DECLARATION

I hereby declare that this thesis is the result of my own investigation, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Sudan University of Science and Technology or other institutions.

Altahir Saad Ahmed Saad

Signature Altahir Saad Ahmed Saad Date **13/7/2019**

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ABSTRACT

Blood transfusions at the right time and in safe clinical settings are lifesaving. However, blood for transfusion is scarce and is in high demand globally. Because blood cannot be manufactured donations are the only means of obtaining blood and keeping blood banks sufficiently supplied. In Khartoum, Sudan, in spite of the increasing number of donors and donation rates, blood banks are struggling to provide enough blood to meet the high demand. In addition, blood donors are unlikely to donate repeatedly due to a lack of motivation. In this thesis, we aim to design a blood donation service that can be used to motivate blood donors and improve the blood donation process. The two research questions are (1) what are the current practices of blood donation in Khartoum, Sudan, and (2), how may those practices be improved through the design of IT-supported services. In terms of methods, a service design approach was used, where semi-structured qualitative interviews, observations, and the collection of documents were used to gather empirical data on the current blood donation practices in Khartoum, Sudan. A thematic analysis was used to analyze interviews data. Findings show that in the current practices, although blood donors consider blood donation an act of humanitarian goodwill, family replacement donors are used more than a voluntary donation. Furthermore, current practices have many limitations that lead donors to be unsatisfied and not motivated to give their blood repeatedly. To mitigate and improve these practices the study examined the design implications for improving these practices with ICT, and a new suggested blood donation service was implemented which has two components, namely, a web-based application and an Android app. To validate and evaluate the prototype, a questionnaire and interviews were used to measures the satisfaction with the new service from the viewpoint of the stakeholders i.e. donors and blood banks. The results of these inquiries show that the new blood donation service prototype can potentially be used to support and improve the current practices of blood donation in Khartoum- Sudan. Donors can, for example, be motivated to give their blood frequently. Finally, recommendations and future extensions to the prototype are presented.

مستخلص البحث

تعتبر عمليات نقل الدم في الوقت المناسب وفي بيئات و إعدادات سريرية آمنة صحيا امراً منقذا للحياة. علي الرغم من هذه الاهمية فإن الدم يعتبر منتجاً نادراً والطلب عليه متزايد عالمياً حتي يتم استخدامها في خدمات نقل الدم والمساهمة حفظ حياة المرضي. و نظرًا لأن الدم لايمكن تصنيعه مختبرياً حتي الأن ، فإن التبرع هو الوسيلة الوحيدة للحصول على الدم والحفاظ على مخزون كاف فى بنوك الدم. في مدينة الخرطوم بالسودان ، على الرغم من العدد المتزايد للمانحين ومعدلات التبرع ، تجتهد بنوك الدم لتوفير ما يكفي من الدم لتلبية الطلب المتزايد. علاوة على ذلك ، من غير المؤكد أن يتبرع المتبرعون بالدم مرارًا وتكرارًا لعدم وجود مايحفزهم للقيام بذلك. تهدف هذه الدراسة لتصميم خدمة للتبرع بالدم يمكن استخدامها لتحفيز المتبرعين بالدم وتحسين عملية التبرع بالدم. يحاول البحث الإجابة على سؤالين هما: (١) ما هي الممارسات الحالية للتبرع بالدم في الخرطوم بالسودان ، و (٢) ، كيف يمكن تحسين هذه الممارسات من خلال تصميم خدمة دم قائمة او مدعومة بتقنية المعلومات. فيما يتعلق بمنهج البحث، تم استخدام نهج تصميم الخدمة ، حيث تم استخدام المقابلات والملاحظات النوعية شبه المنظمة وجمع الوثائق لجمع البيانات التجريبية حول ممارسات التبرع بالدم الحالية في الخرطوم ، السودان. ايضا تم استخدام التحليل الموضوعي لتحليل بيانات المقابلات. تشير نتائج الممارسات الحالية انه على الرغم من ان المتبرعين بالدم يقومون بذلك لدوافع إنسانية ، إلا إن الاعتماد الأكبر فى التبرع يعتمد على التبرع الأسري او العائلي أكثر من التبرع طوعيا. علاوة على ذلك ، فإن الممارسات الحالية لها العديد من القيود التي تجعل المانحين غير راضين وغير متحمسين لإعطاء دمائهم مرارًا وتكرارًا. للتخفيف

من هذه الممارسات وتحسينها ، تناولت الدراسة الآثار المترتبة على التصميم لتحسين هذه الممارسات باستخدام تكنولوجيا المعلومات والاتصالات. بناءً على متطلبات الجهات المانحة وبنوك الدم ، تم تنفيذ خدمة جديدة مقترحة للتبرع بالدم تحتوي على مكونين ، وهما: تطبيق مستند او قائم علي الانترنت وتطبيق جوال لنظام التشغيل اندرويد. للتحقق من صحة وتقييم النموذج الأولي ، تم استخدام استبيان ومقابلات لقياس الرضا عن الخدمة الجديدة من وجهة نظر أصحاب المصلحة أي المانحين(المتبرعين) وبنوك الدم. تظهر النتائج أن النموذج الأولي لخدمة التبرع بالدم الجديدة يمكن أن يستخدم لدعم وتحسين الممارسات الحالية للتبرع بالدم في الخرطوم – السودان. كما يمكن للمانحين ، على سبيل المثال ، أن يكونوا متحمسين للتبرع بشكل متكرر. أخيرًا ، تم تقديم التوصيات والإضافات المستقبلية لتحسين النموذج الأولي لخدمة التبرع بالدم الجديدة.

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LIST OF ABBREVIATIONS

STAC	The Name Refer to the Central or Reference Blood Bank
RBC	Red Blood Cell
CBC	Complete Blood Count
NGOs	Non-Governmental Organisations
AIDS	Acquired Immune Deficiency Syndrome
ICT	Information and Communication Technology
WHO	World Health Organisation
SMS	Short Message Service
GPS	Global Positioning System
ITU	International Telecommunication Union
PHP	Hypertext Pre-processor
MYSQL	My Structured Query Language.
HTML	Hypertext Markup Language
CSC	Cascading Style Sheets
JQuery	JavaScript Library
Bootstrap	Free and Open-source CSS Framework.
CodeIgniter	PHP Framework for Development.
WampServer	Web Development Platform to Develop Web Application.
TextPad	Text Editor for Coding.
SPSS	Statistical Package for the Social Sciences.
SOAP	Simple Object Access Protocol.
GSM	Global System for Mobile communication
GPRS	General Packet Radio service.
GIS	Geographic Information systems.
OPT	On Time Password.

