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Prototype for tracking voluntary blood donors in enhancing emergency medical response: case Aga Khan Hospital

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PROTOTYPE FOR TRACKING VOLUNTARY BLOOD DONORS IN ENHANCING EMERGENCY MEDICAL RESPONSE - CASE AGA KHAN HOSPITAL

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Declaration

I, the undersigned, declare that this work is my original and that it has not been presented in any other university or institution for academic credit. No part or entire document should be reproduced in whichever form without prior permission from the author and/ or Strathmore University.

Patrick Kariuki Mwangi

Signature……………..

9 June 2017

Declaration by the supervisors

This research thesis has been submitted for examination with our approval as University supervisors.

Dr.Vitalis Ozianyi

Signature: ……………..

Faculty of Information Technology

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Dedication

To my family.

Abstract

The World Health Organization recommends in its Global Database on Blood Safety that all activities related to blood collection, screening, processing, storage and distribution should be coordinated at the national level through effective organization and a national blood policy and system.

The researcher developed a prototype that comprised of an android mobile application, and a front end application. The researcher used prototyping methodology to develop the application. The prototype developed in this research aims at making use of the existing telecommunication infrastructure while merging this with the blood bank's information technology systems. The target population comprised of employees working within the Aga Khan University Hospital Blood Transfusion Center and voluntary non remunerable donors. Both quantitative and qualitative techniques were used to evaluate the information collected.

The study concludes that it is difficult to get the domicile location of, voluntary donors. By having system that tracks voluntary donor movement, it is possible to enhance emergency medical response that requires blood transfusion. The diverse activities in the blood donation and distribution service can be streamlined as a result of data mining capabilities.

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List of Abbreviations and Acronyms

3GPP: Third Generation Partnership Project

BS: Base Station

BTS: Base Transceiver Station

CAC: Comprehensive Post - abortion Care

CDC: Center for Disease Control

CS: Control Segment

DGPS: Differential Global Positioning System

EMS: Emergency Medical Services

ENBC: Essential Newborn Care

FSF: Free Software Foundation

GDBS: Global Database on Blood Safety

GPS: Global Positioning System

GSM: Global System Mobile

HIS: Hospital Information System

HL7: Health Level Seven

ICT: Information Communication Technology

KNBTS: Kenya National Blood Transfusion Service

KRC: Kenya Red Cross

LBS: Location Based Services

LMU: Location Measurement Unit

MSC: Mobile Switching Center

RBTC: Regional blood transfusion center

SS: Space Segment

US: User Segment

VNRBD: Voluntary Non Remunerated Blood Donors

WHA: World Health Assembly

WHO: World Health Organization

WSP: Wireless Session Protocol

ZNBTS: Zambia National Blood Transfusion Service

Definition of Terms

Blood: It is a liquid substance that flows through human veins and arteries that carried and transports oxygen, nutrients and other necessary elements to tissues (Claude Bernard, 2006).

Blood Bank: This is a registry or collection data on donated blood kept by a blood transfusion center (Wilkins, 1994).

Blood Bank Management System: This is a computerized system designed to store, process, retrieve and analyze information concerned with the administrative and inventory management in blood bank for storage and issuance of blood (Ekanayaka & Wimaladharma, 2015).

Blood Donors: This is an individual who gives blood to be received by another individual who needs a transfusion (Ekanayaka & Wimaladharma, 2015).

Blood Donation: It is the process through which a willing individual gives blood which is received by another individual in need of a transfusion in order to manage a health condition (Gonsorcik, 2013).

Blood Donor Management System: This is a computerized system created for a blood transfusion center to enable it store, process, retrieve and analyze information on blood donors mostly based on their blood groups. It can be used to track and contact donors whenever there is need to (Magnus, 2010).

Hospital Level Seven: Health Level Seven International (HL7) is a not-for-profit, ANSI-accredited standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic hospital information that supports clinical practice and the management, delivery and evaluation of health services (Gonsorcik, 2013).

National Blood Transfusion Service: This is the body mandated to collect and distribute blood within a country (Williamson & Mulaki, 2015).

Screening: This is a medical process in which blood is scanned to test for diseases such as HIV, Syphilis, Hepatitis B and Hepatitis C or to find out the blood group of an individual (Williamson & Mulaki, 2015).

Voluntary Non Remunerated Blood Donors: This is a blood donor who willing gives blood without receiving any form of payment or reward for his action (Buciuniene, 2006).

Chapter One: Introduction

1.1 Background of the Study

Throughout the world, the availability of integrated health systems is significant in enhancing emergency medical response. While the world has been making significant strides in curtailing the rampant deaths that occur as a result of diseases and emergencies like accidents and terror attacks, slow and insignificant advances are being made in some countries mostly the underdeveloped and developing countries (WHO, 2015). In the beginning of the 21st century, the development and expansion of ICT in healthcare management has been the trend of healthcare innovation and development in all parts of the world, with the wide application and speedy development of information technology solutions that regards computer technique, network technique and multimedia application technique as core (Kumar, Stem &Anderson, 2003).

Particularly, Information Technology is fundamental in a bid to effectively manage donated blood in blood banks and other healthcare facilities, as well as other organs attributed to the donor management systems (GUO, 2009). Blood banks only accept donated blood if the donor fulfils the following conditions: if the donor is between 18 and 60 years of age, if the donor is 45 kilograms or more, if the donor's hemoglobin is at a minimum of 12.5 gm/dL, and if the donor last donated blood 6 months before the present donation time (WHO, 2015).

An integrated blood donor management system is one that helps in enhancing emergency medical response by streamlining supply chain management, improving operational efficiency, aligning collections with demand, managing shrinking donor pool, providing safe, high-quality blood, reduced costs, and enhancing regulatory compliances. Specifically, the shelf life of blood is short, 35 days, yet its demand is high and is ever increasing. For this reason, there needs to be a consistent and reliable supply of blood. However, this is not the case in most parts of the world. Provision of safe and adequate blood in a timely manner for use in various emergency conditions from traumas to surgeries and diseases that necessitate regular blood transfusion should be a fundamental part of each country's healthcare sector and thus the need for a national donation and transfusion agency (Ford, 2007).

There is a widening variance in the supply and demand of blood. This gap is widening by the day and it needs to be bridged. There is need to improve the inter-facility sharing of information relating to blood availability. Requests for blood units of groups that were non-available at the closest blood bank would take up to 7 days to be supplied (Ozianyi & Davdra, 2015). The World Health Organization (WHO) recommends in its Global Database on Blood Safety (GDBS) that every action associated with gathering, screening, processing, safe keeping and distribution should be managed at the national level by means of efficient institution and a national blood guidelines and system**.**

In 1994, Kenya acknowledged the importance of establishing a national blood service that agrees with WHO proposals and World Health Assembly (WHA) declarations recommendations were made to set up a regional system of transfusion centers managed by central coordination. In the year 2001 Kenya's initial blood policy plan was established and opened the first Regional Blood Transfusion Center (RBTC) and national management office was set up in Nairobi (Kenya National Blood Transfusion Service, 2012).

Kenya has made some strides towards sustaining the growing demand for blood (Kimani , Gichangi & Oduor, 2011). Through government initiatives, there are six blood banks in the country. These are known as Regional Blood Transfusion Centers. Willing donors can go to any of the centers located in Nairobi, Embu, Nakuru, Mombasa, Kisumu or Eldoret (Kenya National Blood Transfusion Service, 2012). In addition to this, any provincial or district hospital has facilities that can be used for blood donation. The basis for regional blood repositories is to make sure that numerous neighboring sub-county hospitals are constantly stocked with sufficient blood to cater for the transfusion needs particularly when there is an emergency (Kikwanja, 2007). Effectively introducing technology into the healthcare management systems greatly depends on the accessibility of resources such as communication infrastructure, hardware, as well as the software. Financing for such resources is limited and resources are more accessible in urban than in the rural areas.

After the promulgation of the Kenyan constitution in 2010, services and resources that were initially offered by the national government were rapidly devolved. Among the affected services were the Kenyan health system. Significant capacity gaps are common within county political and management structures. When resources were devolved, few counties possessed the administrative capability to absorb the available funding or plan for its use. Although the national government was concerned about these capacity gaps, it had not outlined training and mentoring plans for the counties, as it expected to use the full three-year transition period originally allowed by law (Williamson & Mulaki, 2015). Currently, the functions of the Kenya National Blood Transfusion Service are still within the mandate of the national government under the ministry of health.

Provision of safe and adequate blood in a timely manner is achieved through the regular collection, screening and storage of blood obtained from Voluntary Non Remunerated Blood Donors (VNRBD). VNRBDs are the main source of donations of blood and their blood is considered safer compared to that from family/replacement and paid donors (Kimani, Gichangi, & Oduor, 2011). In order to minimize the disposal of blood that is occasioned by its short shelf life, a Global Positioning System (GPS) based voluntary donor location and identification system needs to be implemented in order to assist in prompt mobilization of donors. This research aims at adding to the knowledge base of optimization of blood donation and assessing the impact of having an Information System that would assist in streamlining donor management processes.

1.2 Problem Statement

The healthcare system in Kenya has less than fifty percent of the amount of blood it requires for blood transfusion, frequently resulting in just the most insistent cases being dealt with (Kimani, Gichangi, & Oduor, 2011). Blood mainly comes from voluntary non-remunerable donors, students and patient's family members. Less than 10% of Kenyans make a contribution to blood donation (Oduor, 2010). This is besides the fact that the need for blood is directly proportional to the constant population growth. In numerous developing countries, up to 65% of transfusions done are for children below 5 years. Yet these developing countries which make up more than 50% of the world's population donate less than 50% of the total blood donations (WHO, 2012). Emergencies that require blood donation are always on the rise but lifesaving donors are not always present to match the demand of these emergencies. Medical emergencies like the Garissa terror attack and the Westgate shopping mall attack expose the gap that Kenya has in the availability and demand of blood donations in Kenya. In the Garissa attack, more than 80 students were wounded with a large majority of them requiring blood transfusion. The intended target of 2000 units of blood was not met by the officials in charge. Kenya National Blood Transfusion Services (KNBTS), through a national survey, estimates that Kenya needs two hundred thousand units of blood annually. These needs arise from surgeries, accidents and other medical conditions that require replenishing of blood in the human body. The donor facilities lack a system that can be used to get the location of voluntary donors.

1.3 Justification of the Study

This work is an endeavor to understanding the significance of introduction and implementation of a donor locator system in the donor management and healthcare based institutions in Kenya. This research will be helpful to blood banks and health facilities administrators, stakeholders, and the government (ministry of health), as it will present the benefits of using voluntary donor locator system in the healthcare institutions for effective response to medical related emergencies, particularly those offering neonatal and maternal child healthcare services. The voluntary donor locator system provides effective response by availing on demand blood for emergencies that are caused by road accidents and terror attacks. By examining the benefits to be realized, healthcare administrators, stakeholders, and the government have the ability to formulate ways of tackling the next step: the actual acquisition and implementation of a voluntary donor management system. In addition, because of understanding the requirements of their consumers on the basis of satisfaction, this study helps various ICT designers and vendors to satisfy their consumers in all ways because it adds to the bank of knowledge in this research field.

1.4 Research Objectives

i. To investigate the degree of use of voluntary donor location systems in the Kenya donor management and healthcare facilities.

ii. To establish the key challenges of the blood donor management systems currently used in the Kenyan blood donor management and healthcare facilities.

iii. To determine the transformational effects of having a voluntary donor location system in enhancing emergency medical response.

iv. To develop a voluntary donor location prototype that can be used in enhancing emergency medical response.

1.5 Research Questions

i. What are the donor location systems currently used in the Kenyan blood donor management centers and healthcare facilities?

ii. Which are the recorded key challenges attributed to the donor management systems currently used in the Kenyan blood donor management and healthcare facilities?

iii. What transformational effects can be attributed to the use of a donor location management system in enhancing emergency medical response?

iv. What are the features of a prototype that can be used in enhancing the adoption and use of a voluntary blood donor location system in the Kenyan donor management and healthcare facilities?

1.6 Scope

The research sought to study the blood bank facilities in Nairobi with focus on Aga Khan hospital. The researcher developed a prototype that will be used for interaction between voluntary donors and blood transfusion organizations in Kenya.

1.7. Limitations to the Study

The information gathered for this research is limited to one blood donor facility. The research would have ideally required access to hospital information systems to test the efficiency integration and the impact it would have to medical processes. Access to the intended hospital information system was not granted to the researcher.

Chapter Two: Literature Review

2.1 Introduction

The chapter explores literature related to the impact of using a voluntary donor location system in emergency medical response. The elements of a blood donor management systems that influence emergency medical response include the use of information systems in developing effective blood donor recruitment and notification systems, electronic information control and integration to other hospital information systems. This chapter focuses on development of a voluntary donor location system and its adaptability to hospital information systems (HIS).

2.2 Blood Type Classification

The ABO blood group system is the classification of human blood based on the inherited properties of red blood cells as determined by the presence or absence of the antigens A and B, which are carried on the surface of the red cells. Persons may thus have type A, type B, type O, or type AB blood.

		Donors							
		O+	A+	B+	AB+	O−	A−	B−	AB−
Recipients	O+	✓				✓			
	A+	✓	✓			✓	✓		
	B+	✓		✓		✓		✓	
	AB+	✓	✓	✓	✓	✓	✓	✓	✓
	O−					✓			
	A−					✓	✓		
	B−					✓		✓	
	AB−					✓	✓	✓	✓

Figure 2.1 ABO and Rh blood type donation showing matches between donor and recipient types (Gonsorcik, 2013)

Figure 2.1 shows the donor- recipient matching of blood transfusion. Blood containing red cells with type A antigen on their surface has in its serum antibodies against type B red cells. If, in transfusion, type B blood is transferred into persons with type A blood, the red cells in the injected blood will be destroyed by the antibodies in the recipient's blood. In the same way, type A red blood cells will be destroyed by anti-2A antibody in type B blood. Type O blood can be transfused into persons with type A, B, or O blood unless there is incompatibility with respect to some other blood group system also present. Persons with type AB blood can receive type A, B, or O blood (Binder & Roberts, 2003).

2.3 The Use of Information Systems in Enhancing Blood Donor Management

O negative is the rarest blood group, hence the storage and preservation is highly desired. In the storage of blood, computerization benefits are obtained from an extensive set of systems such as automatic processing apparatus, management systems, automatic lab systems, as well as laboratory database systems. Hirsch & Brodheim (2001) investigated the organization of an automated blood donor management systems and found out that; each and every one of them is organized in a ladder of software, hardware and network apparatus. In essence, these systems initially try to automate different processing, experimenting and producing actions in order to evade human errors (Ford, 2007). These actions have been greatly connected to the automated data structure within the blood bank (Hirsch & Brodheim, 2001).

Information system allow the authentic independent processing of the blood in absence of any interruption by people. According to Singman et al (2005), the results of the processing of blood can be introduced into an information systems data structure as technological statistics in record through different interfaces. Secondly, the diverse activities in the donating of blood as well as its distribution may be truly be restructured due to the constant data and information. Similarly, the close structure of the donation of blood and its distribution can be set up to deal with the demanding matters like universal blood distribution optimization, following unfavorable transfusion effects (WHO, 2012).

Larson (1999), conducted a study on electronic statistics interchange, where he indicated that the information systems of a blood bank, has two options broadly acknowledging the giving of blood and its distribution. The first one is to set up the information system for the blood bank as a section of HIS (Singman et al, 2005). This kind of information system is essential to the health facility’s blood banks since it has a close incorporation with other hospital information systems sections such as in-patient and out-patient organization as well as billing. The second aspect of blood donation information systems is the distribution of blood. Majority of autonomous blood banks go for the separate blood bank data systems that transmit data with external systems through the unique interfaces (Kumar & Anderson, 2003).

In order to comprehend the inherent diversity among the options, it is crucial to incarcerate the particular goals of Hospital Information Systems (HIS) and blood bank system (Castells, 2001). A HIS is normally set up with the goal of restructuring the medication movement of a sick person in the health care center that enables other medical staff to work in an effective way. Thus, a HIS is a system that has the fundamental goal of developing the effectiveness of the hospital. The major goal of the blood bank data system is to improve the restructuring of the blood donation and its distribution.

Kros and Yim (2004) did a study on a resolution upholding systems for numerical evaluation of running effectiveness in an amenity charged with the responsibility of blood collection and stated that a small number of healthcare centers appear as multifaceted for controlling blood and its elements. A bank for blood storage should each and every day handle numerous data ranging from the donation of blood to blood dissemination. In line with Castells (2001), to build up a robust blood bank information system, the initial duty must be storing the associated diverse data. Bringing on board donors is the initial step and vital stride towards giving an assurance of the repeat donation and distribution of blood. Thus, it is crucial for any blood bank information system to offer the efficient remedy for donor testing and following (Hirsch & Brodheim, 2001).

Weisshaar (2008) did a study on electronic information movement from one computer to another within blood banks by means of Health Level Seven (HL7). The results showed that in modern blood bank information system, numerous objective information, like correct donation factors and credible health care data from hospitals, are required to boost the security of the donation and dissemination of blood in addition to blood storage so that emergency medical requirements can be met efficiently.

2.3.1 Voluntary Donor Locator System for Emergency Response

It is important for medical facilities to have a steady equilibrium in the demand and supply of blood and products related to blood. This has in it a vital function in securing as the sustenance of life of a patient. Chau et al, (2010) comprehensively assessed connections associated with the dissemination of the donation sites for blood. The study was conducted by use of the archived records of blood donors to allow establish a new donation site of the blood for the Red Cross within Hong Kong. The conclusion gives relationships between spatial expanse as well as the spur for the people donating blood, hence being the distinctiveness of the research. It particularly aids in the efficient establishment of centers with huge number of potential donors.

A user friendly integrated blood bank control system, in relation to the present banks of blood for hospitals, has been highly favorable for the disposition of the people donating blood, thus being of significance for the enrollment and sustenance of the donor. Conversely, with the detection of more transfusion related diseases, it is important to have a sequence of blood testing and evaluation tools so as to have safe donating and distributing of blood. Thus, effective operations of blood banks lead to reducing nationwide healthcare expenses for the tools as well as associated specialized knowledge. Saberton et al (2009) in a comprehensive way, evaluated the connections associated with the dissemination of blood to the site of the donation sites of blood. Their results show relationship between spatial distance and the spur for the blood donors. Thus, this particularly helps in the efficient establishment of sites with huge numbers of potential donors.

