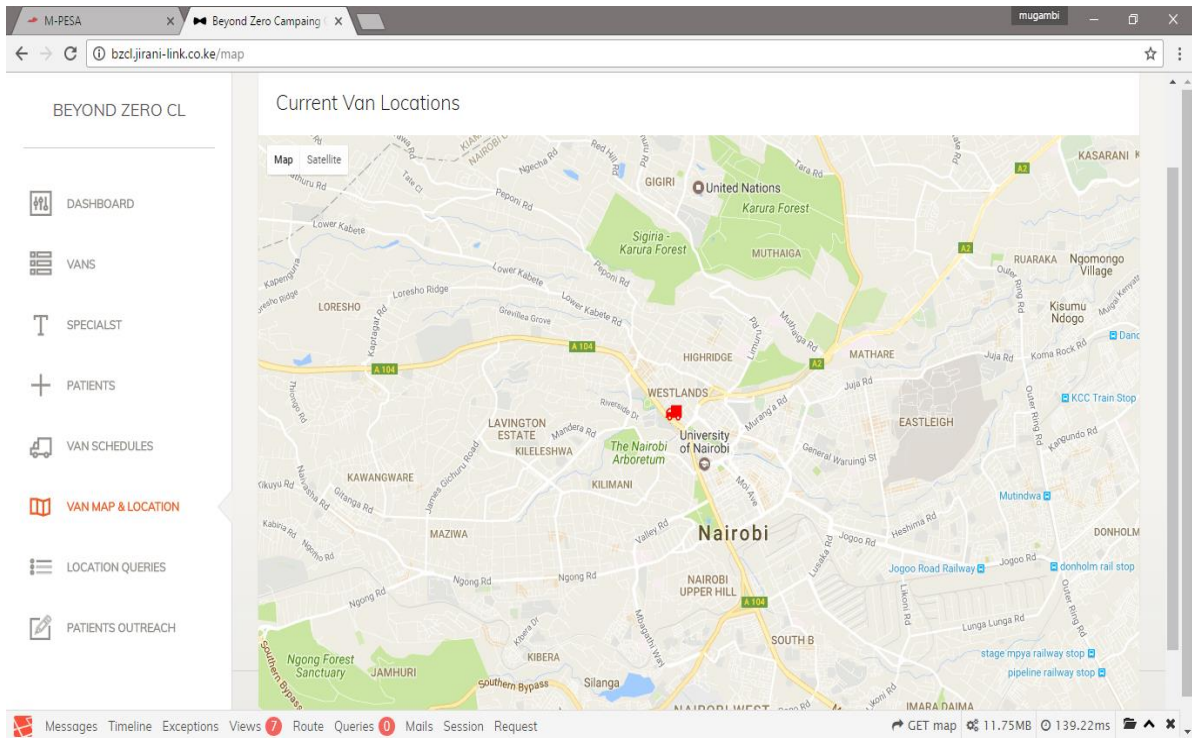


Figure 5: Beyond zero campaign web based application interface

5.2 Results:

The prototype SMS query results, the application has a satisfying near accuracy with an estimation of 1 to 2 Km to the location of the clinic translated to street name and route based on GPS coordinates. Below are screenshots of a user SMS reply interaction with mobile clinic location.



Figure 3: SMS Location inquiry and reply SMS respectively

ID	Phone number	Message	Date:	Response Status	Response Message
1	+254724003890	Location	23-08-2016	success	Riadha House, Bunyala Rd, Nairobi, Kenya
2	+254723603314	Location	23-08-2016	success	Mansour Complex, Witu Rd, Nairobi, Kenya
3	+254724003890	Location	23-08-2016	success	Riadha House, Bunyala Rd, Nairobi, Kenya
4	+254724003890	Location	23-08-2016	success	City Clock, Koinange St, Nairobi, Kenya
5	+254724003890	Location	24-08-2016	success	Riadha House, Bunyala Rd, Nairobi, Kenya
6	+254724286272	Location	25-08-2016	success	Hospital Rd, Nairobi, Kenya
7	+254770645055	Location	29-08-2016	success	Riadha House, Bunyala Rd, Nairobi, Kenya
8	+254770645055	Location	29-08-2016	success	City Clock, Koinange St, Nairobi, Kenya
9	+254770645055	Location	29-08-2016	success	Mansour Complex, Witu Rd, Nairobi, Kenya
10	+254770645055	Location	29-08-2016	success	Riadha House, Bunyala Rd, Nairobi, Kenya