LIST OF APPENDICES

LIST OF PUBLICATIONS

1- Ahmed, A. S. and Christensen, L. R.(2019) ” Practices of Blood Donation in Khartoum, Sudan: Opportunities and Challenges for ICT Support,” Int. J. Comput. Sci. Trends Technol., vol. 7, no. 2, pp. 69– 81.

2- Ahmed, A. S. and Christensen, L. R.(2019) ” Improving and Supporting Blood Donation Practices in Khartoum, Sudan Blood Banks through Android Mobile App and Web Application System,” Int. J. Comput. Sci. Trends Technol., vol. 7, no. 2, pp. 82– 92.

CHAPTER ONE INTRODUCTION

1.1 Overview

The transfusion of blood and blood products at the right time and in safe clinical settings is considered a lifesaving measure. However, blood is scarce and the demand far outweighs the supply (Gillespie and Hillyer, 2002). Furthermore, although there are many technological advances in the health field, blood still remains scarce as it cannot be manufactured and is classified as a shelf life product (Belien and Forcé, 2011), (Abbasi et al., 2016). To deals with the shelf life and unmanufactured properties of blood, frozen blood is presented as a solution to store enough blood for urgent and normal use in hospitals and emergency treatment facilities.

Although, frozen blood is proved to be useful in cases of autologous red blood cell storage and preserving units of a rare but this technique has become inadequate due to cost and time-consuming in thawing blood, the phenomenon of doctors refusing to use the thawed units for insufficient quality and blood as shelf life products is still limited after thawing blood ranging from one day to two weeks depending on the system used (Hess, 2004).

Donations are the only means of obtaining blood and keeping blood banks sufficiently supplied. Blood donation is the process of collecting blood from many sources to be stored in blood banks in order to serve the normal and urgent need for blood. According to the World Health Organization (WHO), to meet the requirements for blood, 1% of the population needs to donate blood (Abbasi et al., 2016). WHO has continuously supported significant progress to improve the availability and safety of blood transfusion such as every year on 14 June, countries around the world celebrate World Blood Donor Day.

However, millions of patients in developing countries do not have timely access to this vital resource. In addition, humanitarian emergencies and armed conflicts in the Region have increased the demand for blood and made delivery of these lifesaving products challenging and complex (World Health Organisation, 2017).

In Sudan, blood transfusion services are authorized by the National Center for Blood Transfusion under the management of the Deputy Minister of National Health. Every state in Sudan has one or more blood banks, which are responsible for providing blood transfusion services. In Khartoum, the central blood bank (STAC) is responsible for such services.

Since 2006, the needs of private hospitals have been covered by the STAC laboratory. This came to be after the government issued an order preventing blood from being sold to private hospitals out of fear that allowing such sales could negatively affect blood donations by volunteers. While every public hospital has a blood bank that is responsible for providing transfusion services, as well as collecting and storing blood, they are all under the management and control of STAC.

In Khartoum-Sudan, blood banks deal with both family replacement and voluntary donation in meeting high demands for blood. In family replacement type, required blood is collected from the patient's family, friends or relatives donors while in voluntary donation required blood is collected from volunteers' donors. Donation place depends on hospital type (public or private) in which the patient admitted. In case of a patient admitted in public hospitals, usually, the donation is conducted at the blood bank of the hospital in which the patient admitted, while in case of a patient admitted in private hospitals, usually donation is conducted at STAC laboratory building or nearest blood bank customized to serve the private hospitals. Besides the responsibility of meeting the needs of private hospitals, STAC laboratory also responsible for collecting blood as a voluntary donation from all society members.

The practices of the blood donation process are different between voluntary donation and replacement donor, and theses process or steps can be explained based on the donation type. To collect the required blood using the family replacement donor blood banks were used the steps such as:

- Hospital in which the patient was admitted, inform the patient's family to prepare donors for donation at STAC laboratory or blood bank of the hospital or nearest blood bank before 48 hours in case of hot cases or they hold the filled form directly to STAC laboratory in case of emergency (family getting required

blood quantities from STAC but they should write an undertaken and leave ID or a passport so they will be back for blood donation).

- The blood bank of the hospital in which the patient was admitted is filling forms that identify the quantity of blood required, blood type, reason for need, patient's name, patients group type, blood components, etc.
- Filled forms are approved and authorized from the patient's doctor and blood bank.
- Patient's Family bring the approved form and their relatives, friends or volunteers donors to the identified blood bank.
- Donors fill out forms of detailed information such as name, age, gender, date of the last donation, type of donation, qualification, chronic diseases, phone number, blood pressure and the desire of being a regular donor.
- Donors who filled the forms stay to see doctors in order to get approval for donation (doctor's signature or Stamp) after routine tests are conducted such as blood pressure and heart rate.
- Approved donors are turned to donation room or blood bank in numbers or list of names waiting for their turn to meet laboratory technician.
- Laboratory technician determines donors blood type group to exclude those unmatched with patients (in case of none willing to make volunteer donation to a blood bank).
- Donors match patient's group type are given small paper contains name and group type and wait to be checked again to determine the ability of donation and enough blood through screening blood sample.
- Eligible approved donors are getting blood bags labeled with group type and directed to the donation room for the process of blood drawing or extract specific blood components such as RBC or plasma.
- The process of blood draw from approved donors is repeated until the required quantities obtained or all donors donate.
- Laboratory technician carries out all processes to prepare the blood to be used and delivered with reception form that contains the patient name and quantities that are collected.
- The patient's family has to sign a document showing that the blood has been received from the blood bank.