Over half a million loss of infant lives occurs annually. 95% of the losses are in low income countries where medical care at times of crisis regularly lacks (Michael, Eddie and Chi Wai, 2010). Roughly 15% of expectant mothers are likely to be in life-endangering state and they need care required at such times. Only the testing done before birth measures can never be efficient in lowering this risk ratio. Even if discovering danger aspects for severe impediments is simple, recognizing which danger women will really build up that is not posing threat to life is unlikely (Graham 1997). The single approach that avoid the loss of lives is by making sure there is availability quick health measures for all expectant mothers.

Injuries cause over 20% of lives lost internationally and over 30% of casualties are disabled through their lives (WHO, 2012). Since the accidental harms as well as harms resulting from conflict are severe cases, practically they need quick response for their care. Majority of the injuries related to conflict entail a principally youths who are the industrious group (WHO, 2012) that can accustom well to suitable health care at the times of crisis.

2.3.2 Rationale of a Voluntary Donor Locator System

The voluntary donor location systems should provide alerts and notification to potential donors in case of a medical emergency. Geospatial information should be incorporated into the blood donor management systems in order to enhance the traceability of volunteer donors also taking into account that they fulfill the mandatory six months' gap between the time they are needed to donate blood and the last time they donated. The prototype that the researcher will develop will take these factors into account.

The entire operation of blood contribution and dissemination system entails gathering, safe keeping, moving, transfusion analysis, and ultimate transfusion (Kohn, Corrigan, Donaldson & editors, 2000). Even if these operations can happen in one blood bank in a given hospital they are frequently operated in at least two different areas. A good example, blood meant for distribution is normally gathered in the autonomous blood sites and then safe kept and distributed for use in hospitals (Binder & Roberts, 2003).

Andrews et al (1997) indicated that the essential system of donating as well as transfusing services must have centers, blood banks for hospitals as well as ambulatory centers. Taking into consideration the benefits and disadvantages, the successful running and control of blood banks must be ascribed to contemporary information and computer technology.

2.4 Existing Blood Donor Management Systems

Valuable investments are made for the purchase of information systems in medical facilities. Emergency healthcare systems handle various conditions which cover the range of infectious diseases, noninfectious diseases, as well as body injuries. According to Waldby and Mitchell (2006), blood transfusion is a crucial element of emergency medical treatment. People whose clinical management needs transfusion should expect adequate blood to take care of their requirements. Nevertheless, majority of patients still suffer unnecessarily or even die due to lack of access to secure blood transfusion (O'Neill, 2003). The suitable accessibility of safe blood is necessary in every medical facility, though in most third world states there is an extensive deficit of blood (Waldby & Mitchell, 2006). The factors above provide the necessity for having blood donor management systems within donor facilities.

2.4.1 Zambia: Integrated Blood Donor Database Management System

In Zambia, blood safety was among the priority medical interventions that are expected to significantly contribute to the achievement of the Millennium Development Goals (MDGs). The Zambian blood donor management system relates especially to child and maternal health, the fight against the HIV/AIDS epidemic, TB and malaria (IICD, 2009).

Since 1998, Zambia has made significant achievements towards the establishment of a comprehensive, nationally coordinated blood safety system, based on the World Health Organization (WHO) guidelines on the organization and management of national blood safety programs (WHO, 2014). The Zambia National Blood Transfusion Service (ZNBTS) was set up by the Zambian Ministry of Health (MoH) and is the institution mandated by the ministry to coordinate and manage the national blood transfusion program. That is, it runs the country's blood safety system and is therefore responsible for the collection, screening, processing, storage and distribution of blood in the country.

The Integrated Blood Donor Database Management System (IBDDMS) in Zambia for with the support of Zambia Country Programme (ZCP) started in July 2008. The project involved developing and implementing a computer based Blood Donor Tracking System. This system was developed for use by the staff of ZNBTS who were trained in basic ICT by the E-Brain Technical Support Group, and with the aim of reducing the risks of incorrectly identifying donors and blood units (IICD, 2009).

The main objective of the ZNBTS project is to develop and maintain an appropriate integrated blood donor tracking database system for the efficient and effective recording and management of blood donor data and blood donor retention. The use of a blood donor tracking database system improves the quality of recording and management of information about blood donors which facilitates the effective tracking of repeat blood donors and the establishment of a reliable pool of regular repeat blood donors.

Another objective is to improve the accuracy, efficiency and effectiveness of tracking information on blood donations, from "Vein to Vein" and ensure blood safety through accurate labeling and identification of blood units at every stage.

The project is still in progress and according to ZNBTS, more than 17,000 blood donors and patients in need of blood transfusion benefit from the blood donor tracking system. This is because repeat donors can effectively be tracked and a reliable pool of regular repeat blood donors has been established. The system also ensures blood safety through accurate labeling and identification of blood units at every stage.

With the old paper based donor system all donors including the regular ones, had to fill out new registration forms every time they donated blood, because the old forms were not stored in an accessible way. The problem was that if a donor moved to another location, even if this was only to another village or city, and wanted to donate blood again they would then have to redo the entire registration process. But with the integrated blood donor tracking system donors only have to register once with ZNBTS if they want to donate blood, even if they have moved from one province to another. This is because the donor database is accessible from every ZNBTS office. With this donor tracking system retention of reliable blood donors, from low risk population groups is easier.

The donor tracking system makes it easier to reach registered blood donors since ZNBTS has their contact details in its donor database. Registered donors receive text messages reminding them that they can donate blood. A simplified version of the text message is: "*Dear sir, you are kindly reminded that you are able to donate blood again*." This text message comes from a fully automated system that recognizes when a donor is capable of donating blood again and therefore sends him or her the text message in advance (IICD, 2009).

The blood donor database was developed using open source software based on Java. Kannel, an SMS gateway, runs the short messaging system. It is an adjustable program that is listed in The Free Software Directory; a project of The Free Software Foundation (FSF) and the United Nations Education, Scientific and Cultural Organization (UNESCO).

2.4.2 Malawi: Blood Donor Management System

In 2003 the Government of the Republic of Malawi with funding from the European Development Fund (EDF) and the Commission of the European Communities (EC) and in accordance with WHO recommendations and guidelines, established an independent and autonomous Malawi Blood Transfusion Service (MBTS) with three Blood Transfusion Centers.

MBTS has an autonomous Board of Trustees (MBTST) which has facilitated the setting up the Malawi blood donor program and the formation of the Blood Donor Association of Malawi (BDAM) whose aim is to ensure blood donor education and recruitment is coordinated and no longer fragmented as it was before MBTS was established. BDAM works to bring together all the disparate blood donor interests under one body in order to improve and unite the national blood donation campaign and help diffuse any misconceived myths and misunderstandings that had been prevalent in the past and led to low donor turn outs during blood donor recruitment (Emmanuel, 2006).

MBTS provided 66.7% of all the blood used by hospitals in Malawi in the year 2005 (Emmanuel, 2006). The organization did not have the capacity to provide blood required by many of the district hospitals in the country.

MBTS aims to increase this and has therefore opted to use technology for donor recruitment and retention strategy. In 2005, the MBTS IT Department was tasked with the responsibility of overseeing the development of a Blood Donor Management System (BDMS) by a Malawian IT company. This system is an important component of the donor management and recall system as well as the laboratory ‘look-back’ system. The laboratory ‘look-back’ system tracks serological markers and statistical analysis.

The donor management system is operational and currently in use in the all the MBTS regional offices (Emmanuel, 2006). The regional IT officer is responsible for training secretarial staff, laboratory and nursing staff on data capture and retrieval using the systems. With the BDMS in place, MBTS now supplies all four central hospitals and 80% of district hospitals in the country.

2.4.3 Kenya: Text4 Life

The Kenya National Blood Transfusion Service (KNBTS) is the institution mandated by the Kenyan Ministry of Health (MoH) to coordinate and manage the national blood transfusion programme. KNBTS has a manual Blood Bank Management System and that most of the processes including record keeping and inventory management are manual. KNBTS has intentions of eventually automating its processes and has recently started storing some data in excel format, but at the moment most of its data is in paper form.

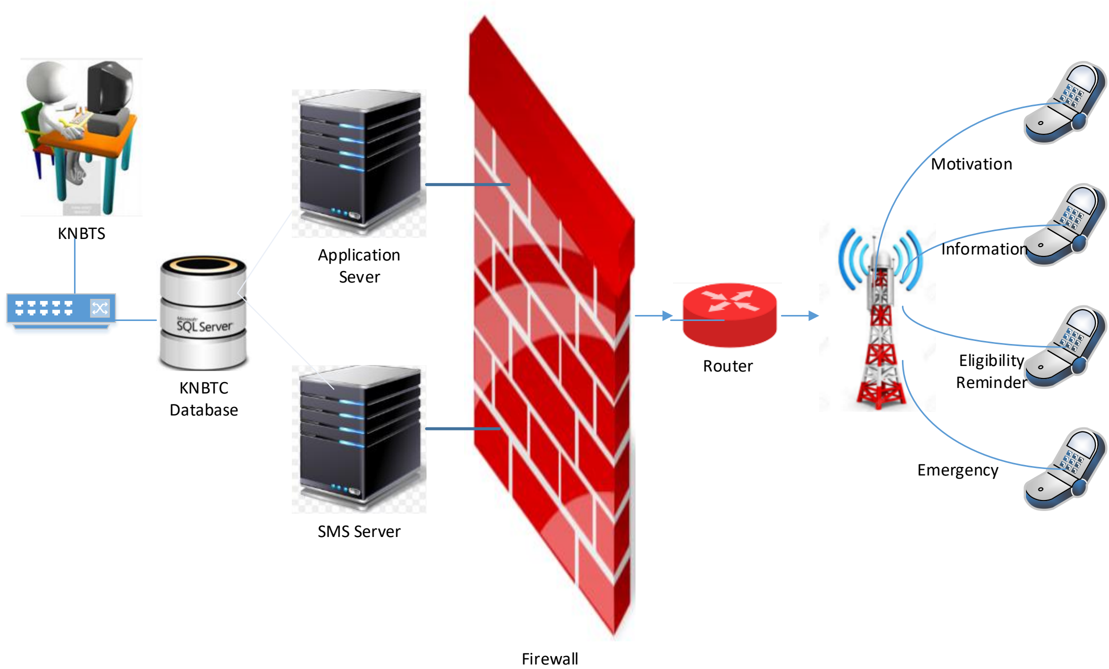

Figure 2.2 Text4life architecture (Bloodlink Foundation, 2008)

In January 2013 KNBTS launched a project funded by the CDC Foundation and supported by partners including the Blood Link Foundation, Intellisoft Consulting and mHealth Kenya. The main aim of this project being to come up with a solution to avert low donor turn outs and encourage donor participation during blood drives. Figure 2.2 shows the architecture of the text for life application. The project involves the creation and setting up of the text4life system, a platform through which KNBTS aims to ease the process of donor mobilization by sending text message notifications to potential donors on dates and venues of future blood donation drives in their county. Using this system, a potential donor registers online on the KNBTS website by entering their phone number, email address and county of residence.

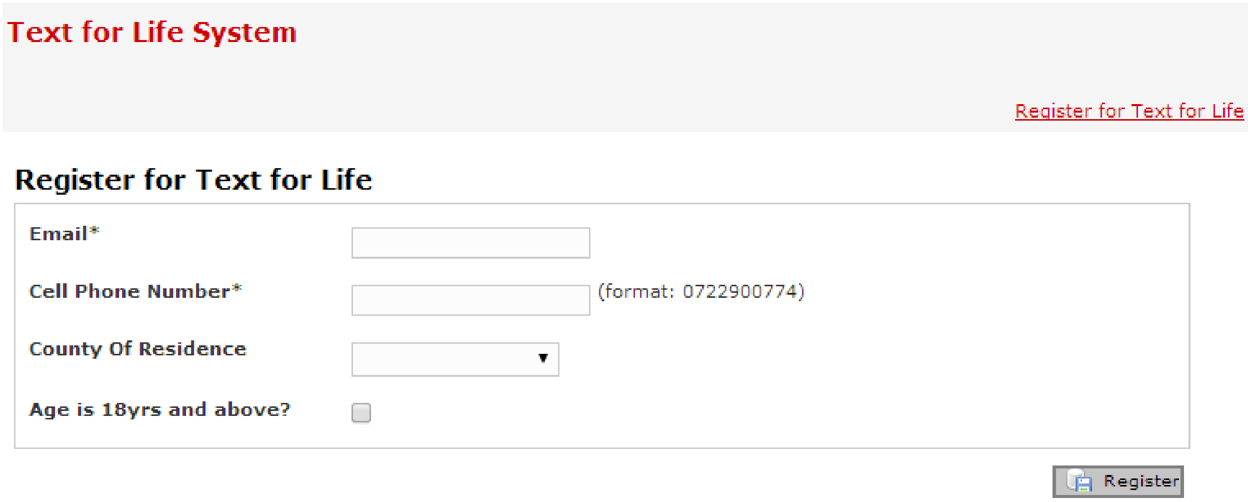

Figure 2.3: Online Registration for Text4 Life

Once donors register online they can receive text messages on when and where KNBTS is holding donation drives and also the results of their blood screening test.

Some of the shortcoming of this system include: A donor must register by filling in a form before being allowed to donate blood, even when they have registered online. One of the reasons for this is that the online registration collects only the contacts and county of residence of the donor. Details like age, gender and blood group are not entered online. The main aim of coming up with the text4life system was to enable donor mobilization and not donor management.

A study conducted on the perception of blood donation reveals that not all donors who register for text4life receive text notifications on dates and venues of blood drives or the results of their blood screening test. Some of those who receive text messages from text4life stop the service.

The KRC and several other organizations including Pledge 25 focus on mobilizing donors and creating donation awareness among the public on behalf of KNBTS. These organizations do not run blood banks and therefore do not collect or distribute blood. They also use social media and members of their clubs in schools and campuses across the country to create awareness. This shows that most of the blood collected by KNBTS is from the youth of between 16 and 25 years of age. Figure 2.3 shows the user facing form used for registration of potential donors.

2.4.4 Kenya: Life Buddy

Life Buddy is the winning innovation for the 2014 Microsoft Kenya Imagine Cup, a global student technology competition which centers on the use of imagination, creativity and technology to help solve some of the world's toughest problems. Life buddy is a mobile-based application created by the Africon team. (Imagine Cup, 2014). The mobile application that seeks to help blood recipients to easily connect with the blood donors of the same blood group as them. It allows anyone who needs blood urgently to quickly post a request on the application. The application then sends a notification to users of a compatible blood group and who are within a radius of 20 Kilometers. The willing donor then receives a notification providing them with the details of the hospital to donate blood to and the contacts of the recipient. Life Buddy saves lives by ensuring those who need blood receive it in the fastest possible time thus saving time (Karuiki, 2014).

2.5 Reasons why Donor Recruitment is a Challenge

Lack of awareness about donation drives, lack of donor education on the importance of donating regularly, they do not donate because they are not informed on where blood goes and how it is used especially in public hospitals, those who donate blood voluntarily do not get it when they need it, potential donors believe that hospitals sell the blood that they gave for free, potential donors do not donate is that they fear knowing their status, potential donors do not donate because they fear that do not have enough blood and fear of needles.

2.5.1 Reasons for Lack of Continuity among One Time Donors

The lack of sustainable strategies to recruit and retain donors is one of the main challenges the KNBTS faces. The reasons why donors stop donating or do not return after they donate for the first time are diverse, and may correlate with demographic factors like age (Shah, Patil, et. al., 2011).

A report published by KNBTS March 2012 indicated that majority of the donor in Kenya are between 16 and 20 years of age that is 57.7% of all donors. The report also shows that donor between the age of 21 and 25 years make up 27.8% of all donors which is a decrease a big decrease from the previous age group. These are the main reasons:

Donors require feedback and appreciation on their efforts which they do not receive, they are not reminded to go donate or informed when and where blood drives take place, they don't get blood when they need it, they do not know where their blood goes especially when they donate in public hospitals, they believe that when they donate their blood will be discarded and not used therefore there is no need to donate.

The reasons for lack of donation are well known and technology can be used to bridge the gap. In Kenya studies have been done on the need for computerized systems for management of blood banks (Nzoka and Ananda, 2014) but not on the perception of blood donation and the use of technology to manage blood donors.

Less than 2% of the respondents of the study on the perception of blood donation have been contacted by the KNBTS and are aware of the text4life service. Most donors do not receive their screening test results despite being told that they will be contacted with the results. 67% of respondents, who had donated blood once, indicated that receiving immediate feedback on several aspects relating to their blood donation would motivate them. In addition, 79% of all the respondents would welcome educative information on blood donation via text message or email. 59% of the respondents knew their blood group even though the majority of both donors and non-donors do not know who is eligible to donate and how often one should donate.

There has been a drastic increase in mobile technology use over the recent years and it makes sense to make use of this technology to contact donors. Kenya has a mobile phone penetration rate of over 80% therefore almost every adult has access to a phone (ITU Report, 2013). Internet penetration rate is at an all-time high with 20% of Africa's population able to access the internet. This implies that more people would be able to access the KNBTS website today and register online if they are unable to visit the KNBTS regional offices and register (ITU Report, 2014). Due to the increase in the use of the internet, there has also an increase in access to tools that can be used to create awareness on blood donation such as social media.

2.6 Donor Location Tracking using Location Based Services

Positioning methods are generally based on the determination of distances, directions or angles between known and unknown points (Figueiras & Frattasi, 2010). The ubiquity of mobile devices has focused renewed attention on the Global Positioning Satellite System (GPS), the configuration of space-based vehicles that is used to provide location data to users through their smartphones and tablets. New technologies like Global Navigation Satellite Systems have replaced the old methods. Developments in GPS (Global Positioning System) and Differential Global Positioning System (DGPS) over the last few years have greatly changed the options for geo-location procedures in the survey and utilities mapping industry. Full availability of GPS signal and varied choices for differential corrections, together with competitive pricing for good quality receivers and data logging equipment, mean that high accuracy real time positioning is available for relatively low cost (Pennings, 2013).

Figure 2.4 illustrates the segments in GPS infrastructure. The basic GPS infrastructure consists of three major segments: The Space Segment (SS) consisting of 27 satellites that orbit the planet every 12 hours and transmit time-encoded information; the Control Segment (CS) that monitors and directs the satellites from the ground; and a User Segment (US) that picks up signals from the system and produces useful information.