Figure 6: System location queries

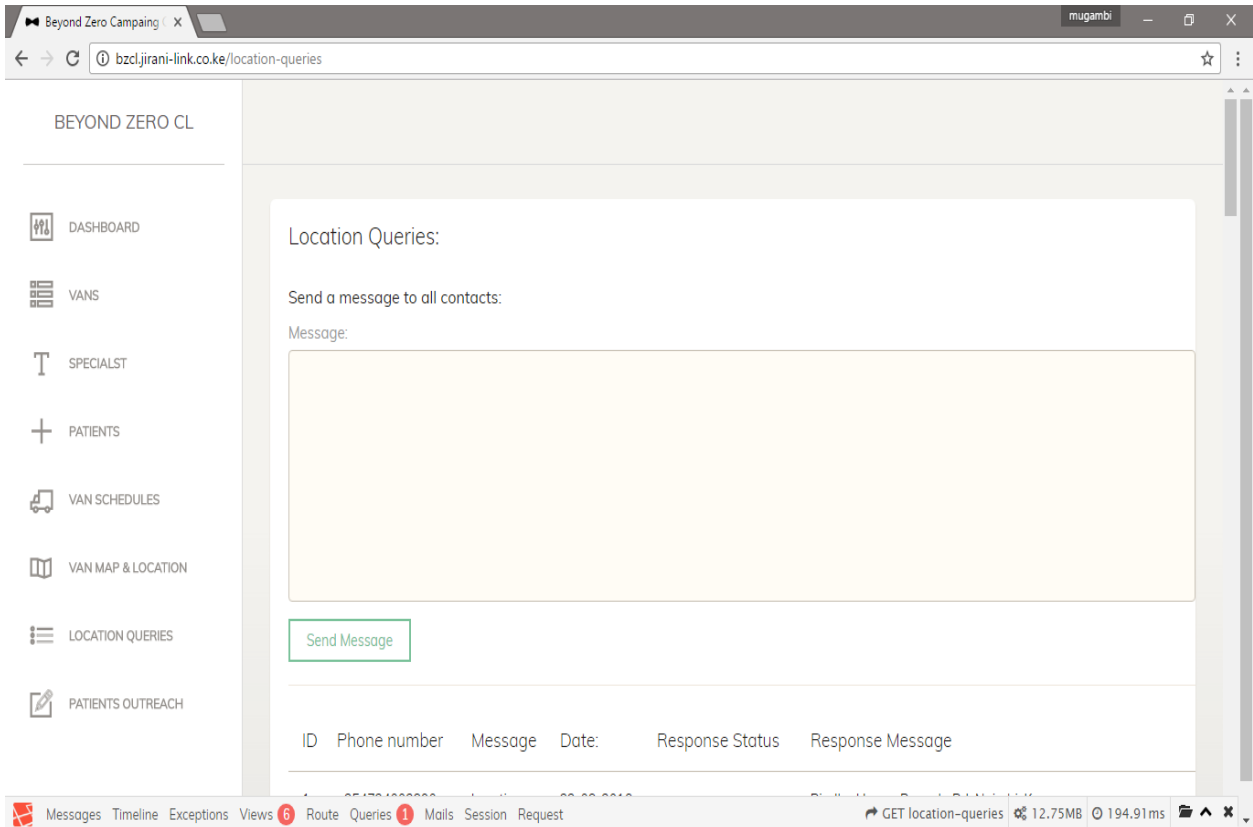


Figure 7: Bulk messaging for patient outreach

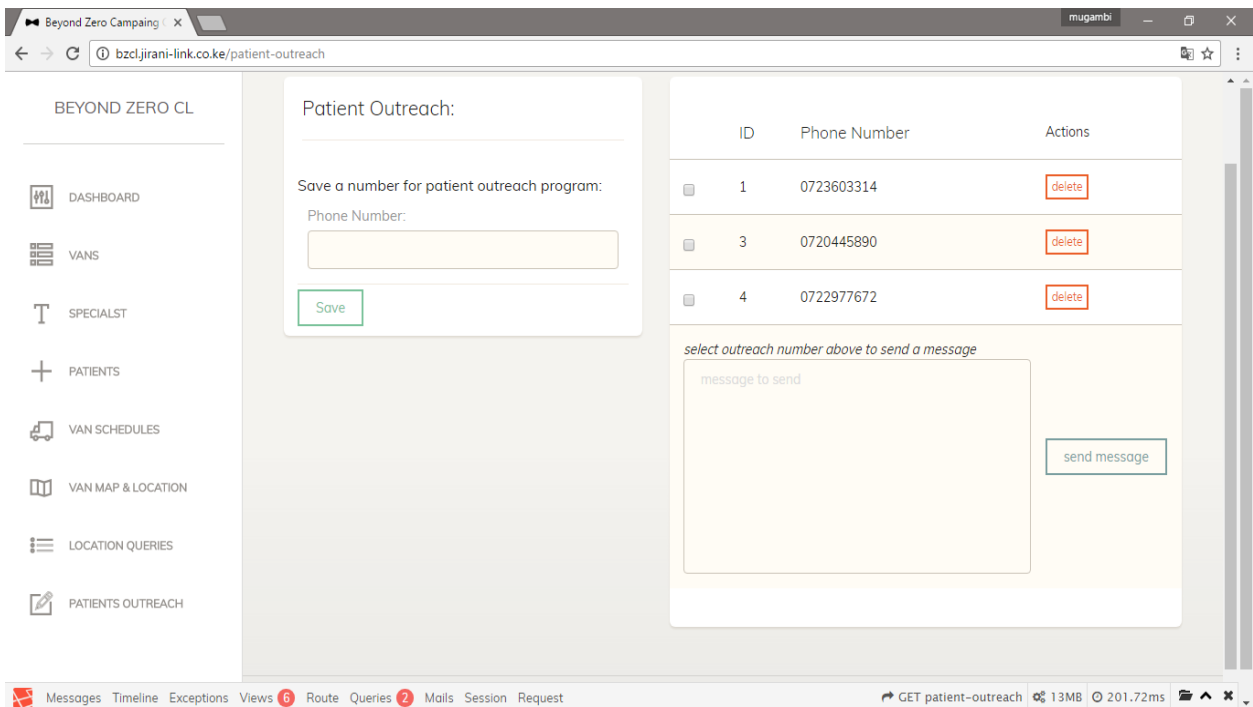


Figure 8: Enrolled patients for follow-up and monitoring

5.3 Participant results:

The results showed 75% of the participants were satisfied with the application ease of use from its simple Short Message inquiry of the location using any kind of phone, regardless of whether the phone is a smart phone or a feature phone, timely message reply, and real time location with street name and route instead of coordinate; longitude and latitudes. (Strongly Agree 16.7% n=2, Agree 75% n=9, Disagree 8.1% n=1)

VI. CONCLUSION AND RECOMMENDATIONS

The system can reduce the time at which patients search for clinic location within a rural and urban context using any phone (smartphone or feature phone). The Location Based Services model can be implemented to save time and offer convenience to beyond zero campaign patients. Users can easily access the application over the web browser. The prototype SMS query results proves the application has a satisfying accuracy in estimating the location of the mobile clinic, SMS outreach to a number of patients at once, also a patient enrollment module allows a clinic administrator to remind enrolled patients of a scheduled clinic appointment.

The limitations from this study include the sample size of the involved population, time constraints, limited access to the beyond zero campaign mobile clinics, therefore the prototype was developed and tested as a prove of concept.

During the testing phase, an encounter was documented where the geo-location functionality was not synchronizing with the current GPS position. This could be attributed to GPS service provider 4G coverage area. For instance, the application was tested while on location at college of physical and biological sciences at Chiromo Campus, Nairobi; however, the SMS replies the location as Ondiri – Kikuyu road at Muguga, Kikuyu.

It was also observed that the geo-location functionality required high internet data speeds such as the 3G network for it to function optimally while on 2G network it performed dismally; yet 3G network coverage and data speeds within Nairobi is poor (COFEK, 2012).

A sequential and scalable implementation of the prototype should be carried out to test its scalability and user acceptance by the general public especially where low numbers of patient turn out has been recorded, such as, Kiambu, Homabay and Elgeyo Marakwet. A pilot application of the prototype should first be developed to be tested with a given sample of participants. Afterwards a viable production application should be implemented to test its viability.

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