While in case of voluntary donation, STAC laboratory is considered the only institution that authorized for arrangement and receiving the volunteers' donors to meet high demand particularly for private sector hospitals, and in case of emergency in public hospitals. The practices in this type of donation can be described using the points below:

- Donors come to STAC building reception asking or requesting to donate his blood.
- Donors are registered in a notebook and received blood donation form that contains vital information such as name, age, gender, chronic disease, date of last donation and number of pregnancies and children in case of females donors that are required to accept the donation.
- Employee reception checked the filled form, and donors are seated in chairs as they arrival time. Then they wait to meet doctors for conducting routine test such as blood pressure, heart rate, weight, etc.
- Doctor signing and stamping the form for those passing the routine test and donation don’t cause health problems for it.
- Approved donors are turned or directed to blood banks and they waiting for screening and test blood to identify blood group and eligibility to donate blood.
- Eligible donors are recorded manually in a paper document by registering their name, phone, address, and blood group.
- Eligible donors are an arrangement in queues waiting their turn for drawing blood or extracting specific component by calling their names or numbering donors using small paper to save the order.
- Blood is drawn from donors according to numbering is saved in blood bags labeled with the name or both name and donors blood group for each donor.
- Donors will be regular donors or donors with rare blood group information such as name, blood group and contact information are registered in regular donors document or document of donors rare blood group.
- All drawn blood is delivered to blood bank using paper form that contains blood quantities, type, blood group, name of deliverer and name of the recipient, after that blood can be saved or processed directly to be used in meeting blood demand.

Establishing effective donor recruitment and retention program is essential to meet Sudan's massive demand for blood components. In addition, it is essential to continuously revise these programs, to maintain the nation's blood supply and ensure its ability to meet future needs.

1.2 Motivation and Problem Statement

Blood transfusion is considered a life-saving intervention, regarding this importance every country established blood banks to keeps sufficient blood bags that can be used in case of blood loss related to road traffic accidents, pregnancy complication, malaria, anemia, hemorrhage, surgery, and chemotherapy. Safe and sustainable blood supply is an essential component in the health care system worldwide, therefore, preserving sufficient quantity of blood in blood banks represents a significant challenge in many hospitals and emergency treatment facilities as the result of blood cannot be manufactured and merely way to obtain blood is done through donation (Belien and Forcé, 2011), (Abbasi et al., 2016).

Voluntary blood donations are fundamental to maintaining a safe and adequate supply of blood to meet high demands. As is shown in Figure 1.1, A report by the WHO indicates that the proportion of voluntary non-remunerated blood donations in Sudan is about 17.1% including both whole blood and apheresis donations (World Health Organisation, 2017).

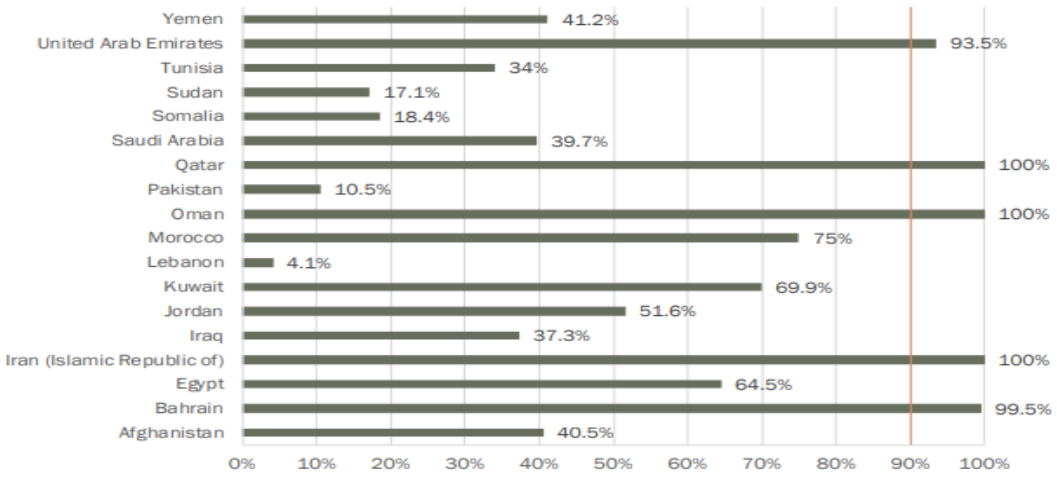

Figure 1. 1 Voluntary Donation per Countries(World Health Organisation, 2017).

Currently, according to STAC, the proportion of voluntary donation is improved where 40% of the blood is collected from voluntary donors as a result of spreading blood donation culture within Sudanese community especially among young and educated people. Despite the tangible improvement, family replacement tends to be used more frequently than voluntary donations particularly in the urgent case of blood transfusion.

Understanding the current practices of blood donation can help blood banks to eliminates or reduce the limitations that may an effect donors decision to donate or become regular donors, and also this understanding can help create effective promotional strategies intended to increase blood donation behaviors to attract more donors and improve donation rates. Many people wish to donate blood to help others but this willing may face many obstacles due to lack of information such as people do not know how to find out information, schedules, and activities of existing blood donor (Sugiatno and Zundi, 2017), (Prajapati et al., 2017). Moreover, satisfaction with the blood donation process represents an important factor in donors recruitment and retention programs because positive satisfaction is strongly linked with the donors intent to return (Pagliariccio, 2010), (Nguyen et al., 2008).

According to STAC, in Khartoum- Sudan, as shown in Table 1.1, in spite of the increasing number of donors and donation rates, blood donation process still struggles to provide enough blood to meet the high demand.

Table 1. 1 Activity of Khartoum Blood Banks 2018(STAC Reports, 2018)

Blood quantity	**O**		**AB**		**B**		**A**		**Sum**		**Total**
	-	+	-	+	-	+	-	+	-	+	
Beginning of year	6623	709	838	91	2368	275	4329	402	14158	1477	15635
Blood received	37517	2415	2563	387	13637	949	23548	1358	77265	5109	82374
Blood distributed	37569	2382	2756	391	13118	974	23292	1307	76735	5054	81789
Blood balance	6571	742	645	87	2887	250	4585	453	14688	1532	16220

In addition, blood donors are unlikely to donate repeatedly due to a lack of motivation. Therefore, blood donation still remains challenging and there is a need to be innovative in this area.

In sum, additional efforts are required to motivate donors to give more frequently, in order to move away from family replacement donation and towards a voluntary program.

1.3 Research Questions

To design blood donation service that can be used to motivate blood donors and improve the blood donation process as well as recruitment and retention donors in Khartoum-Sudan, this thesis concentrates on two main research questions:

1) RQ1: What are the current practices of blood donation in Khartoum, Sudan?

In this research question, the researcher aims to explore the limitations and weak points of current practices that may potentially challenge both the blood donation process and the willingness of blood donors.

2) RQ2: How may those practices be improved through the design of IT-supported services?