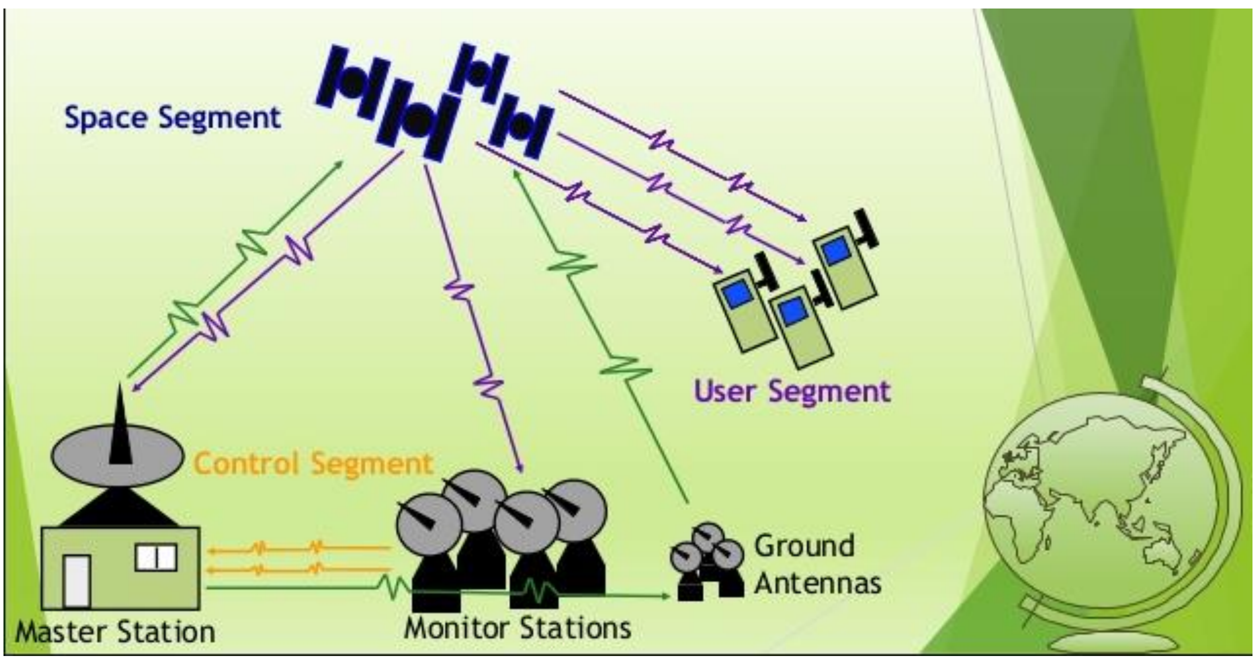

Figure 2.4 Three Segments of GPS (Pennings, 2013)

The GPS satellites broadcast signals from space that are 'triangulated' by the user devices, although the more satellite signals that are accessed, the better the coordinate information. Devices such automobile GPS systems produce three-dimensional location information (latitude, longitude, and altitude) as well as the current time from the transmitted signals. Assisted GPS however, which is used with Apple's iOS devices such as the iPhone and iPad, combines standard GPS data with information derived from cellular towers and known wireless network spots for faster and more accurate readings(Figueiras & Frattasi, 2010).

2.6.1 Cellular Network Architecture

In the radio access subsystem, the Mobile Station (MS), sometimes called user equipment is the device whose position is to be determined. Base Stations (BS) are fixed transmitters that are points of access to the rest of the network. A mobile station communicates with a base station during idle periods, cellular phone calls or other data transmission. Base stations are controlled by Radio Network Controllers (RNC) that also manage the radio resources of each base station and mobile station (Pennings, 2013).

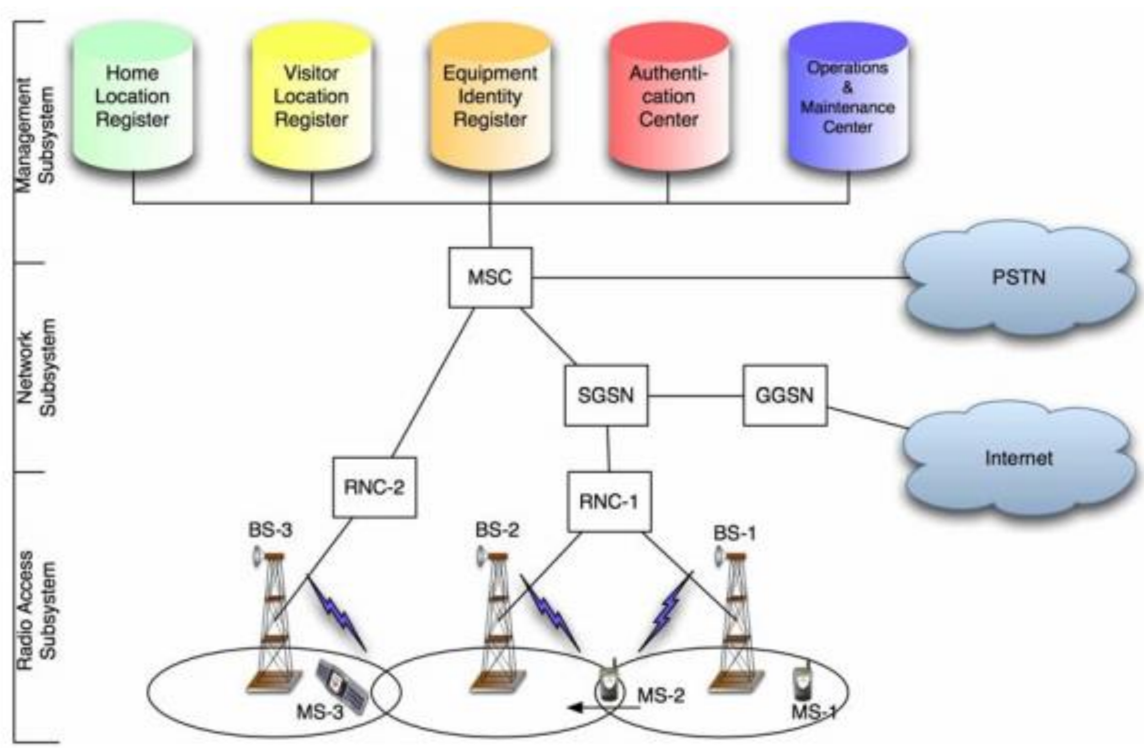

Figure 2.5 Cellular Network Architecture (Tipper, 2013)

Figure 2.5 shows a schematic of the architecture of a cellular system. While this schematic is not particular to a specific standard, it provides an idea of the different components in the network.

2.6.2 Cellular Location Service

As shown in Figure 2.6, additional network entities are required to support location services. The architecture shown in Figure 2.6 does not correspond to any particular standard, but tries to present some of the important network entities that are part of different standards. Also, some of these entities may be co-located although they are shown separately.

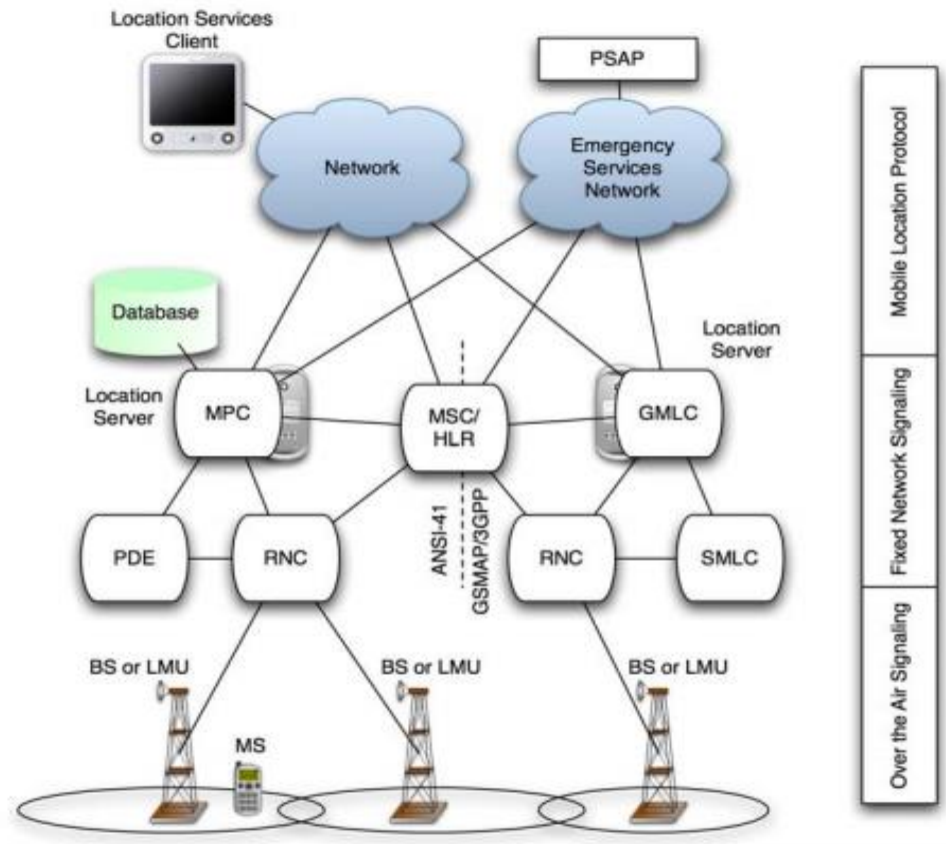

Figure 2.6 Architecture for location services in cellular networks (Tipper, 2013)

The Location Measurement Unit (LMU) is a device that assists the Mobile Station (MS) in determining its position or uses signals from the MS to determine the position of the MS. It is used with assisted GPS to help the MS determine its position. With other positioning techniques such as uplink time difference of arrival, it makes measurements of radio signals and communicates this information to network entities such as the Radio Network Controllers (RNC). A Location Measurement Unit (LMU) may be associated with a BS, in which case it communicates with the RNC over a wired link. Alternatively, it may be a stand-alone LMU which uses the air interface to communicate with the RNC (Pennings, 2013).

The Mobile Positioning Center (MPC) is the entity that handles position information in cellular networks that use ANSI-41 for signaling. It uses a Position Determining Entity (PDE) to determine the MS's position using a variety of technologies such as assisted GPS or observed time difference of arrival. The PDE can determine a MS's position while the MS is in call or when it starts a call. There may be multiple PDEs that are used by one MPC. The Mobile Switching Center (MSC) is associated with an MPC. The same MPC may be associated with multiple MSCs. The MPC and MSC communicate with the emergency services network as described later. The MPC also handles access restrictions to the position information (Tipper, 2013).

2.6.3 The Mobile Location Protocol

The Mobile Location Protocol (MLP) is an example of an application level mechanism used by a location services client to obtain position information about a MS from a location server (Pennings, 2013). The goal of the MLP specification was to develop standard methods using Extensible Markup Language (XML) for Internet applications to obtain position information from cellular network entities. The work of the location interoperability forum was rolled over into the activities of the Open Mobile Alliance (OMA) (Brenner et al, 2005), an industry form consisting of hundreds of telecommunications and related companies for generating market driven specifications for mobile services to ensure interoperability between these services.

Advanced and other services can be developed to follow the MLP specifications as required. Some services that have been already defined include standard and emergency location services (Tipper, 2013).

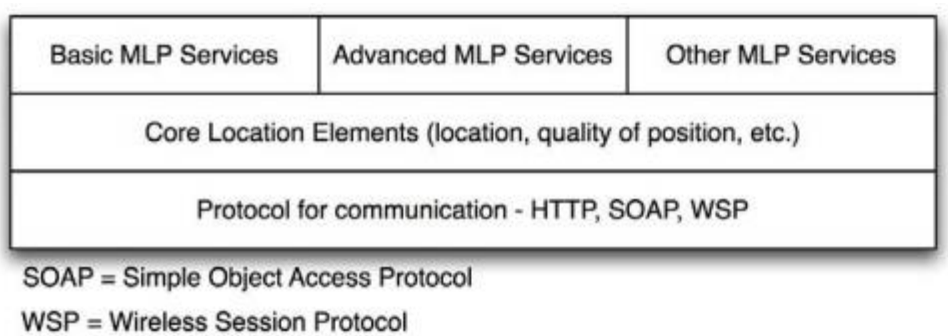

Figure 2.7 Part of the Mobile Location Protocol Stack

Some protocol/service layers associated with the MLP are shown in Figure 2.7. At the top, three types of MLP services are defined. The Basic MLP service corresponds to emergency services as it is defined by 3GPP. Advanced and other services can be developed to follow the MLP specifications as required.

2.6.4 Trilateration

A GPS receiver uses trilateration to determine its position on the surface of the earth by timing signals from three satellites in the Global Positioning System. Each satellite in the GPS constellation sends out periodic signals along with a time signal. These are received by GPS devices, which then calculate the distance between the device and each satellite based on the delay between the time the signal was sent and the time when it was received. The signals travel at the speed of light, but there is a delay because the satellites are at an altitude of tens of thousands of kilometers above the earth (Brenner et al, 2005). Once a GPS device has distances for at least three satellites, it can perform the trilateration calculations. Trilateration works in a similar way to pinpointing your position on a map knowing the precise distance from three different landmarks using a pair of compasses (Pahlavan & Krishnamurthy, 2002).

Where the three circles centered on each of the landmarks overlap is your location given the radius of each circle is your distance from each landmark. In the GPS version, the calculations are carried out in three-dimensions with an imaginary set of 3D compasses so that your location is where three spheres of radius given by the distance to each of three satellites overlap. If the GPS device can see a fourth satellite, then the measurements can be double-checked. The calculation process happens very quickly, allowing the GPS device to pinpoint its location, altitude, speed and direction. The transmissions are timed to begin precisely on the minute and the half minute as indicated by the satellite's atomic clock. The first part of the GPS signal tells the receiver the relationship between the satellite's clock and GPS time. The next chunk of data gives the receiver the satellite's precise orbit information (Pahlavan & Krishnamurthy, 2002).

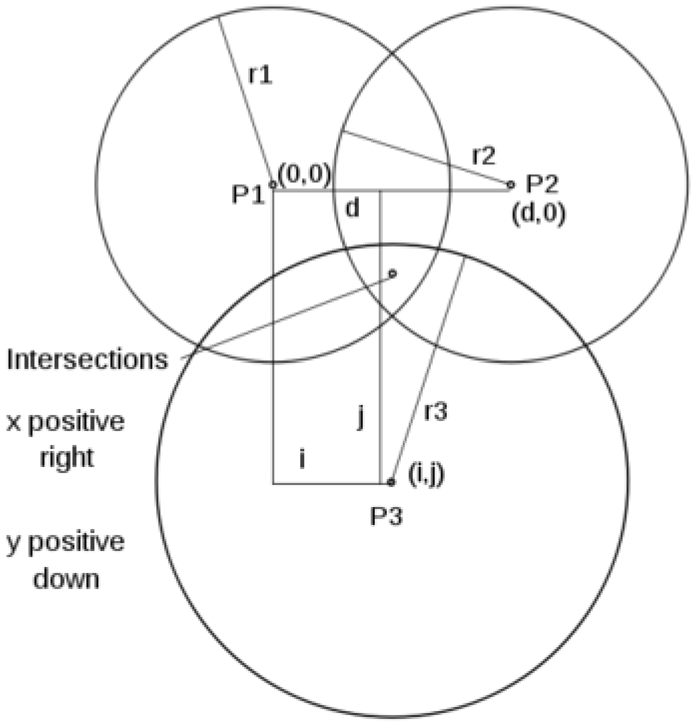

Figure 2.8 The two intersections of a three sphere surface

In the figure 2.8, The plane $z = 0$, showing the three sphere centers, *P*1, *P*2, and *P*3; their *x*,*y*-coordinates; and the three sphere radii, *r*1, *r*2, and *r*3. The two intersections of the three sphere surfaces are directly in front and directly behind the point designated intersections in the $z = 0$ plane

The intersections of the surfaces of three spheres is found by formulating the equations for the three sphere surfaces and then solving the three equations for the three unknowns, *x*, *y*, and *z*.

The outlined calculations as stipulated by (Pahlavan & Krishnamurthy, 2002) is the equation of the three spheres.

$$r_1^2 = x^2 + y^2 + z^2$$
$$r_2^2 = (x - d)^2 + y^2 + z^2$$
$$r_3^2 = (x - i)^2 + (y - j)^2 + z^2$$

d is the x coordinate of point P2. You have to subtract it from x to get the length of the base of the triangle between the intersection and r2 (x, y, z are coordinates, not lengths). We need to find a point located at (x, y, z) that satisfies all three equations. We need to use r1 and r2 to eliminate y and z from the equation and solve for x:

$$r_1^2 = x^2 + y^2 + z^2$$
$$r_2^2 = (x-d)^2 + y^2 + z^2.$$
$$r_1^2 - r_2^2 = x^2 - (x-d)^2$$
$$r_1^2 - r_2^2 = x^2 - (x^2 - 2xd + d^2)$$
$$r_1^2 - r_2^2 = 2xd - d^2$$
$$r_1^2 - r_2^2 + d^2 = 2xd$$
$$x = \frac{r_1^2 - r_2^2 + d^2}{2d}.$$

Assuming that the first two spheres intersect in more than one point, that is that

$$d - r_1 < r_2 < d + r_1.$$

In this case, substituting the equation for x back into the equation for the first sphere produces the equation for a circle, the solution to the intersection of the first two spheres:

$$y^2 + z^2 = r_1^2 - \frac{(r_1^2 - r_2^2 + d^2)^2}{4d^2}.$$

Substituting $z^2 = r_1^2 - x^2 - y^2$ into the formula for the third sphere and solving for y there results:

$$y = \frac{r_1^2 - r_3^2 - x^2 + (x-i)^2 + j^2}{2j} = \frac{r_1^2 - r_3^2 + i^2 + j^2}{2j} - \frac{i}{j}x.$$

Now that the *x*- and *y*-coordinates of the solution point are found, the formula can be rearranged for the first sphere to find the *z*-coordinate:

$$z = \pm\sqrt{r_1^2 - x^2 - y^2}.$$

Now the solution to all three points *x*, *y* and *z* is found. Because *z* is expressed as the positive or negative square root, it is possible for there to be zero, one or two solutions to the problem.