In this research question, the researcher seeks to address how to improves and mitigate the limitations and weak points of the current practices through the design of IT-supported services that could lead to improve blood donation rate and subsequently motivates donors to give blood repeatedly.

1.4 The Potential Benefits

The advent of information and communication technologies has encouraged new and innovative approaches that have been used in different fields for different purposes. For instance ICT, social networks and mobile technologies have been widely used to support and improve the practices and process of education, business, health, etc. In relates to blood donation theme, ICT can potentially provide many benefits such as:

1. Using ICT in supporting the blood banks practices can help them to arrange their facilities and workforce according to the number of expected donors.

2. Providing an appointments service to donors may potentially increase their willingness to donate.
3. Build a blood donation service supported by ICT can make the blood donation process easier and faster.
4. Build a blood donation service supported by ICT allows blood banks to prepare statistical information about blood needs and blood donors to help them anticipate and plan for future demands.
5. Timely sharing for blood requirements between hospitals, blood banks, and donors minimize the time consumed in tracking and meeting these needs.
6. Develop a blood donation service supported by ICT may enhance donors practices and motivated them during the whole process.
7. Electronic recording of donors and donation information enables to find the donor record easiest and quicker.
8. Using ICT in supporting the blood banks practices and activities may enable doctors and technician laboratory to conduct their duties with fewer mistakes and motivate them.
9. Providing an appointments service to donors may minimize frustration resulting from non-compliance with ordering queues or waiting too long.
10. Blood donation practices supported by ICT may satisfy and save time for both blood consumer and provider.
11. Improve the weak points of current blood donation practices that challenge blood banks and donors to meets blood needs.

1.5 Aim and Objectives

To this end with the conjunction of the problem statement and research questions sections, this research is concerned with improving blood donation in Khartoum-Sudan. The research aims to investigate the current practices of blood donation in Khartoum, Sudan, to design blood donation service that can be used to improve blood donation and motivates donors to give blood repeatedly.

The major objectives here are:

- Investigate the ability to apply ICT in designing blood donation services according to both the needs of donors and blood banks.

- Improving the blood donation process to motivate donors to give blood repeatedly.
- Investigate the ability to build a central database of donors with rare blood groups types.
- Assist in shifting from replacement donors to voluntary blood donation.
- Promote a culture of voluntary blood donation in the population.

1.6 Methods

Methods from service design (informed by experimental computer science) will be employed in this thesis.

Increasing the blood donation rate through recruitment and retention of blood donors is totally depending on the donors' satisfaction regarding blood donation practices. Therefore a service design approach represents an opportunity to help by acquiring a holistic understanding of the whole blood donation process and create a beneficial, usable and desired blood donation service seen from the perspective of the donors, and at the same time an efficient, effective and unique service seen from the clinics or hospitals point of view (Mager and Sung, 2011).

With service design, we can put the users (donors and blood banks employees) in the center of the design process regardless of the type of service because people are always part of it (Polaine, Løvlie and Reason, 2013). In addition, through service design we are able to establish a good understanding of the aim, motivations and underlying needs of customers (donors) as well as not neglecting the service provider (hospitals and clinics) because customers, service provider and all other relevant stakeholders can be involving in the service development process early.

Developing service with high quality and accepted by target customers requires study and design service holistically rather than designing each part of the service individually because it is not enough that each individual part of the service is designed carefully when the service has not been considered and designed holistically (Polaine, Løvlie and Reason, 2013). Therefore to overcome these challenges, an approach that looks at the service holistically and considering all aspects of the service during the development should be found to deliver successful services.

Service design provides a wide range of methods and tools that can help us to acquire and understand the whole service holistically as well as delivering services that are beneficial, usable and desired services from customers viewpoint without neglecting services provider viewpoint such as creating efficient, effective and unique services (Mager and Sung, 2011).

Although service design has many models, in this thesis, we will focus on the Double Diamond Design Process because, According to (Moritz, 2005), there is an emerging pattern in the processes when these models are compared and this pattern is combined in the design council's double diamond structure, as is shown in Figure 1.2.

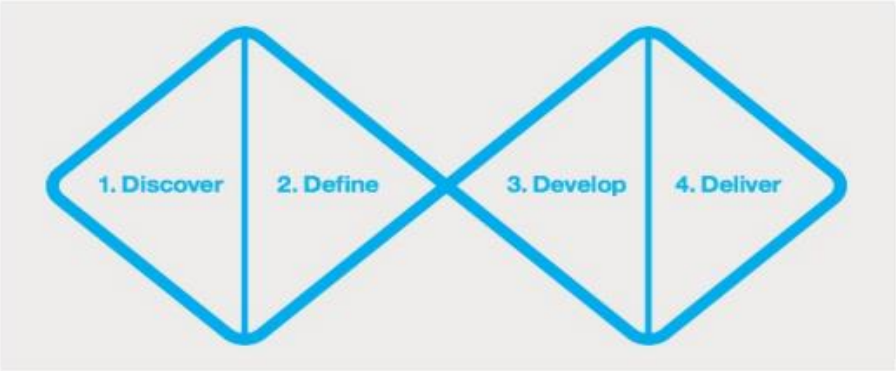

Figure 1. 2 The Double Diamond Design Process (Design Council, 2013).

The designed artifacts and methods on each phase include in-depth interviews, observations and document collection, and personas, customer journey map, and blueprints of the new service, while the technologies and tools to use implementing the prototype of the new service the researcher used the following list of technologies and tools:

- Android Studio
- PHP and My SQL
- Java and JavaScript
- Html5,CSS and JQuery
- Bootstrap
- CodeIgniter, WampServer, and TextPad8

In sum, understanding blood donation as a process or service provided by blood banks or hospitals to blood donors will provide the opportunity to use service design methods to improve blood donation practices in Khartoum- Sudan. The intention is to re-design the blood donation process in Khartoum- Sudan as an IT-supported process or service, and in turn make it more attractive to donate blood for the benefit of healthcare in Sudan.

1.7 Contribution

The main contributions of this thesis is an attempt to apply ICT and service design methodologies to develop a blood donation service based on the needs of donors and the blood banks requirements to improve blood donation rates and motivate donors to give blood frequently by mitigating the limitations of the current practices of blood donation.