2.7 System Integration using Web Services

The integrated blood donor management system can only be optimized by integration with existing hospital information systems. A variety of these systems have been developed and deployed to different health facilities. The researcher intends to have secure integrations with these systems using web services. A web service is any piece of software that makes itself available over the internet and uses a standardized XML messaging system. XML is used to encode all communications to a web service. For example, a client invokes a web service by sending an XML message, then waits for a corresponding XML response. As all communication is in XML, web services are not tied to any one operating system or programming language—Java can talk with Perl. Windows applications can talk with Unix applications (Gustavo, 2013). They are self-contained, modular, distributed, dynamic applications that can be described, published, located, or invoked over the network to create products, processes, and supply chains. These applications can be local, distributed, or web-based. Web services are built on top of open standards such as TCP/IP, HTTP, Java, HTML, and XML.

The basic web services platform is XML and HTTP. All the standard web services work using the following components: SOAP (Simple Object Access Protocol), UDDI (Universal Description, Discovery and Integration) and WSDL (Web Services Description Language). A web service enables communication among various applications by using open standards such as HTML, XML, WSDL, and SOAP. A web service takes the help of: XML to tag the data, SOAP to transfer a message, WSDL to describe the availability of service.

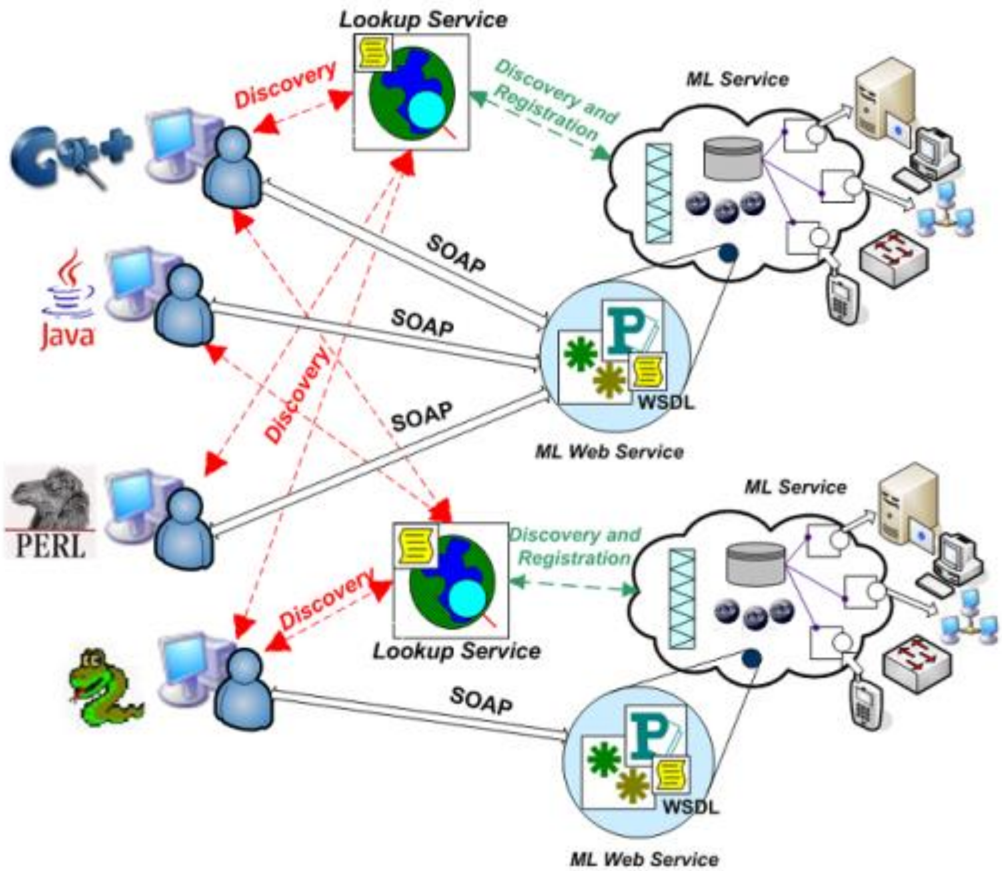

Figure 2.8 Description of a Web Service (Gustavo, 2013)

Figure 2.8 shows the interoperability of languages and systems using web services.

The researcher intends to use web services because of the following: A web service is a unit of managed code that can be remotely invoked using Hypertext Transfer Protocol (HTTP). That is, it can be activated using HTTP requests. Web services allow you to expose the functionality of existing code over the network. Once it is exposed on the network, other applications can use the functionality of your program. Web services allow various applications to talk to each other and share data and services among themselves. Other applications can also use the web services. For example, a VB or .NET application can talk to Java web services and vice versa. Web services are used to make the application platform and technology independent. Web services use Simple Object Access Protocol (SOAP) over HTTP protocol, so you can use your existing low-cost internet for implementing web services. Besides Simple Object Access Protocol (SOAP) over HTTP, web services can also be implemented on other reliable transport mechanisms like File Transfer Protocol (FTP) (Gustavo, 2013).

2.8 The Proposed Architecture

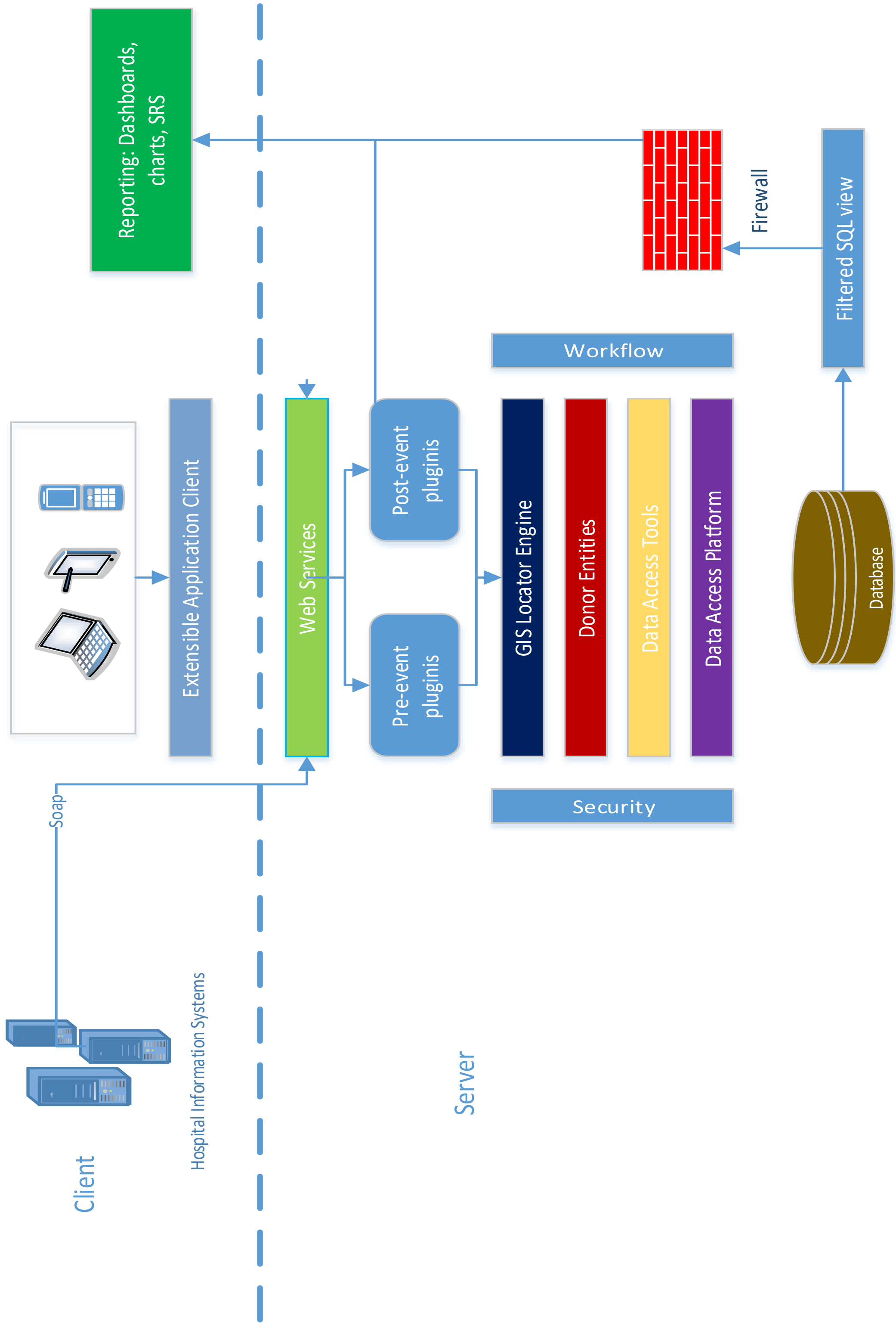

Figure 2.9: Architecture of the Prototype.

The architecture of the prototype depicts the two major components of the system. This is shown in figure 2.9. These are the server and the client. The client side covers access to the application by the public. This can be done via a mobile application. The prototype is based on android.

The server side has the GIS locator engine that fetches the domicile location of the voluntary donor. A firewall will be used to secure the application. The SQL database resides in the server side.

2.10 Summary

Mobile applications remain the mainstream way to locate and contact voluntary and potential donors. Mobile applications can also be used to make appeals for blood in case of an emergency. Some of the applications discussed in this chapter are used only as reminders, a function that can be performed using a simple bulk messaging service.

The researcher identified a gap between donor management systems and hospital information systems. The model proposes to have integration points between the two systems in order to enhance efficiency in the patient care systems and donor management systems. GPS is commonly used for outdoor geo-location. This is a functionality of high end smart phones. It is also unlikely that owners of such devices will leave the location services on due to high consumption of battery charge. The researcher intends to use location based mobile system that will be make use of the highly available telecommunication infrastructure. Communication between the back-end server application and the mobile application will make use of Unstructured Supplementary Service Data that can be used in all mobile phones regardless of whether they are smart phones or not.

Chapter Three: Research Methodology

3.1 Introduction

This chapter explains the research methodology that is used in this research. The areas presented include, the research design, target population, sampling and sample size, data collection methods and procedures, pilot study as well as data analysis used in this study. The researcher used two approaches to the research work which are: data collection in order to identify the issues around the location of voluntary donors, and the development of a prototype that enable the researcher to conceptualize the voluntary donor location system.

3.2 Research Design

This study used quantitative and experimental research methods so as to examine the relationship between variables and aimed at analyzing and representing the relationship through statistical analysis. It involves gathering data that describes events and then organizes, tabulates, depicts, and describes the data.

3.3 Population and Sampling

According to Neuman (2006), a population is a well-defined set of people, services, elements, and events, group of things or households that are being investigated. This research was carried out at the blood donor facility of the Aga Khan University Hospital Nairobi. The unit is entrusted with the responsibility of managing blood collection and transfusion at the hospital. The target population comprised of donors between the age of 18 and 50. The participants were selected through non-probability sampling because the researcher was bound by time and resources. The researcher applied random sampling in order to obtain the required sample size.

3..3.1 Sampling Technique

Sample Size

A sample is a subset of a population or simply the number of items to be selected from the population. Aga Khan University Hospital gets 148 voluntary donors every month. These are walk in repeat donors who respond to SMS notifications having fulfilled the requirements for donation. The formula approaches to determining the sample size. The sample size for respondents was calculated using Yamane’s formula (Yamane, 1967).

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = the sample size
N = the population size
e = the level of precision $\pm 7\%$

$$n = \frac{148}{1+148(0.07)^2} = 74$$

Sample size for preliminary study is 74

Cooper and Schindler (2003) explain that the basic idea of sampling is selecting some of the elements in a population, so that the same conclusions can be drawn about the entire population.

3.5 Data Collection

A questionnaire was used as the principal survey instrument to gather information in the research. The researcher sought to obtain data regarding the usability and adaptability of the prototype that was developed. The questions were designed in such a way as to elicit answers to all pertinent issues in order to provide solutions to the research problem. The survey instrument had structured questions in the Likert format and unstructured questions for increased breadth of information. The first section captured the general information on the respondents, while the second section through to section five sought to capture information on the transformational effect of a voluntary donor tracking system in enhancing emergency medical response, model for adoption followed in adoption, the impact seen thus far and what the key success elements will be in implementing an integrated donor management system in blood banking facilities in enhancing emergency medical response.

Interviews were used to gather information from the staff at the blood donation unit of the Aga Khan hospital. This offered a good approach to understanding the current process of blood collection. Interviews offered an avenue for further explanation and better understanding of the process. It also offered an opportunity for requirements gathering for the prototype.

3.6 Data Analysis and Presentation

Both quantitative and qualitative techniques were used to analyze the data collected. Quantitative data was analyzed using Microsoft Excel. Data analysis results were presented in tables, pie charts in order to present a visual analysis of the correlations. The data obtained from the research instruments was analyzed by use of descriptive statistics including frequencies and percentages, as well as inferential statistics (Binder & Roberts, 2009).

3.7 Software development methodology

The researcher used prototyping as the software development methodology for application development. Software prototyping is the activity of creating prototypes of software applications, which is incomplete versions of the software program being developed. It is an activity that can occur in software development and is comparable to prototyping as known from other fields, such as mechanical engineering or manufacturing. A prototype typically simulates only a few aspects of, and may be completely different from, the final product (Jacobson, 2011). The architecture design and module phases follow the process shown in Figure 3.1.

The researcher chose the methodology because of the primary advantage that he would get feedback from the end users before development of the software is complete.

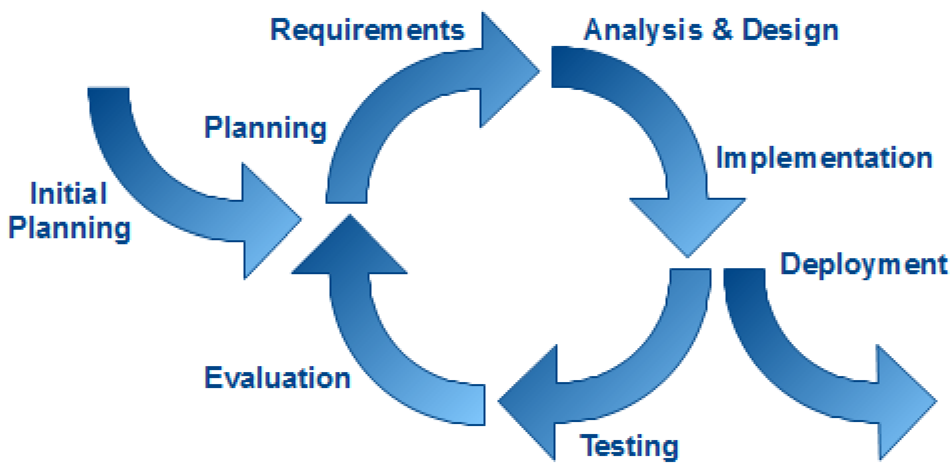

Figure 3.1: Software Prototyping (Jacobson I. , 2011)

Figure 3.1: Software Prototyping (Jacob I. ,2011)

3.8 Research Validity

To ensure the validity of the research, the researcher made sure that the data collected from the respondents was relevant to the research topic. The academic supervisor checked the study so as to ensure that the research objectives were met. The researcher followed the guidelines prescribed by the university and adhered to the standards.

Test cases were developed and used to test the functionalities of the major milestones.

3.9 Ethical Considerations

Before conducting the study on the perception of blood donation, the respondents were informed of what the research project was about, its tentative research goals and objectives and they gave their consent before filling in the questionnaires, answering interview questions and taking part in group discussions. All respondents were guaranteed confidentiality since they did not identify themselves using their names on the questionnaires.

The researcher collected the data without filing personal information about the respondents. He did not include identification details during collection of data. Data collected for the purpose of research was secured in a secured structured query language database with a password only available to the researcher.

Chapter Four: System Analysis and design

4.1 Introduction

This chapter presents the findings of the research that sought to examine data driven integrated blood donor management system in enhancing emergency medical response. The analysis is based on the research objectives

The findings presented in this study are on the basis of data that was collected from donors and staff at the Aga Khan University Hospital blood donation unit who were selected by the researcher to participate in the study by answering questions that pertain to data driven integrated blood donor management system in enhancing emergency medical response.

4.2 Response Rate

	Frequency	**Response Rate**
Responded	60	81
Not responded	14	19
Total	74	100

Table 4.1: Response Rate

A total of 74 questionnaires were distributed to the Aga Khan University Hospital blood donation unit. According to the research findings, 60 respondents answered and returned their questionnaires whereas 14 of the questionnaires were not responded to or were returned while incorrectly filled. This therefore gave the study a response rate of 81% which is adequate according to Mugenda and Mugenda (2003) who advocate for a response rate of above 75% is adequate for an academic research. Table 4.1 shows the response rate.

4.3 Demographic Information

4.3.1 Gender of Respondents

Gender	Frequency	Percentage
Male	24	40
Female	36	60
Total	60	100

Table 4.2: Gender of respondents

Table 4.2 presents findings on the gender of respondents reached by the study. According to the results, majority of the respondents reached were female as shown by 60% while the rest were male as shown by 40% respectively. This is an implication that the researcher tried as much as possible to avoid gender bias during the data collection. The results on gender are also as shown in figure 4.1.

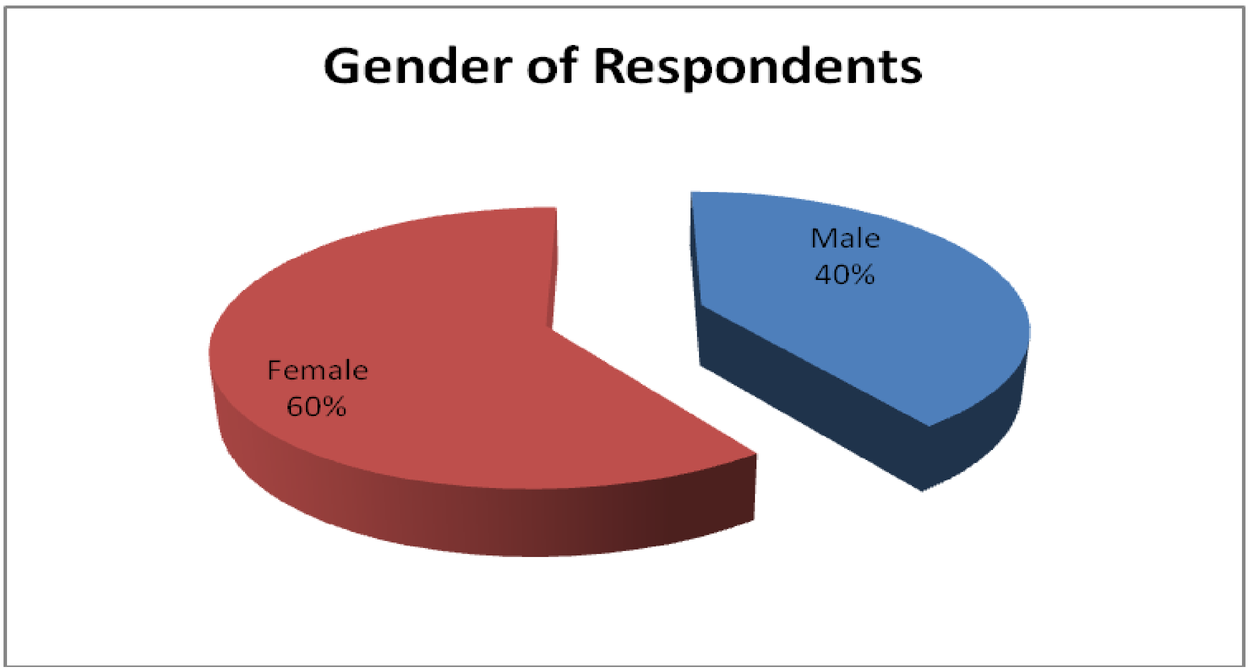

Figure 4.1: Gender of Respondents

4.3.2 Age Bracket of Respondents

Age bracket	Frequency	Percentage
21 - 30 Years	15	25
31 - 40 years	32	53
41 – 50 years	7	12
Over 51 years	6	10
Total	60	100

Table 4.3: Age Bracket of Respondents

The researcher intends to establish the age bracket of the respondents. According to the study findings, majority of the respondents as shown by 53% were aged 31-40 years, 25% were aged between 21-30 years, 12% were aged between 41-50 years whereas 10% said they were aged over 51 years respectively an implication that majority of the respondents reached were people of tender age who understand well on integrated blood donor management system. The information on age bracket of respondents is presented in the figure 4.2.

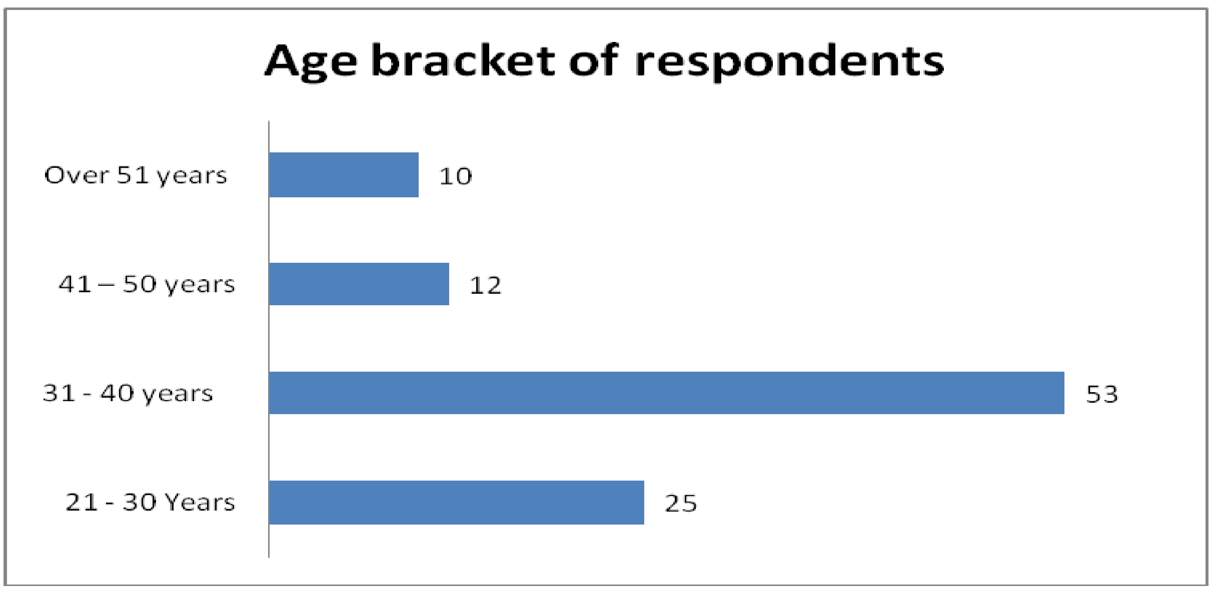

Figure 4.2: Age Bracket of Respondents

4.4.1 Ease of Location of Blood Donors

The researcher intends to know how easy it was to trace donors at the moment of a medical emergency. According to the respondent's response, 66 % of the time it was difficult to trace a donor the moment of need. 14 % said it was difficult, 5% did were neutral on the issue, 8 % said that it was easy while 7% said that donors are easily available as shown in figure 4.3.

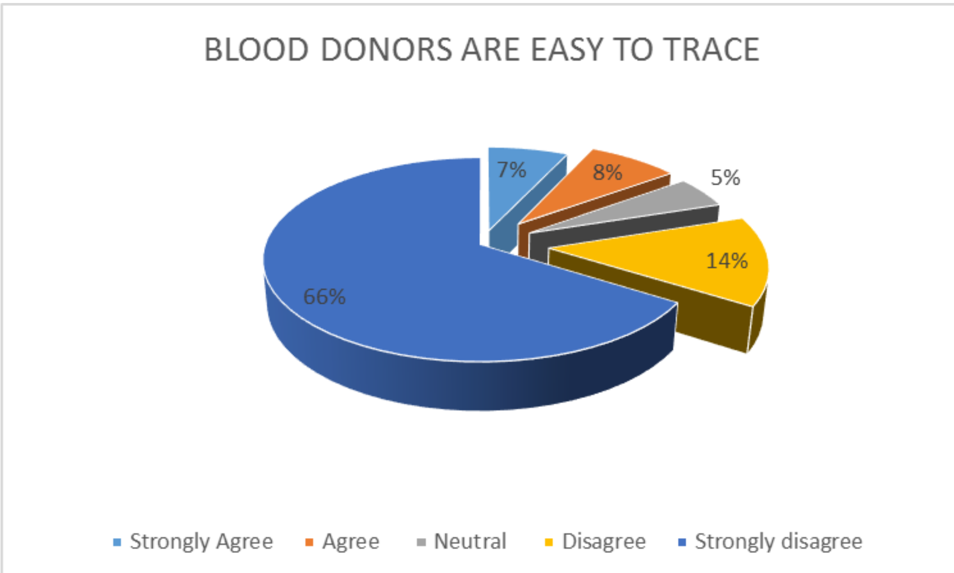

Figure 4.3: Ease of Tracing Voluntary donors

4.4.2 Efficiency of Current Methods of Tracing Donors

The researcher intended to know whether the currently available methods of tracking blood donors was efficient and user friendly. 72 % strongly disapproved the current methods used, 11% disagreed, 9% were neutral on that issue, 5 % agreed and 3% agreed as shown in the figure 4.4

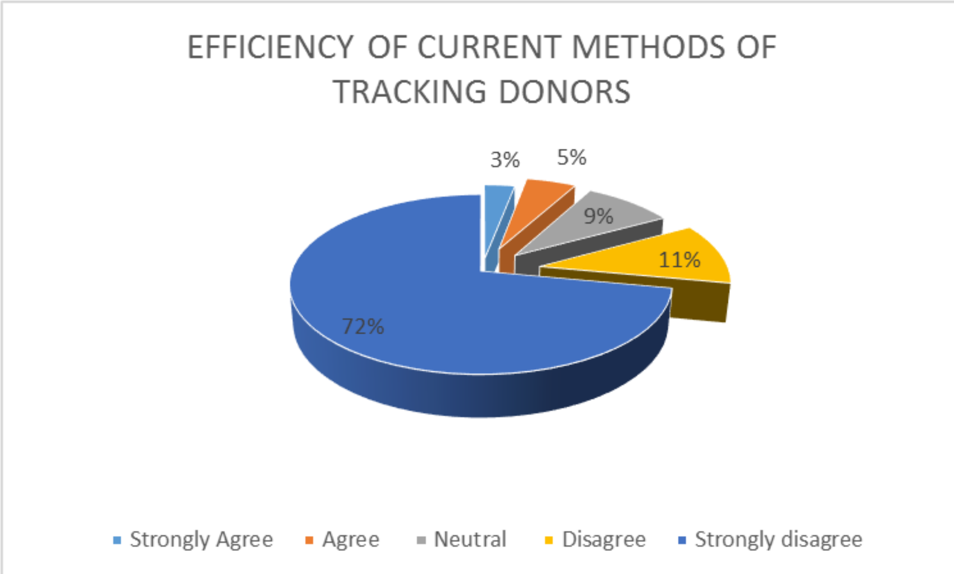

Figure 4.4: Efficiency of Current Methods of Tracking Donors

4.4.3 Communication to Donors in Case of an Emergency

The researcher intends to know whether donors are notified in case of an emergency. Most coverage was from radio communication. 35 % of the respondents disagreed that the current methods are efficient, 34% disagreed, 15% disagreed, 9% were neutral, while 7% agreed. This is as indicated in Figure 4.5.

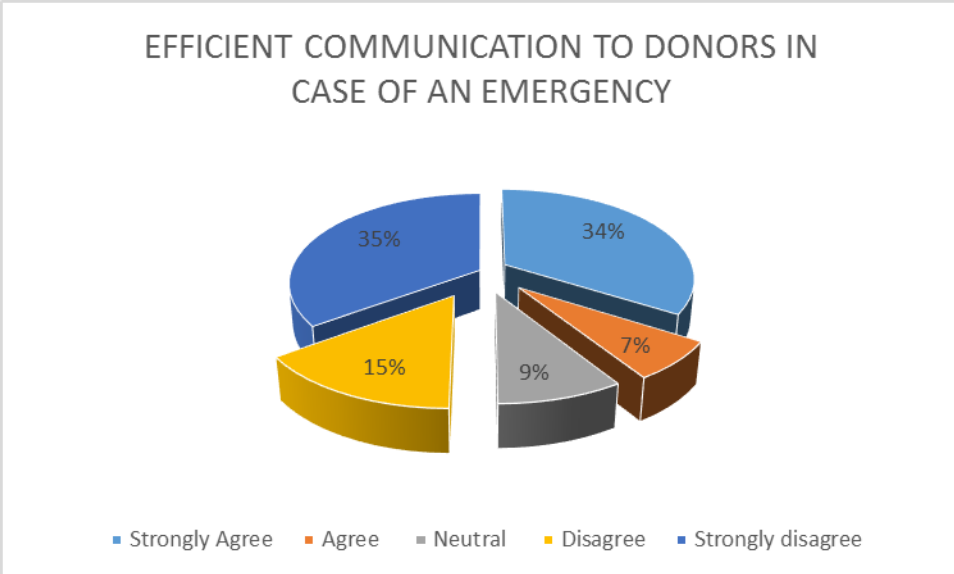

Figure 4.5: Efficiency of Communication to Donors in Case of an Emergency

4.4.4 Adaptability and User Friendliness of Current Systems

The researcher sought to find out if the current systems in place are adaptable to the demands. He also sought to find out if the current systems are user friendly hence making them usable to the general public. 58% of the respondents stated that the current systems are not friendly to use, 18% responded as neutral, 9% disagreed, 8% strongly disagreed, whereas 7% agreed. This is according to figure 4.6.

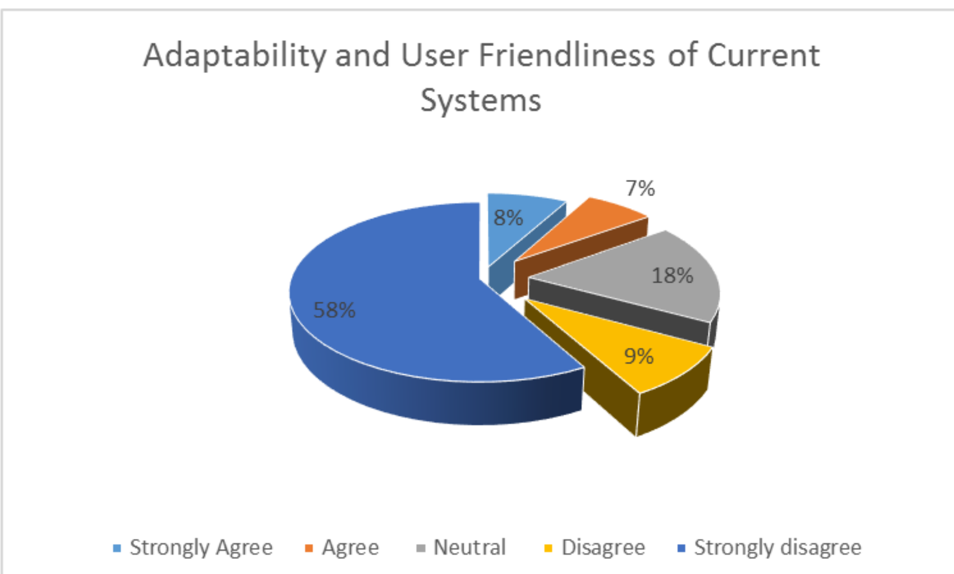

Figure 4.6: Adadptability of Current Systems

4.4.5 Information Security of the Current Systems

The researcher intended to know whether the current systems have the information in a secure and encrypted manner noting that the data is sensitive. 37% of the respondents said that the data is not secure, 19% disagreed that the data is secure, 3% were neutral, 19% agreed that the data is secure and 22% said that the data is secure. This is shown in figure 4.7.

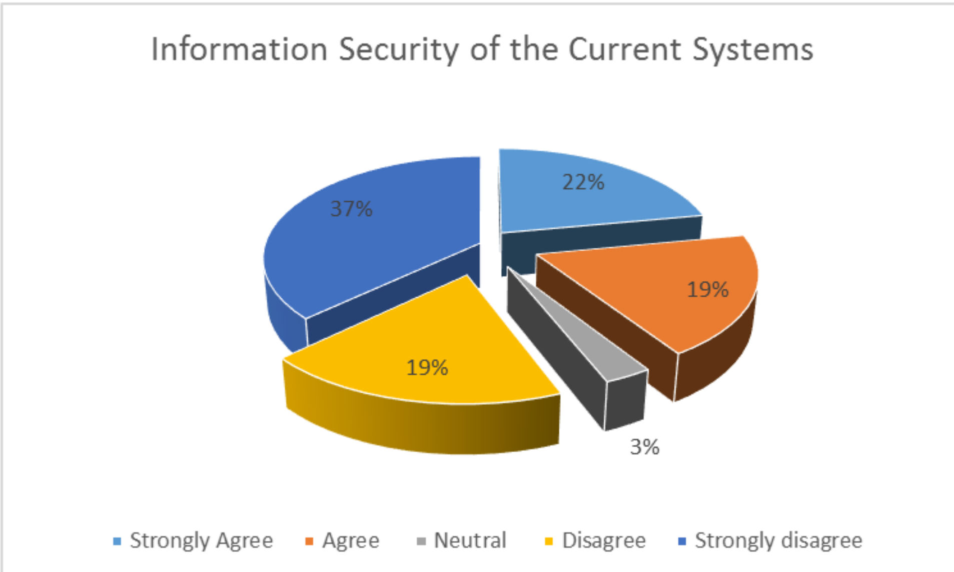

Figure 4.7: Informtion Security of Current Systems

4.4.6 Recommendation for a Donor Tracking System

68% of the respondents strongly agreed that there need to be a donor tracking system, 16 % agreed, 3% were neutral, 13% disagreed and 0 % strongly disagreed. The results are shown in figure 4.8.

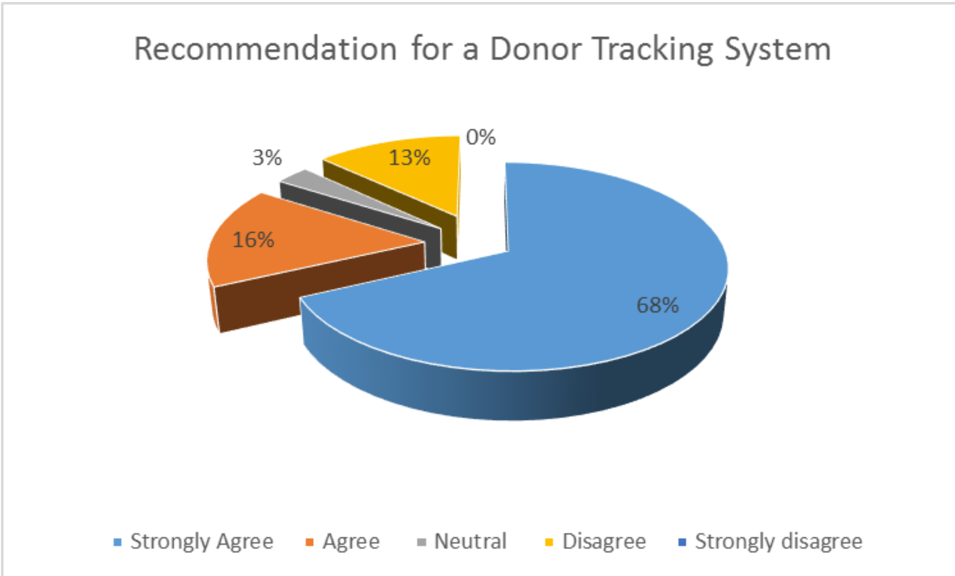

Figure 4.8 Recommendation to have a Donor Tracking System

Table 4.9: Degree of Use of Donor Tracking Systems

The researcher intended to find out the degree of use of blood donor tracking. 11% of the respondents said that the degree of use of Donor Tracking Systems was very high, 12% said high, 18% said average whereas 19% said the usage was low and 40% responded with very low.