The second contribution is the benefit that can be achieved by blood banks where they can be able to monitor the current situation of donation rate, tracking and identifying the distribution of rare blood groups among donor's community type and design strategies towards movement from family replacement to voluntary.

1.8 Structure of the Thesis

In the present chapter, the background about the theme, problem and motivations, objectives and research questions, and potential benefits are illustrated. While the next paragraphs will describe the organization of the remaining chapters as follows:

Chapter 2 Literature Review

This chapter will present an overview of related research in regard to blood donation practices, including (1) knowledge, attitude, and practices, (2) barriers and obstacles, (3) motivation and influencing factors, and importantly (4) technology use.

Chapter 3 Methodology

In this chapter, we will explain the service design method used in this thesis in more details including concepts, model, phases and tools.

Chapter 4 Analysis and Findings

This chapter will be based on interview and observation data, present findings in regard to the current practices of blood donation in Khartoum- Sudan, including challenges and opportunities for IT-supported (service) design.

Chapter 5 Design and Implementation

This chapter will present the service design artifacts, implementation of the prototype to be used in improving blood donation and donor's practices in Khartoum-Sudan.

Chapter 6 Results and Discussion

This chapter will present the results after the prototype been put in used and evaluated from the service provider and service consumer and then discusses them comparing with the situation before the solution suggested solution applied.

Chapter 7 Conclusion

This chapter presents the final takeaways and main findings from this thesis. In addition, it gives recommendations for future works and limitation need to be covered.

CHAPTER TWO LITERATURE REVIEW

2.1 Research about Blood Donation and Blood Donors

Many studies have been conducted regarding blood donation, in relation to different topics and from various perspectives, in order to highlight the most important factors for developing and implementing effective programs that motivate donors and improve overall donation rates. These studies can be presented under the following headings below.

2.2 Knowledge, Attitude and Practices

Understanding knowledge, attitude, and practices of blood donation in the target population are essential due to these factors are strongly linked with the donation rate. In regard to knowledge about blood donation, most studies found that inadequate knowledge and misconceptions about blood donation and the donation process (such as ideas that giving blood causes impotence or loss of appetite) are common between donors population particularly in developing countries. In addition, most individuals get the majority of their information about blood donation from their friends and relatives (Oswalt, 1977; Abderrahman and Saleh, 2014; Márquez-Melgarejo et al., 2015; Papagiannis et al., 2016; Abera et al., 2017; Gao and Wang, 2017).

In terms of attitudes, the studies found that altruism, repositioning, social pressure, rewards, and advertising were cited as major reasons that people donate blood, while medical concerns, fear of needles, negative reactions to the idea of donation, apathy, busy schedules, lack of adequate publicity, and convenience were cited as major reasons for an unwillingness to donate (Oswalt, 1977; Abderrahman and Saleh, 2014; Márquez-Melgarejo *et al.*, 2015; Papagiannis *et al.*, 2016; Abera *et al.*, 2017; Gao and Wang, 2017).

However, although blood donation is considered as humanities acts, high levels of altruism and empathy to helps other by giving their blood as a gift but this indicator is not related to donor frequency to donate blood and recruiting efforts should also address convenience of blood donations, community safety, and personal benefits gained by donating blood (Steele *et al.*, 2008).

According to (Sojka and Sojka, 2003), although the social impacts of donating blood are cited that the majority of impression are positive such as feeling satisfied or an increased sense of wellbeing but there is a negative impression that should be eliminated to recruit future blood donors.

In regard to practices, studies found that developing countries depend on replacement blood donors far more than voluntary donors. In addition, fewer women donate than men. Since voluntary blood donations are a fundamental resource for maintaining safe and adequate blood supplies, organizations should make more of an effort to improve the donation experience, reinforce positive KAP, develop health science campaigns to improve general knowledge and attitudes towards donation, and encourage voluntary blood donation through motivational packages and incentives such as a leave of absence from work, t-shirts, and donation certificates (Oswalt, 1977; Abderrahman and Saleh, 2014; Márquez-Melgarejo *et al.*, 2015; Waheed, 2015; Papagiannis *et al.*, 2016; Abera *et al.*, 2017; Gao and Wang, 2017).

Eliminate misconception regarding blood donation, and finding appropriate methods to motivate the population to have a great impact on improving blood donation within communities with diverse characteristics. To eliminate misconception, (Waheed, 2015) suggested that the frequent and heavy use of electronic media and social network can be used as the major source to create a reliable and effective public awareness campaign in order to correct misconception and knowledge gaps prevailing among the population.

Furthermore, the design of an effective strategy for donor recruitment and retention is also challenged by the disparity of social-demographic characteristics within a single community and between countries. For instance, (Burgdorf *et al.*, 2017) study the socio-demographic characteristics of Danish blood donors (Children- age of youngest child, Income, Education, Cohabitation, Level of urbanization and Ethnicity) including all Danish in the age range eligible for blood donation to characterize the entire population of blood donors in Denmark in 2010.

The study finds that the socio-demographic factors most strongly linked to blood donation are income levels among both women and men and cohabitation status among men. Also, the study finds the prevalence of blood donation for both men and women

are depending on having children and the age of the youngest child. Finally, the study recommends that this information must take into account when planning donor recruitment and donor care and retention strategies.

2.3 Barriers and Obstacles

Increasing blood donation rates requires participants from all society member including both active and first-time donors but sometimes although people have willing to donate there are many barriers and obstacles that may challenge this willingness. Moreover, these elements besides their have a negative effect on the recruitment of new donors but also may lead to an increase in the percentages of lapsed donors.

Many studies have looked to identify barriers and obstacles upon blood donation as well as finds effective methods that can be used to remove it or used as a starting point to develop recruitment and retention strategies. In terms of barriers and obstacles, medical concerns, fear of needles, negligence, lifestyle barriers, perceived inconvenience, lack of marketing communication, lack of knowledge, long waiting times, unpleasant physical environment, bad treatment and negative experiences are cited as the main barriers and obstacles for increased blood donation (Oswalt, 1977; Abderrahman and Saleh, 2014; Márquez-Melgarejo *et al.*, 2015; Waheed, 2015; Papagiannis *et al.*, 2016; Abera *et al.*, 2017; Gao and Wang, 2017).

Moreover, in spite of all these elements have negative impact on donors decision to donate and blood donation rates, (Sojka and Sojka, 2008) argued that the most reported obstacle to overcome, in order to continue being an active donor, was laziness, followed by fear of needles, fainting, or discovering an illness.