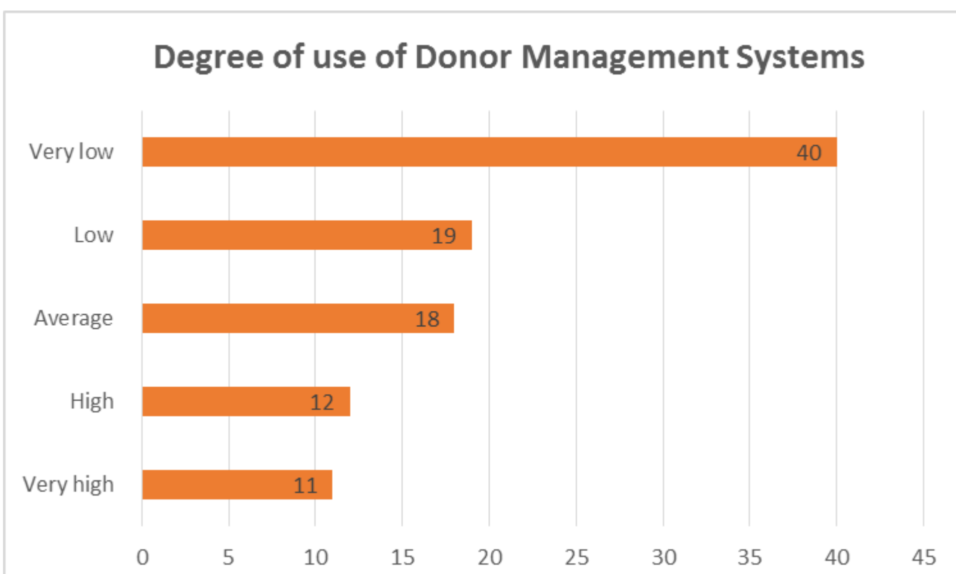

Figure 4.9 Degree of Use of Blood Donor Tracking Systems

Description of question	**Never**	**Seldom**	**Most of the time**	**Always**
The system provides sufficient information	0%	80%	20%	0%
I am satisfied with the format of output from the system	5%	45%	25%	25%
The system easy to use	0%	3%	56%	41%
I am satisfied with the application of the IT system in tracking donors	0	5%	18%	76%

Table 4.4: Respondents level of satisfaction with the use of Donor Tracking Systems

The table 4.4 displays findings on respondents' level of satisfaction with the use of donor tracking systems. According to the findings, 0% of the respondents said that they were always satisfied that the system provides sufficient information to them, 25% said they were most of the time satisfied with the format of output from the system, 56% said that the system is easy to use whereas 76% said they were always satisfied with the application of the IT system in the blood donor management systems respectively.

4.5 Implication of the Findings

Despite having a large population of potential donors, there is a deficit of blood in blood banks in Kenya. Voluntary non-remunerable blood donors contribute most of the blood in the blood banks. Due to the short lifespan of blood, a significant amount of it is disposed. This is despite the fact that there is continuous demand for blood due to medical procedures and emergencies. Potential donors lack information on when and where blood donation drives will be held. There is disconnect between hospital information systems and data available in donor facilities. Medical facilities cannot determine the availability of blood at donor facilities hence the turnaround time between reporting of an emergency and acquisition of the blood required is largely unacceptable. The researcher proposes to have a blood donor tracking system. A mobile application will be used to determine the domicile geolocation of a voluntary donor. The mobile application will relay information on donation drives.

4.6 Requirements for the Proposed System

The researcher proposed to have a system which could fulfil the following requirements:

i. A system that would enable blood donation facilities to track registered voluntary donors

ii. A system that could keep a database of the domicile location of voluntary donors

iii. A system that could send alerts to donors

iv. A system that could verify the eligibility of a donor and send them the eligibility to donate status

v. A secure system that can maintain the privacy of information given.

vi. A user friendly interface.

vii. A system that can generate reports for decision making.

The user requirements are further grouped into functional and nonfunctional requirements. The functional requirements capture the intended functions while the nonfunctional requirements form the constraints of the functional requirements.

4.6.1 Functional Requirements

i. The system shall have a user management module where system users will be enrolled and security levels assigned.

ii. Voluntary non remunerable donors will register themselves in the mobile application.

iii. The information will be stored in a central database and will be available to system administrators.

iv. The system shall check the eligibility of donors to donate blood at any particular time.

v. The system shall alert eligible donors within the donor facility in case of an emergency.

vi. The system shall generate reports.

4.6.2 Non-Functional Requirements

i. Access to the system will be restricted to only enrolled users.

ii. The system should be user friendly.

iii. The mobile application should be portable even to android mobile phones with low processing capability.

iv. The system should be robust.

v. The system should allow for future customizations.

vi. The system should be reliable, and highly available.

4.7 System Requirements

The researcher proposed to develop a system with the following requirements.

4.7.1 Rational Database Management System

The proposed database shall store and archive information that is put into the system. The characteristics of this database should satisfy both the functional and non-functional requirements. SQL server was the database management software of choice.

4.7.2 Graphical User Interface

The mobile application was built on an android platform. This shall be used for collecting donor data.

4.7.3 Security

The backend application will sit behind a firewall in order to secure donor information and to ensure integrity of the data stored in the application.

4.8 Process Modelling

Software process modelling tries to capture the main characteristics of the set of activities performed to obtain a software product, and a variety of models have been created for this purpose. A process model can be used to define a recommended software process (Silvia, 2010). The software to be implemented shall follow the processes and guidelines as outlined in the design.

4.8.1 Context Level Diagram

Context level data flow diagram demonstrates the interactions between the process and external entities. The external entities involved in the main process are, the voluntary donor, the donor facility, managerial staff and the system administrator. The core process is getting the domicile location of a voluntary blood donor. The donor has a mobile application which tracks his eligibility to donate blood based on his hast donation, and his domicile location, which is the place he is likely to be at a given time. System administrator evaluates the role of any given user. The blood bank searches for the voluntary donor and his eligibility to donate blood at that particular time. Managerial staff view system reports generated by the reporting tool.

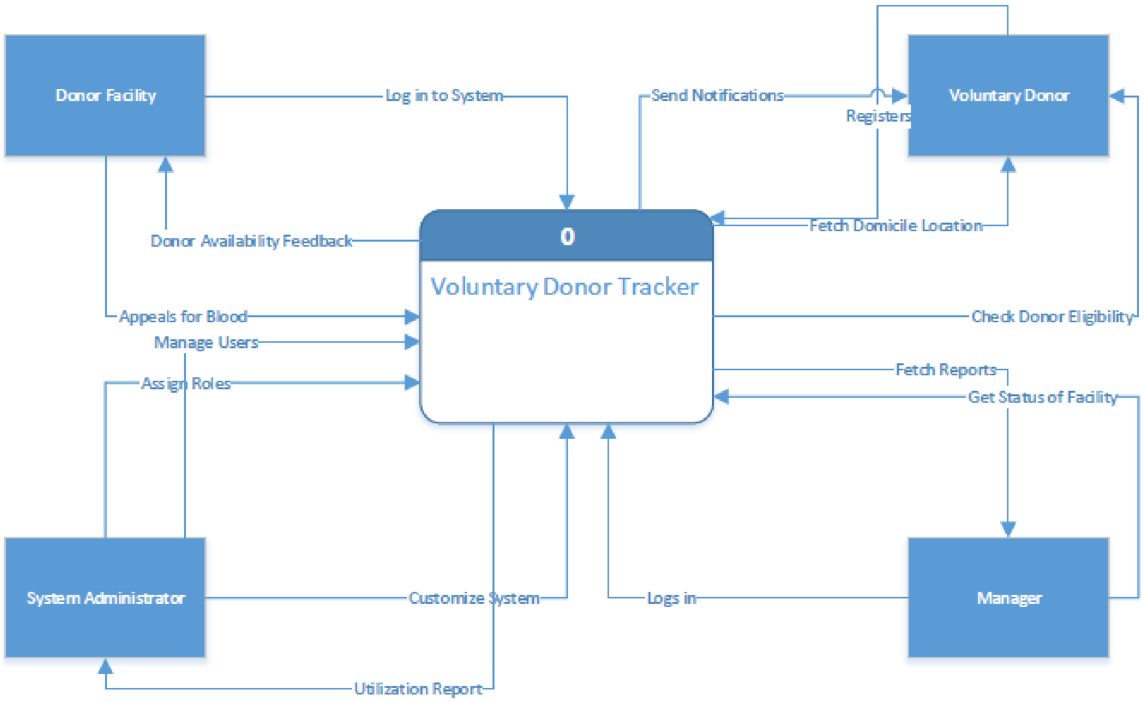

Figure 4.10: Context Diagram for a Donor Locator System

4.8.2 Level 0 Diagram

As illustrated in the context diagram in figure 4.10, the major processes involved in tracking voluntary donors are:

i. **User Management**

The system admin authorizes and gives roles to all those that will have access to the donor tracking software. This involves creating users, deleting users and modifying the roles of users.

ii. **Voluntary Donor Registration**

With the mobile application, the donors will be enrolled into the donor management system. The data includes, the blood group, last date of donation, contact information and the domicile location which will be automatically taken by the system.

iii. **Request for Blood by the Donation Facility**

The blood bank will put a request to the donor tracking system and input the requirements of the donation. The facility operator will be able to track the location of the nearest and eligible donor and will be able to send an alert to them with the details of the request. Based on the domicile location address, the facility operator will see a heat map of the eligible donors within close proximity of the donor facility.

iv. Check for Location and Eligibility of Voluntary Donors

When the facility operator makes the appeal for blood, the locator engine will track the donor within close proximity of the facility. It is of critical importance that the application also checks the eligibility of this donor to ensure that he is within the medically recommended donation period and his blood group matches the required blood group.

v. Report Generation

The system users and managers will periodically require to view the performance of the facility. This can be achieved using the reporting tool that will be provided. The reports will include, list of donors, enrolled donor blood groups and number of request for that period.

The data stores are shown in the level 0 diagram in the figure 4.11.

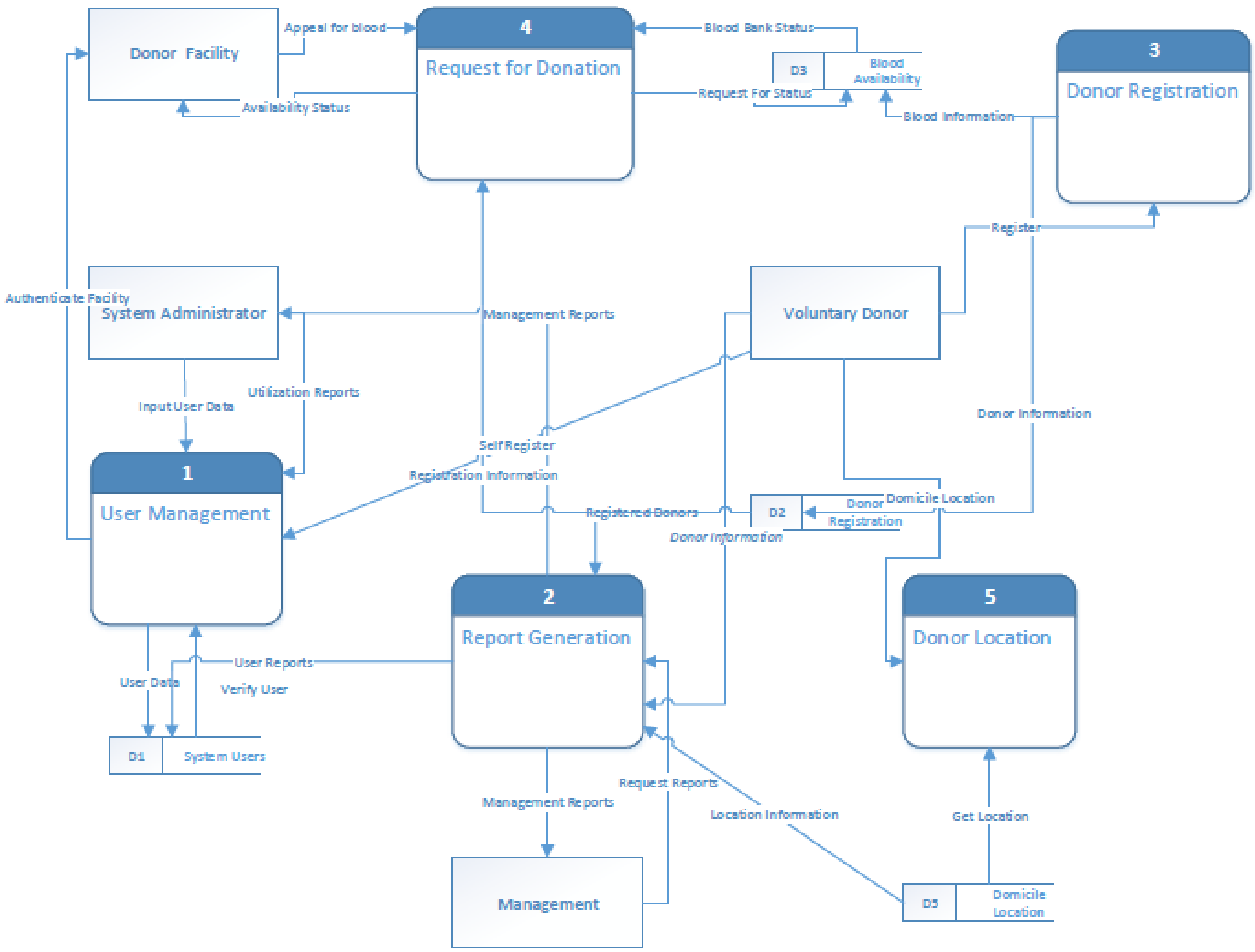

Figure 4.11: Level 0 Diagram for a Donor Tracking System

4.8.3 Use Case Diagram

A use case is simply as list of actions which typically define the interactions between an actor and the system with the aim of achieving a certain goal. Each interaction is a single unit of work and captures a "contract" for the behavior of the system under discussion to deliver a single goal (Kettenis, 2007). Majority of the functional requirements are captured by the use case in the figure 4.12.

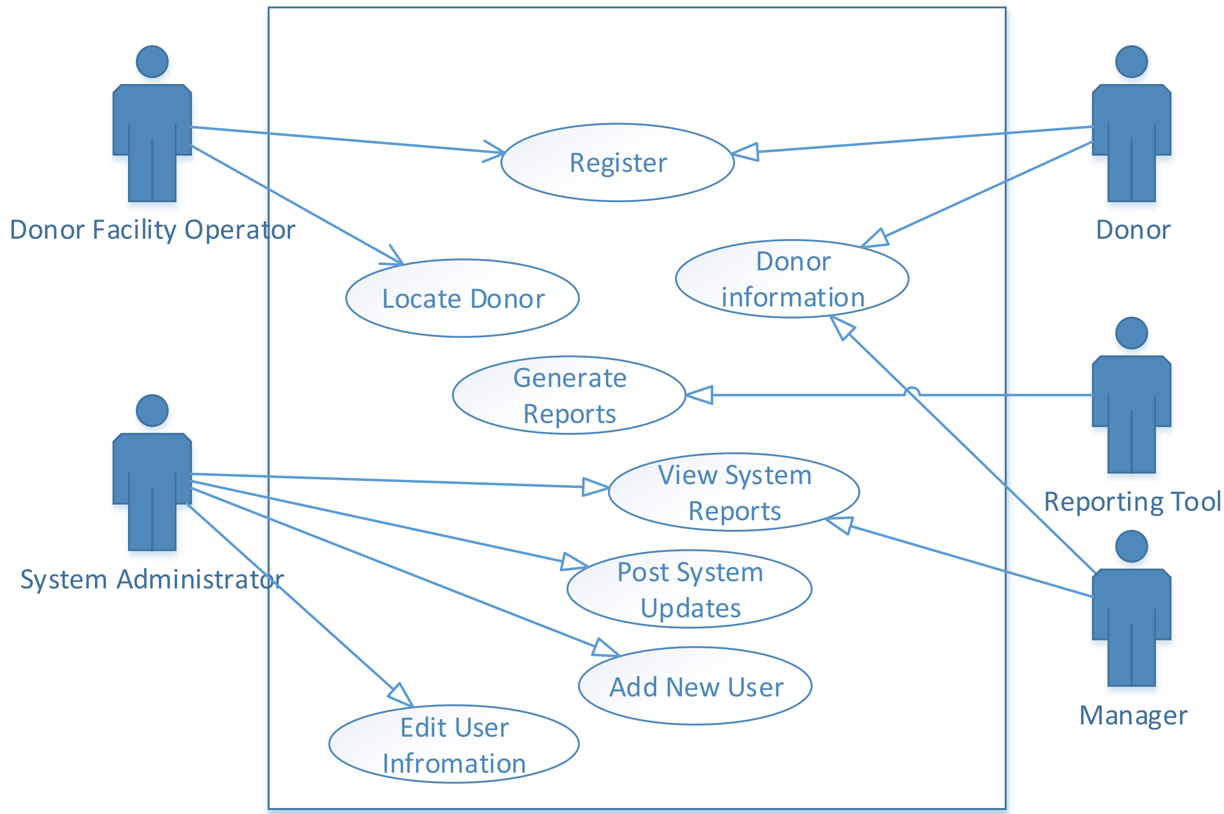

Figure 4.12: Use case diagram

User management involves enrolling users, deleting and managing their roles in the system. For the purpose of audit trail, users should not be deleted in entirety but their accounts should be disabled. The system administrator logs in and he is able to perform the actions above. System reports will be generated and accessed by the system administrator and the management staff. Donor information which includes blood group, medical condition, and last donation date is given in the donor information use case. Voluntary donors will self-register on a mobile application that will integrate to the backend application.

After successful login the donor facility users will be able to search for the location of the voluntary donor and send an alert to them.

4.9 Control Modelling

4.9.1 Entity Relationship

An entity relationship model is a high level conceptual model that describes data in terms of entities, their attributes and their relationships (Riccardi, 2002). The entity relationship diagram shows how data is presented and organized in the database schema without specifying the actual data.

According to the control diagram in figure 4.10, the blood donor has the Donor ID attribute as the primary key. Other attributes are name, age, phone number and gender. The system generates, the GIS coordinates that will populate the domicile location field of the donor entity.

The blood bank has a one to many relationship with the donors. This implies that the data of the registered donors will be available to the application.

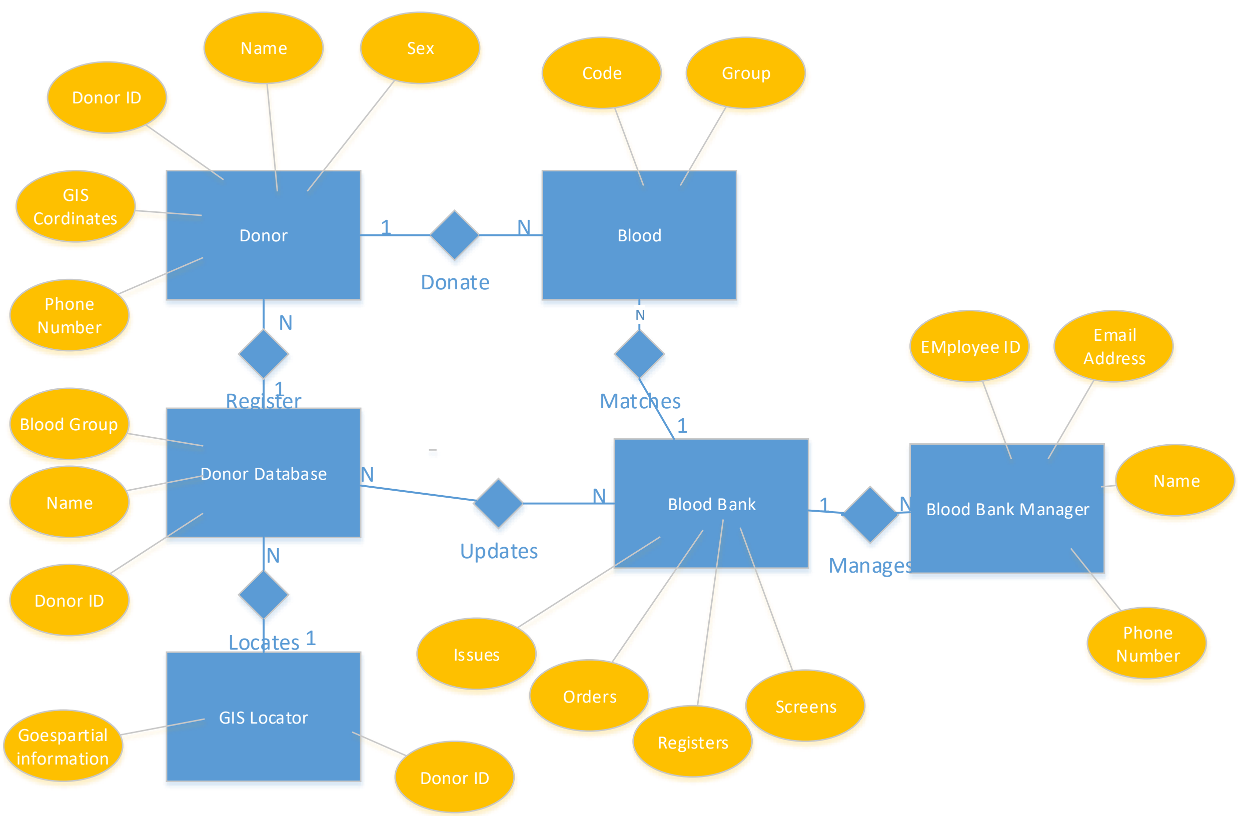

Figure 4.13: Entity Relationship Diagram

4.9.2 Prototype Architecture

There are four major components of the architecture of this prototype. These are the mobile application, the web interface, the donor locator engine, and the database server. The web interface has been optimised to work with any browser including Firefox, Google Chrome, internet explorer, Edge and Safari. Internet access offers a channel for transfer of data from the client side to the database server through a secure connection.

The web interface was developed using C#, a .Net technology. Google firebase cloud messanger was used to send notifications to voluntary donors. The resercher chose the notification method because it is inexpensive and the delivery status of the message is sent bach to the server.

The Android mobile application was developed using Java. A web service was developed to fetch the messges on the mobile application and post them to the web application and subsequently the database. The resercher used prototyping as his implementation methodology.

Chapter Five: Implementation and Testing

5.1 Introduction

The application was developed based on the design prepared in chapter 4. The prototype was developed using HTML, PHP, Javascript and MS SQL as the database. To execute the logic, Java was used. Unit and regression testing was done to validate the system.

5.2 Program Flow

After successful registration to the mobile application, a first time user enters his details which include his blood group and the last date of donation and any underlying medical conditions that could affect him from donating blood. The mobile application then picks his location. This data is pushed to the database.

The facility administrator will be able to view the registered voluntary donors on a heat map and on hoovering on the location, he should be able to see the donor information. He can then send an alert to the donor informing him/her of the requirement for a blood donation based on his current location.

5.3 Software Prerequisites

5.3.1 Hardware Requirements

Component	Minimum	Recommended
Processor	x64 architecture or compatible dual-core 1.5 GHz processor	Quad-core x64 architecture 2 GHz CPU or higher such as AMD Opteron or Intel Xeon systems
Memory	4-GB RAM	8-GB RAM or more
Hard disk	10 GB of available hard disk space	40 GB or more of available hard disk space

Table 5.1: Hardware Requirements

Table 5.1 shows the minimum and the recommended hardware specifications to run the server application. The column with the recommended specifications takes care of growth of the database.

5.3.2 Software Requirements

Software	Minimum
Operating System	Microsoft Server 2008 R2
Client Operating System	Windows XP/Vista/7/10
Database Manager	Microsoft SQL Server 2008
Web browser	Internet Explorer, Chrome, Opera mini, Firefox Mozilla

Table 5.2 Software Requirements

Table 5.2 shows the minimum requirements to run the application**.**

5.4 Sample Processes Used

5.4.1 Process Flow

5.4.1.1 Login Process

Informal description: The user initiates the login process by keying in their login credentials which permits them to access the system with specified roles and permissions. Access to the system is controlled by the domain's active directory.

Pre-condition: The user is a registered user and has the relevant access permissions.

Post condition: The user has successfully logged into the system and he can perform tasks that he has been assigned roles for.

5.4.1.2 Blood Donor Registration on the Desktop Application

Informal description: The user navigates to the donor registration form and is able to create a new donor.

Pre-condition: The user has the rights to create a donor in the donor entity.

Post condition: A donor is successfully committed to the donor database.

5.4.1.3 Blood Donor Registration on the Mobile Application by Self Registration

Informal description: The donor navigates to the donor registration form on the mobile application and is able to enter their details and save.

Pre-condition: The donor has downloaded the application.

Post condition: A donor is successfully committed to the donor database.

5.4.1.4 Evaluation of Geospatial Coordinates of a Donor

Informal description: From the backend application, the user should be able to send a trigger to the donor's phone and activate GPS. The mobile application will send the location of the donor to the back-end solution.

Pre-condition: The user has access rights to the donor entity.

Post condition: An alert pop-up is triggered on the donor's mobile phone.

5.4.1.5 Sending of an Emergency Alert to Donors within a given Geospatial Location

Informal description: From the application's back-end, the user should be able to send an alert to volunteer donors in the event of an emergency.

Pre-condition: The user has access rights to the donor entity.

Post condition: An alert pop-up is triggered on the donor's mobile phone.

5.4.1.6 System Administration and configuration

Informal description: The system should have an interface where the system administrator can insert, delete and update user records .

Pre-condition: Administrative rights can be issued to a system administrator.

Post condition: The insertion, deletion and update of information has been successfully inserted, deleted and updated respectively.

5.4.1.7 Determination of Domicile Location of a Donor

Informal description: Using statistical evaluation, the system should determine the domicile location of a potential donor .

Pre-condition: The system should compute the usual location of a donor.

Post condition: Time variable domicile location is marked on the map.

5.4.1.8 Real Time Reporting

Informal description: The system shall provide accurate and factual reports on various variable of data captured in the system .

Pre-condition: The system should have data.

Post condition: Depending on the role assigned to a user, he/she can view and download reports on various aspects of the system.

5.5 System Architecture

5.5.1 Web services interface

A critical ability of the of the donor locator system is its ability to integrate to other systems. One of the more critical systems would be a hospital information management system. The Web service interface for applications are used to access and manipulate platform data, metadata, and to interact with platform services, implemented using the Windows Communication Foundation (WCF). These services allow one to write .NET applications using Microsoft Visual Studio or non-.NET applications using other developer tools by simply referencing the web services.

5.5.2 GIS Locator Engine

Using Application Programming Interface (API) calls to the Bing maps imagery service, the researcher is able to create heat maps and to get the domicile location of a voluntary blood donor.

The Bing maps API for Silverlight includes Bing imagery service support in a Tile Layer component, which can be added to a Map's layer collection.

5.5.3 Donor Entities

Figure 5.1 depicts the user login to the system. This is the first entry point to the system.

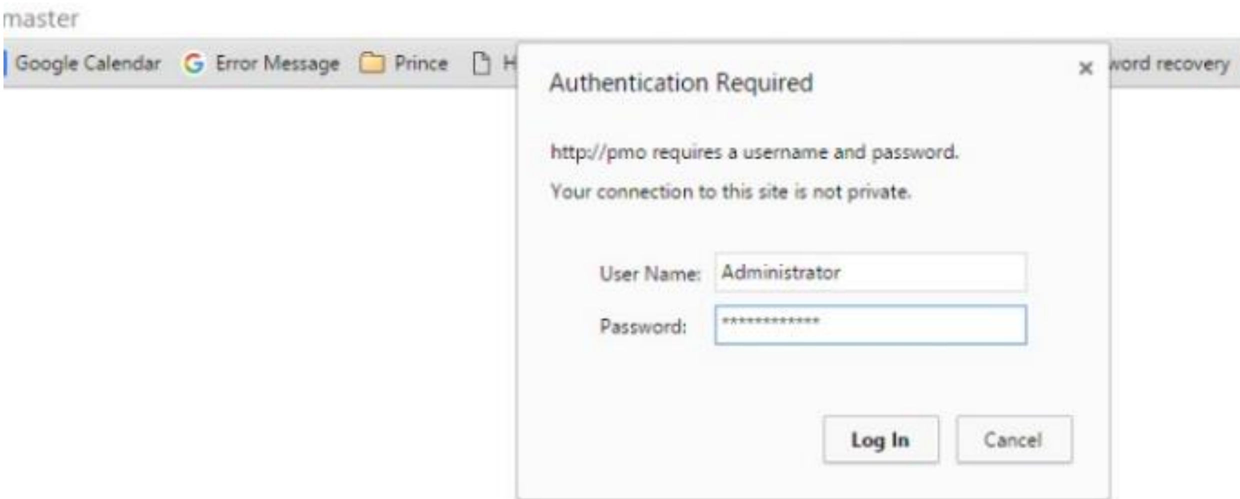

Figure 5.1 Log-in Form

The donor entities mainly record information about the donor. The attributes are name, ID number, age, gender, blood group, phone number, and domicile GIS coordinates. An iframe with a map will show the domicile location of the donor.

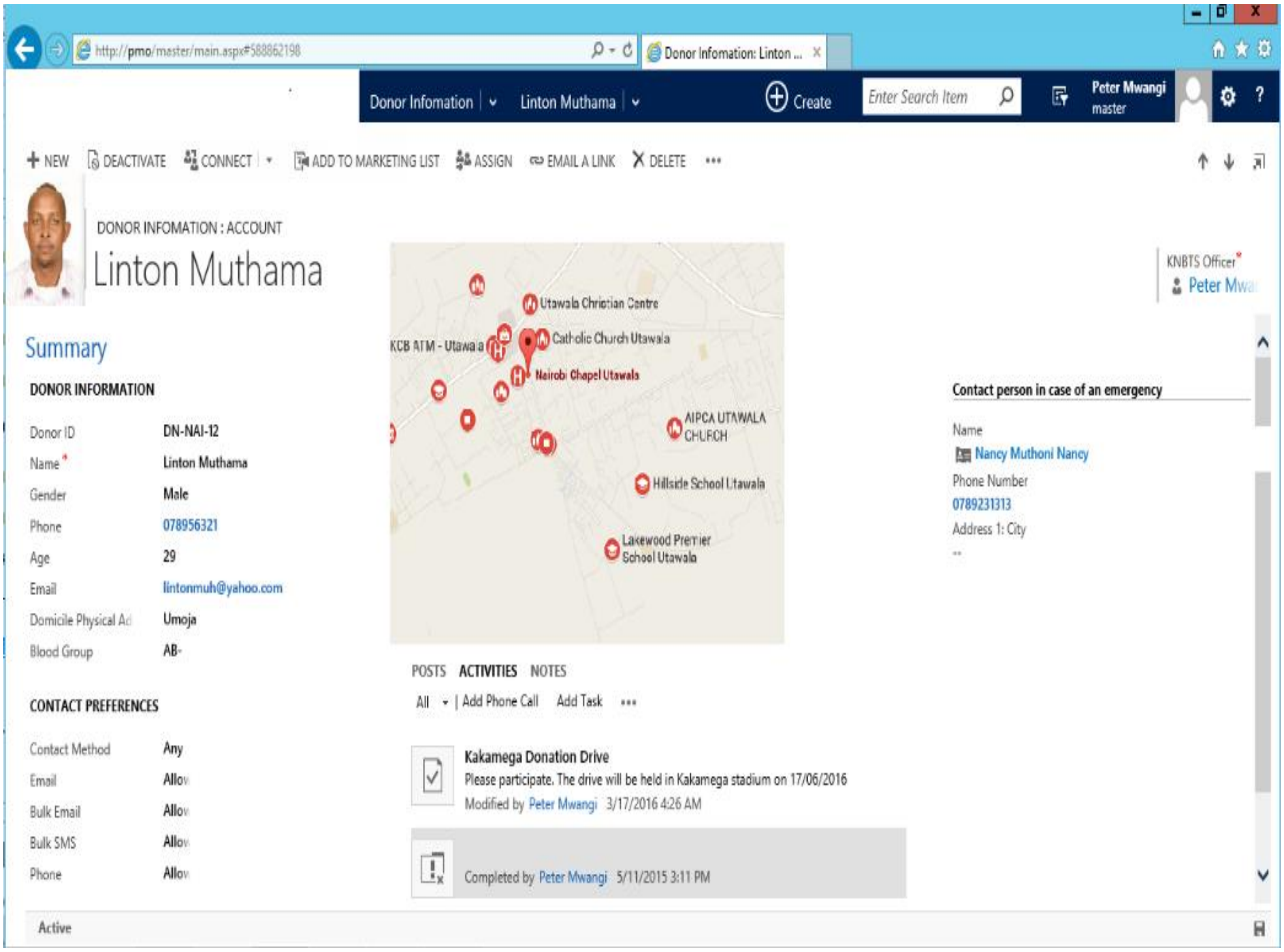

Figure 5.2 Donor registration form

Figure 5.2 shows the fields that are populated in the donor registration form. The domicile location of the voluntary donor is shown on the map. All the interactions of the donor with the donor facilities are also recorded in the form.

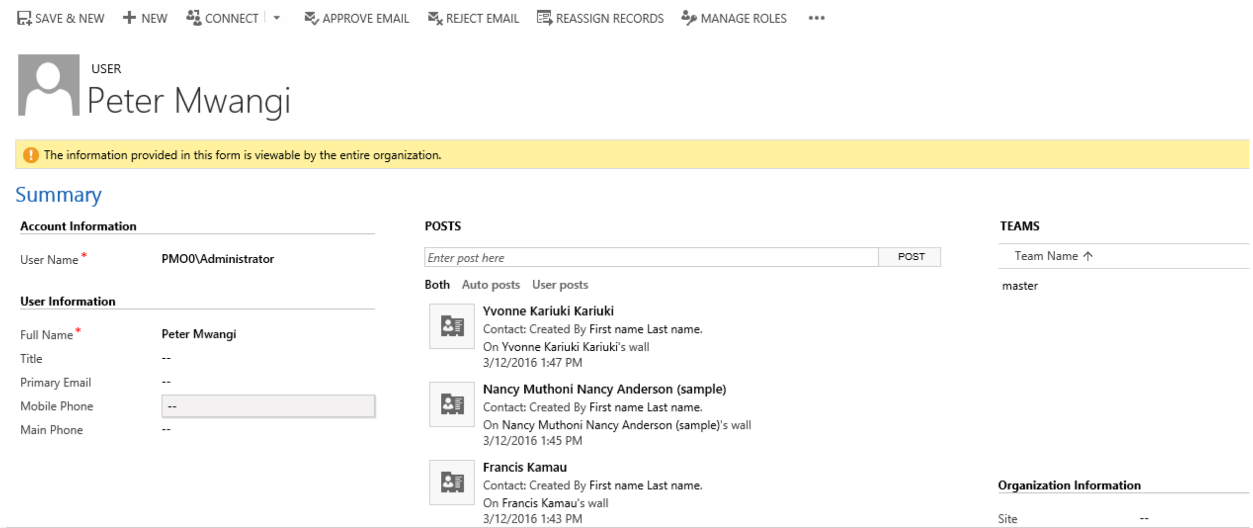

Figure 5.3: User Registration Form

The user registration form, as shown in Figure 5.3 allows the administrator to add new users to the system. It also keeps track of the recent activities that the logged in user performed while logged in.

A list of all registered donors is shown in Figure 5.4. High level information is displayed on the grid view.

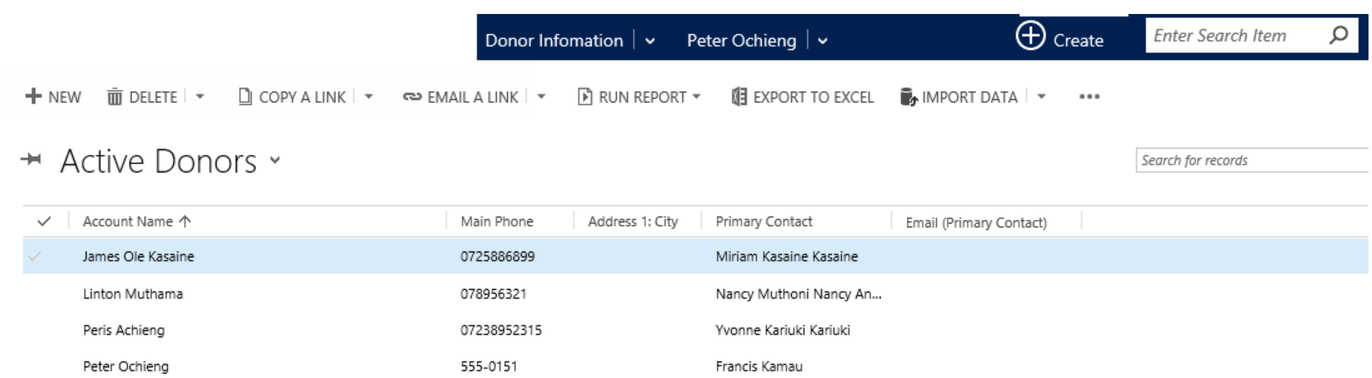

Figure 5.4 Donor listing

5.5.4 Process Engine

The process feature supports extending the functionality of the donor locator system by enabling the administrator to create and execute custom processes. The process engine is built on top of Windows Workflow Foundation, which provides the programming model, run-time engine, and tools for quickly building processes. This includes XAML processes and custom process activities (.NET assemblies).