On the other hand, the donation process is considered as the most important and essential for both keep active donors and recruit new donors. Therefore, exploring donor satisfaction regarding the blood donation process is necessary to identify and improve the weak links in the chain of the overall process, maximize donor satisfaction, and determine which donors become regular (this is particularly important when it comes to young and first-time donors) (Setiawan and Putra, 2015).

In a study conducted by (Vavić *et al.*, 2012), that aimed to identify and improve the weak links in the chain of the blood donation process in order to maximize donor

satisfaction. The study find that although the majority of the respondents have high satisfaction ratings of their overall donation experience but staff communication with blood donors are need to be improved and First-time donors (FTD) are more frightened and less sure they would donate again as well as the youngest are less satisfied with the staff's behavior after donation, Therefore identifying the more scared FTDs and diminishing their anxiety before donating could positively influence their decision to become regular donors.

On the other hand to understand motivation and determine key factors between first-time and regular donors (Godin *et al.*, 2007) and (Yu *et al.*, 2007) are presents a study using regression to determine the relevance of variables such as intention, perception of control, anticipated regret, moral norm, age, and past behavior.

In disasters situations blood are considerably demand and require collecting blood from more donors to meet massive need, therefore promotion of regular blood donation should implemented to ensure the adequacy of the blood supply at all times rather than mass appeal as way to collect a large quantity of blood in a very short period of time because adverse reaction rates for first-time donors are usually higher than for regular donors (Sönmezoglu *et al.*, 2005).

Furthermore, in predicting of blood transfusion donation direction, (Darwiche *et al.*, 2010) are studied multilayer perceptions (MLPs) and support vector machines (SVMs) to develop and evaluating machine learning algorithm that could reliably predict blood transfusion donations with 65.8% of donors and 78.2% of none donors as possible to donate in the future through using group of 148 patients.

On the other hand, (Cumming *et al.*, 2008) presented a study that aims to develop forecasting model to improve blood collection plans and eliminate shortage and overstocking through predicting and classifying of donor arrivals using first-in-first-out (FIFO) policy with considering the use of the blood as well as differences in the use of the blood during a period of time of seven days.

To raise donor satisfaction, reducing wait times and delivering better services are cited as key factors that may help increase the number of donors and frequency of donations. Therefore, most blood collection organizations utilize an appointment-based schedule in order to reduce wait times, increase staff efficiency, and improve equipment

utilization, thus guaranteeing better service to donors, which is essential to ensure frequent donations and recruit new donors (Ghandforoush and Sen, 2010; Mobasher, Ekici and Özener, 2015).

In sum, gain insight into the barriers and obstacles of blood donation and eliminating these barriers is essential, particularly for first-time donors, as previous donation experiences play a large role in shaping one's attitude towards donation (Gazibara *et al.*, 2015).

Furthermore, while increasing the number of donations and donors is essential, finding an effective means to manage donor visits is also fundamental and will greatly improve the performance of the overall blood donation system and maintain a reliable supply of blood (Natukunda *et al.*, 2015).

2.4 Motivations and Influencing Factors

Although altruism is frequently mentioned in the literature as an important factor to start or to continue as a blood donor more gain insight into the elements that can be used to motivate donors and influencing their decision to give their blood frequently is important to donor recruitment and retention program. According to (Ferguson and Lawrence, 2016), altruism mechanisms influencing people to donate blood are warm-glow and reluctant altruism.

While it is crucial to recruit new donors to replace ineligible repeat donors and deferred donors to achieve a safe and adequate blood supply, blood donation organizations must also focus on donor retention (Gillespie and Hillyer, 2002). Increasing the proportion of first-time donors that become regular donors can provide numerous benefits, such as minimizing infections transmitted during transfusions and motivating others to donate. In addition, it costs less to use returning donors than first-time donors and makes it easier to schedule future donations (Devine *et al.*, 2007; Ringwald, Zimmermann and Eckstein, 2010).

Many studies are seeking to explore and analyze the motivational factors of blood donation to understand the antecedents of blood donation behavior and intentions (Bednall *et al.*, 2013) because exclusion criteria to safeguard and demographic change (as the result of a decrease of the population in age groups of blood donors) are

increasingly, and that will increase the risk of blood product shortages as well as lead to a further reduction in the donor pool (Greinacher *et al.*, 2016), (Goette *et al.*, 2009).

These studies have been tackled blood donation motivation and influencing factors from different perspective include such as the impact of anticipated affective reactions such as satisfaction, the impact of positive and negative experiences and using an incentives to influence donation behaviour (Nguyen *et al.*, 2008), (Pagliariccio and Marinozzi, 2010), (Vavić *et al.*, 2012), (Bednall *et al.*, 2013), (Lacetera, Mario and Robert, 2013).

According to (Pagliariccio and Marinozzi, 2010), blood donor satisfaction and the donors sense of well-being after the donation process can positively influence their decision to donate again, however (Nguyen *et al.*, 2008) argued that a donor's sense of satisfaction is immediate but evanescent and may play a critical factor on intent to return for future donations, therefore better customer service are needed to be included in the development of robust recruitment and retention efforts along with continuously assessing areas of strengths and weaknesses for on-going quality improvement.

In regard to impacts of donation experience on the decision to donate or become regular donors, a positive donation experience, especially among first-time donors, are cited as key factors that can positively effect on their decision to return and to become a regular donor (Vavić *et al.*, 2012). In contrast to a positive donation experience, a negative experience can make donors unlikely to return for frequent or second donations (Newman *et al.*, 2006).

Many elements are identified and strongly connected with negative experience including both adverse reactions to blood donation and staff members' treatment with donors. In terms of adverse reaction, the studies found that adverse reactions of blood donation are associated with a decreased likelihood of repeat donation and cited as a negative event known to impact subsequent blood donation (France *et al.*, 2004), (Newman *et al.*, 2006), (Notari Iv *et al.*, 2009).

Whilst staff members with impoliteness, carelessness, moodiness, and a lack of sympathy are also cited as means of blood donation negative, therefore, blood donation agencies and their staff members must eliminate the elements that may lead or cause any negative experience in blood donation and donors itself.

Furthermore, to motivate donors and increases blood donation rates, blood donation agencies can use incentives as a motivational factor along with autisms (Goette *et al.*, 2009). Many studies have tackled the role of incentives in motivating and encouraging both new and existing donors to donate blood (Healy, 2006), (Goette *et al.*, 2009), (Lacetera, Mario and Robert, 2013), (Stutzer and Goette, 2010) (Zeiler and Kretschmer, 1995).

According to (Goette *et al.*, 2009), there are many elements can that be used as an incentive to motivate donors to donate frequently as well as attracting new donors such as gifts, coupons, paid days off work or even health-related testing. Moreover, (Lacetera, Mario and Robert, 2013) also argued that these incentives can be used to increase blood donations but it must be offered sporadically at the times of greatest need. In addition, a study conducted by (Zeiler and Kretschmer, 1995) found that money remuneration can be used increasingly to increase blood donation rate but in terms of covering travel expenses and appreciation of the time spent for blood donation rather than considering it as paid for donation.

On the other hand, many communication campaigns use slogans and arguments, such as “save lives”, to encourage people to give blood. However, studies have shown that the effectiveness of donation campaigns is heightened when they rely on experimental evidence, instead of generalized arguments, as these slogans do not lead to increased donor returns (Moussaoui et al., 2016). Moreover, blood donation rates improve when donations are described as a means of preventing death rather than saving lives (Chou and Murnighan, 2013).

Although incentives can positively boost the attitude of donors, the extent to which incentives can attract and facilitate repeat donation is unclear and depending on target donors. For instance studies conducted in Saudi Arabia, where (the mostly young) donors preferred to receive token gifts as incentives for donation (Abdel Gader *et al.*, 2011), Nigeria, where donors preferred to receive certificates (Olaiya *et al.*, 2004), Iran (Kasraian and Maghsudlu, 2012), where male donors prefer receiving free blood tests, and the USA, where more than half of donors prefer free health checks (Glynn *et al.*, 2003).

Furthermore, although incentives can positively motivate donors to donate and improve donation it's may negatively affect donor motivation when they are removed and could jeopardize overall blood safety by attracting higher-risk donors who conceal information to obtain said incentives (Healy, 2006; Stutzer and Goette, 2010).

2.5 Technology Use

While increasing the number of donations and donors is essential, finding an effective means to manage donor visits is also fundamental and will greatly improve the performance of the overall blood donation system and maintain a reliable supply of blood (Natukunda *et al.*, 2015).

The tremendous growth of communication technologies presents many opportunities that can be invested in many different purposes within healthcare scoters. For instance, social networks and mobile technologies have been widely used to direct efforts towards patient-centric healthcare by involving the patients in the healthcare process (Abbasi *et al.*, 2016).

In the past, various forms of media were used to disseminate appeals for blood donors, including cinema slides before films, book covers, postal flyers, magazine advertisements, and posters (Wang, 2018). Today, social media has completely changed the concept of communication and sharing. In regard to blood donation, social media can reach a broad audience in a very short time and can play a vital role in eliminating misconceptions about the process by disseminating accurate knowledge about donation as well as disseminate appeals for blood donors (Vavić *et al.*, 2012).

According to (Abbasi *et al.*, 2016), analysis of the blood donation network on social media to explores how people use social media to request for blood donations and identifying the characteristics and trends of the requests can be very helpful to be used in both facilitate future planning, especially for patient-centric healthcare and to understand the behavior of patients and donors to provide personalized services in a timely manner.

Furthermore, many studies (Wakefield, Loken and Hornik, 2010; Briones *et al.*, 2011), have sought to take advantage of the heavy use of social media to engage communities and raise awareness regarding blood donation by sharing stories about

donors and the blood donation process. Doing so creates connections between donors and transfusion services while supporting and developing relationships focused on recruiting and maintaining volunteers by encouraging donors to help tackle shortages.

In sum, social media can play vital roles regarding eliminating misconceptions by disseminating accurate knowledge about donation, and disseminate appeals for blood to reach the largest number of audience but advertising alone cannot increase blood donation, wait times, queues, the location of fixed clinics, and the promotion of mobile blood clinic visits were all cited as pivotal factors that could increase donations (Healy and Murphy, 2010).

Furthermore, in the age of information technology, smartphones, and other communication technologies represent the advent of tremendous growth. During the last decade, the number of smartphones per person has increased dramatically. In regard to blood donation, this growth can play an important role in information dissemination and supporting the donation process.

In the past mobile phones have limited used such as making calls and sending messages but today with the advent of smartphones that combine the power of computing and communication into a single device makes smartphones a valuable asset that exceeded traditional use in the past and becoming central to our communication and information needs (Butler, 2010).

The use of Mobile phones in supporting health care interventions are significantly increasing in developing countries such as used in the dissemination of health information and raising awareness (Aranda-Jan, Mohutsiwa-Dibe and Loukanova, 2014). Moreover, the WHO announced that the mobile health sector has the ability to transform the face of health service delivery around the world (World Health Organization, 2011). In reared to blood donation, mobile phone SMS text messages It is used frequently by blood transfusion services to increase awareness of blood donation (Wangendo, Ochieng and Oduor, 2011).

However, although SMS can play vital roles in raising awareness but may face challenges within communities that have audiences with limited ability to read or write (Yoo *et al.*, 2015).

According to (Appiah *et al.*, 2018), the use of voice messages based on languages of the target audience can be feasible within these communities. In addition, as means to encourage an individual's to donate blood, (Appiah *et al.*, 2018) argued that caller tunes feature of mobile phones has so far not been used for aiding blood donation, and designing free caller tunes particularly relevant for non-blood donors with no caller tunes can be used to promote them to donate blood.

Mobile Apps are software that can be installed onto a mobile device, such as a smartphone or tablet to conduct business, commutations, and entertainment. Today mobile based application have widely used and become a part of our daily life (Hamlin and Mayan, 2017a), (McKay *et al.*, 2018).

In regard to blood donation, globally various smartphone applications have been released to support blood donation practices and motivate donors to become regular (Rahman *et al.*, 2011; Islam *et al.*, 2013; Mostafa, Youssef and Alshorbagy, 2014; Snigdha *et al.*, 2015; Turhan, 2015; Fahim *et al.*, 2016; Sugiatno and Zundi, 2017). These apps can help blood donation organizations manage and track donor records, find new donors, check donor eligibility, schedule donations, visualize the available bloodstock, and inform users of donation needs in nearby locations using geo-location services.