5.5.5 Reporting

The reporting tools embedded in the system allow for development of reports that can be download to give a real time status of the blood bank. Filtered views can be used to create custom reports. The reports can be downloaded in excel or PDF formats.

5.5.6 Audit Trails

Filtering through all user records can be too cumbersome, even though access control requests and decisions are stored in the user repository. To ease, this process an audit trail is described in which events are logged. In cases where the administrator, requires carrying out an investigation, then there exists a structured data to investigate.

5.6 Prototype Validation

When a voluntary donor attempts to register, the system will check if his details exist in the system. This validation check ensures that the system has data integrity. The audit trail will log in the attempts to double register in order to detect malicious attacks.

Exception messages are presented to the logged in user to notify him of missing fields or critical data that he might have missed to enter. The system shall also log out any user that remains dormant for more than ten minutes.

5.7 Prototype Maintenance

The researcher intends to develop the prototype to be a fully functional system that can be deployed in the Kenyan Healthcare Facilities. Enhancements shall be done to be able to develop a robust system that can support a vast and dynamic population.

5.8 Summary

In order to evaluate the effectiveness of the prototype, the researcher tested the system. These included donor information and the geolocations from the mobile application for a duration of one week. The researcher simulated an emergency scenario. Initially, the key challenge in the application was how to trigger the calls to activate the mobile phone locator from the server application hence the need to alert the owner to switch on their locator.

The application developed will give real time updates on the location of voluntary donors in case of a medical emergency that requires the donor to act. The donor can trace the nearest donor facility when he receives the alert or can go to the health facility where the demand has arisen. The application should be integrated to health information systems. This is a capability that the researcher has implemented. The researcher used a familiar user interface, one that emulates Microsoft office applications. This makes the system more adaptable to the users without need of specialized training. Ubiquity is enhanced by use of a web application. Health care facilities with internet connectivity can access the information system.

Chapter Six: Discussions

6.1 Introduction

After developing of the prototype, the user tested the system and shared the application with the target users so that they could express their sentiments about the software. The feedback obtained was collected using a questionnaire and was summarized using pie charts.

6.2 Findings

6.2.1 User Interface

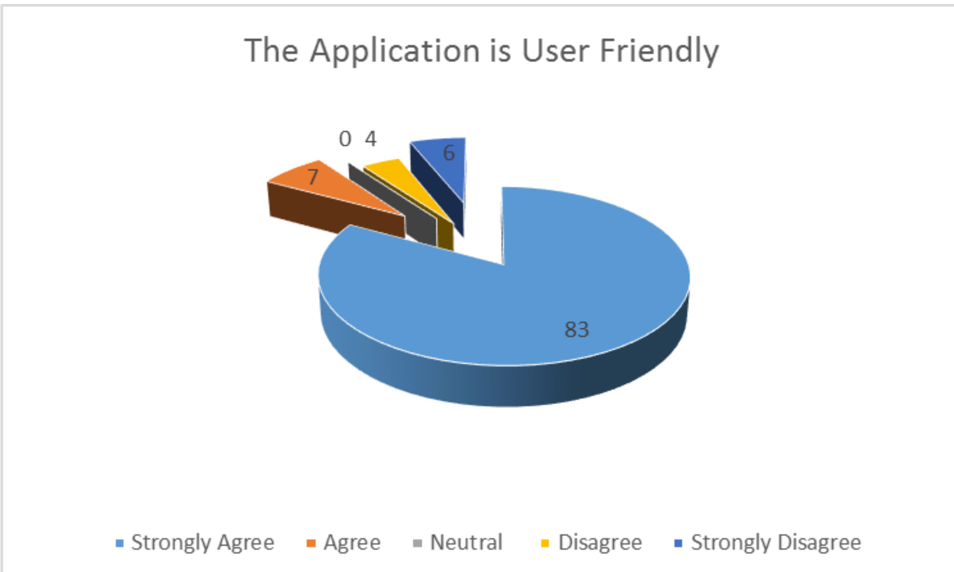

Figure 6.1: User Friendliness of the Application

As shown in figure 6.1, 83% of the respondents strongly agreed that the application is user friendly, 7% agreed, 7% recommended chages to the application and 4% disagreed.

6.2.2 Ease of Use of the Application

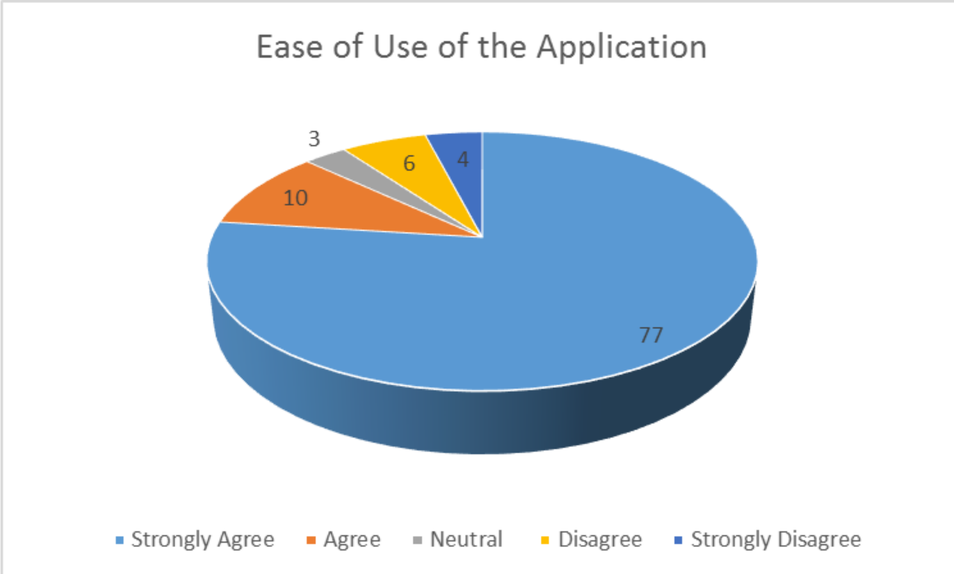

Figure 6.2 Ease of Use of the Application

Making reference to figure 6.2, 77% of the respondents strongly agreed that the application is easy to use, 10% agreed, 3% were neautral, 6% disagreed and 4% strongly disagreed.

6.3 Accuracy in Determining Location

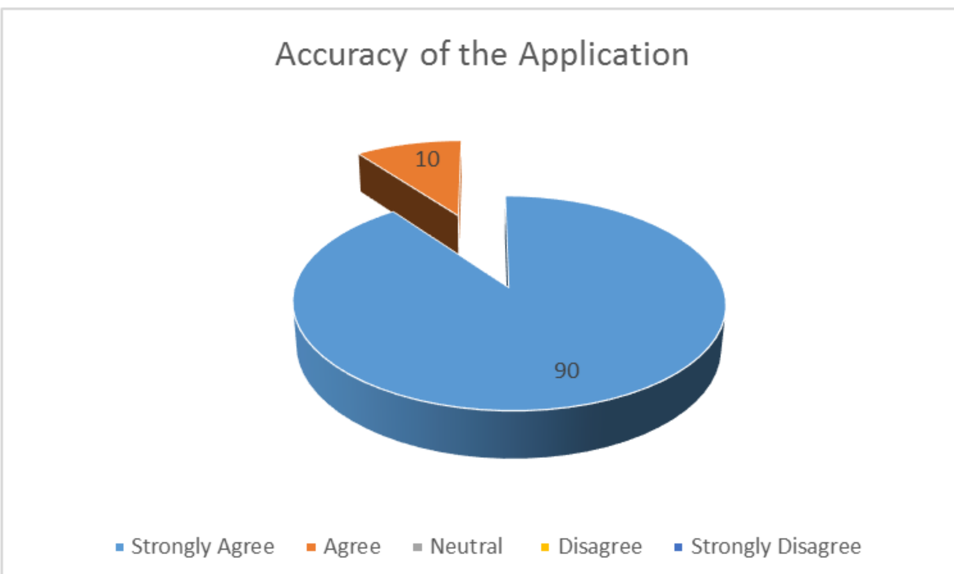

Figure 6.3 Accuracy in Determining Donor Location

Figure 6.3 shows the results of the determination of the accuracy of the location of the voluntary donor. 90% of the respondents strongly agreed that the application was accurate and 10% agreed that it was accurate.

6.4 Availability of the Application

Ubiquity is a critical factor in the success of the prototype. Being a web application, it was hosted online for the general public to access.

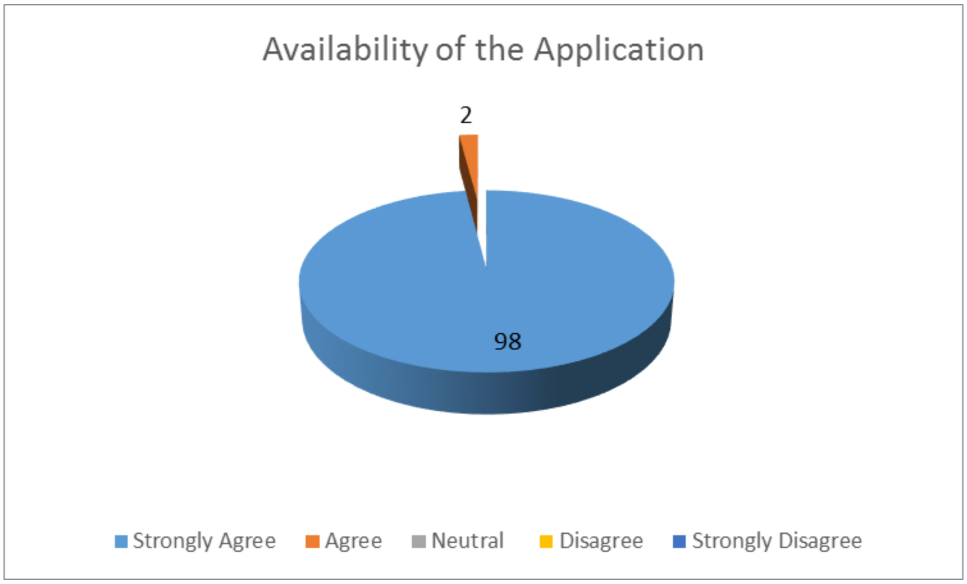

Figure 6.4: Availability of the Prototype

Figure 6.4 shows that 98% of the respondents strongly agreed that the application was highly available while 2% agreed.

6.5 Imrovement to Voluntaty Donor Management

The resercher intends to know whether the prototype would be an improvement to location of voluntaty donors. 96% of the respondents agreed while 4% disagreed. This is summarized in figure 6.5.

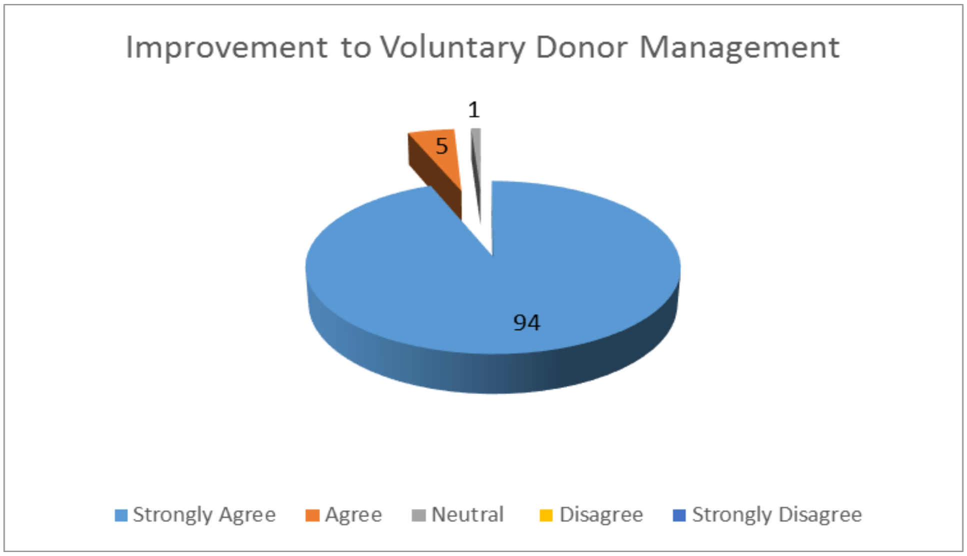

Figure 6.5: Applications' Enhancement to Voluntary Donor Location

6.6 Limitations of the Prototype

During the course of the resaerch the, researcher observed that the majority of general public are not aware of their blood group. The prototype is not able to independently verify the blood group of the respondents without integration to other systems. Further enhancements to the prototype are recommended so as to be able to validate this information.

Chapter Seven: Conclusions and Recommendations

7.1 Conclusions

There is low utilization of voluntary blood donor location systems which by extension contributes to the deficit of blood at our donation facilities. Identification and location of voluntary donors is a daunting task especially in times of crisis or emergencies. Currently, there donor facilities depend on relatives making blood appeals through mass media such as radio. These advertisements have a cost implication. Human blood transfusion, being an activity that requires rapid response needs, to be automated. The research concludes that the degree of use of voluntary donor location systems in the Kenyan donor management and healthcare facilities low.

Blood donor management systems that are currently utilized have no way of frequently engaging blood donors hence there is low donor participation in cases where there is need for rapid response as a result of a medical emergency. A voluntary donor locator management system would transform the blood donation workflow with the ability to frequently send alerts and notifications to donors as well as get their location in a timely manner.

7.2 Recommendations and Future perspective

The adequacy of blood depends on blood donation rates and numbers of blood donors as concluded by this research. There is need for the Kenyan government through the ministries concerned to fund such projects. The research recommends that donor management institutions should adopt the use of donor management system. The organizations should leverage on the government's expenditure in healthcare to procure information systems that can enhance emergency medical response.

i. Donor facilities should implement a system that can be used to locate donors. In the case of an emergency, donors will be quickly alerted hence reducing the turnaround time between when an incident is reported and when the requisite blood transfusion is done.

ii. Through continuous training, professionals at the donor facilities can be enlightened on the technological development in blood bank management and operations.

iii. Through the ministry of health, a standard platform for blood donor facilities, both private and public should be implemented. Voluntary non-remunerable donors should be able to register themselves and information about them shared across a single platform.

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Appendices

Appendix A

Turnitin in Report

PROTOTYPE FOR TRACKING VOLUNTARY NON REMUNERABLE DONORS IN ENHANCING EMERGENCY
MEDICAL RESPONSE - CASE POINT AGA KHAN HOSPITAL

ORIGINALITY REPORT

PRIMARY SOURCES

15%	11%	2%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

1	www.iicd.org Internet Source	1%
2	www.sis.pitt.edu Internet Source	2%
3	Submitted to Strathmore University Student Paper	1%
4	mio.com Internet Source	1%

Appendix B

User Requirements Questionnaire

Researcher: Patrick Mwangi

MSc. IT, Strathmore University

This research will be used for academic purposes only. The main objective is to collect the requirements that will be used to develop a prototype for locating voluntary blood donors. Please provide candid response to the following questions. The response will be treated with utmost confidentiality.

1. Please indicate your gender

   Male [ ]   Female [ ]

2. Indicate your age bracket

   21 - 30 Years [ ]

   31 - 40 years [ ]

   41 – 50 years [ ]

   Over 51 years [ ]

3. Voluntary blood donors are easy to locate and contact in a timely manner that will assist in saving a patient's life.

   [ ] Strongly Agree

   [ ] Agree

   [ ] Neutral

   [ ] Disagree

   [ ] Strongly Disagree

4. Current methods of locating voluntary donors are efficient and enhance response in case of a medical emergency.

   [ ] Strongly Agree

   [ ] Agree

[ ] Neutral

[ ] Disagree

[ ] Strongly Disagree

5. There is efficient communication to voluntary donors in case of a medical emergency.

   [ ] Strongly Agree

   [ ] Agree

   [ ] Neutral

   [ ] Disagree

   [ ] Strongly Disagree

6. The current systems for tracking and locating voluntary donors' user are adaptable and user friendly.

   [ ] Strongly Agree

   [ ] Agree

   [ ] Neutral

   [ ] Disagree

   [ ] Strongly Disagree

7. The systems used for tracking donors are secure.

   [ ] Strongly Agree

   [ ] Agree

   [ ] Neutral

   [ ] Disagree

   [ ] Strongly Disagree

8. Other comments

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THANK YOU FOR YOUR PARTICIPATION

Appendix C

Part B: User Acceptance Questionnaire

Researcher: Patrick Mwangi

MSc. IT, Strathmore University

This research will be used for academic purposes only. The main objective is to collect the requirements that will be used to develop a prototype for locating voluntary blood donors. Please provide candid response to the following questions. The response will be treated with utmost confidentiality.

1. The user interface is friendly and the application is easy to adapt.

[ ] Strongly Agree

[ ] Agree

[ ] Neutral

[ ] Disagree

[ ] Strongly Disagree

2. The system provides for an easy way to locate voluntary donors.

[ ] Strongly Agree

[ ] Agree

[ ] Neutral

[ ] Disagree

[ ] Strongly Disagree

3. The system is highly accurate when it comes to determining the domicile location of a voluntary blood donor.

[ ] Strongly Agree

[ ] Agree

[ ] Neutral

[ ] Disagree

[ ] Strongly Disagree

4. The application is highly available and can be accessed from anywhere.

   [ ] Strongly Agree

   [ ] Agree

   [ ] Neutral

   [ ] Disagree

   [ ] Strongly Disagree

5. The voluntary donor locator will improve medical response in case of an emergency.

   [ ] Strongly Agree

   [ ] Agree

   [ ] Neutral

   [ ] Disagree

   [ ] Strongly Disagree

9. Other comments

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THANK YOU FOR YOUR PARTICIPATION

Appendix D

Donor Location Legend

GIS Donor Locator