In addition to the features mentioned above, apps are considered valuable resources for blood donation organizations, as they can assist in planning for future demands and easily remind existing donors to donate more frequently. This is especially useful since studies indicate that most blood donors are young (more likely to have smartphones) and would like to track their donations (Foth *et al.*, 2013). Apps can even help users find blood centers, allow donation centers to advertise their needs, monitor blood bank levels, and map the exact path to reach a donation center using GPS (Global Positioning System).

In Sudan, using mobile apps to support business and practices upon different fields are attract the attention of many organizations, and in regard to blood donation there is an app called "Revived" it as one blood application that aims to connect blood donors with those asked for blood as a means to speed up access to donors and receive required blood, and these app are sponsored by a telecommunication company called

Zain. In addition, to facilitate the process of finding donors at right time, a volunteers group are designed an electronic bank as a means to connect the donors and the needy of blood where the system shows the information of the needs including the phone number to communicate with needy and direction on how to reach the target bank, and the system does not support blood donation practices during and after the donation journey.

Although mobile applications provide many advantages, better incentives are still required to retain existing donors and recruit new, less-willing ones. Moreover, most apps do not support multiple languages and use traditional authentication methods, such as social media logins. Because of this, most apps are connected to social networks rather than IT resources, such as laboratory websites or medical devices (Ouhbi et al., 2015; Parras, Bataille and Alio, 2017).

To conclude, the table below (Table 2.1) present some contributions of the researchers regarding blood donation in terms of investing mobile phones and developing apps that can be used to support blood donation practices as well as motives and rising donors awareness to participates in saving the human life.

Table 2. 1 Research about Blood Donation and Mobile Apps

Authors, Year	Title	Research Aims	Technology used
(Adsul, Bhosale and Autee, 2018).	Automated blood bank system using Raspberry Pi	Reduce the time span between donor and patient.	Android App, GSM Modem, raspberry pi kit.
(Kumar et al., 2017).	Life share blood service	Build a network of people who can help each other during an emergency	GPS technology, Android App and SOAP.
(Mandale et al., 2017).	Implementation of blood donation app using Android Smartphone	To create an e-Information of both donor and blood donation organization that can be used to make blood provided in a timely manner	Cloud Computing, GPS and Android App.
(Hamlin and Mayan, 2017).	Blood Donation And Life Saver-Blood Donation App	To search a blood donor during the emergency.	Android App, GPS, and OPT.
(Fahim et al., 2016).	mHealth: Blood Donation Application using Android Smartphone	Establish a connection between the requester and donor at any time and anywhere.	Android App and Cloud Computing.
(Snigdha et al., 2015).	Android blood bank	Finding a willing donor at the right time.	Android App and GPS.
(Gupta, Gawande and Thengadi, 2015).	MBB: ALife-Saving Application	To help control a blood transfusion service and create a database to hold data on stocks of blood in each area	Android App and GIS.
(Turhan, 2015).	An android application for volunteer blood donors	Identification of the nearest available blood donor volunteer in emergency situations	Android App and Google's maps services.
(Priya et al., 2007).	The Optimization of Blood Donor Information and Management System by Technopedia	To make blood donors are available easily within the required time	Android App, web application and GIS.
(Jenipha and Backiyalakshmi, 2014).	Android Blood Donor Life Saving Application in Cloud Computing	Create a web application known as cloud application for android mobiles that will link all donors.	Cloud Computing, SMS, GPRS, and Android App.

CHAPTER THREE METHODOLOGY

3.1 The Concept of Service Design

The concept of service design was coined by Lynn Shostack in 1982 to be used in marketing and management disciplines to integrate the design of material components (products) and immaterial components (services) using service blueprint.

In the early 1990s, service design has become an academic discipline and introduced as design discipline by Prof. Dr. Michael Erlhoff from Köln International School of Design (KISD). In 2000, Engine Service Design, the first service design consultancy, opened for business and then the promotion and use of service design has taken off in academia in both private and the public (van der Veer, Consiglio and Benvenuti, 2012).

Service design is an emergent field evolving from many disciplines such as service business development, service marketing, industrial design and graphic design that can be used to improve the productivity and quality of services (Moritz, 2005).

Service design can be defined as the application of design thinking and design methodology that aim at creating innovation services or improving existing services to provide benefit for both service users and providers through implementing higher quality services that enhance customer satisfaction, create value and competitive advantage for the service provider (Mager and Sung, 2011).

Today service design has become a necessity and an interest for many businesses to stimulate and find creative and innovation processes to implement useful and effective service that satisfy and appeal to customers. Service design puts the user of the service at the center and looks at service holistically from all the processes and actors involved in the production of the service to identify user need, behavior, practices and underlying drivers that can be used to generate journey map and implementing successful service design (Antwi, 2015).

3.2 Service Design Opportunities and Challenges

Although the technological advance in this era presents a wide range of possibilities that can be used to develop sophisticated services but finding innovative ways for developing successful services are challenged by nature and the growing complexity of service (networks of interactions, involving people, systems, products, and organizations). Moreover, the relationship between customers and service providers is always affected and drastically changed as the result of a technological revolution (Polaine, Løvlie and Reason, 2013), (Moritz, 2005).

To overcome or mitigates these challenges, the study involved several participants with different background and that was facilitated and accommodated all the stakeholders of the service. Furthermore to overcome the challenge of technological change the service was designed firstly and later design implication of selecting specifics technologies for implementation was discussed with the stakeholders.

In addition, making the process of the design collaborative between different participants with different understanding levels help to mitigate the misunderstanding between them as well as the protocol or process used in blood banks are similar that made the process of collecting data about process and practices non-complex. In sum, representing different categories for personas and customer journey map made the process effective, efficient and satisfied for all the participants as well as provide feedback for every phase to the participants made them encouragement and excitement to continue.

Developing service with high quality and accepted by target customers requires study and design service holistically rather than designing each part of the service individually because it is not enough that each individual part of the service is designed carefully when the service has not been considered and designed holistically (Polaine, Løvlie and Reason, 2013). Therefore to overcome these challenges, an approach that looks at the service holistically and considering all aspects of the service during the development should be found to deliver successful services.

Service design provides a wide range of methods and tools that can help us to acquire and understand the whole service holistically as well as delivering services that are beneficial, usable and desired services from customers viewpoint without neglecting

services provider viewpoint such as creating efficient, effective and unique services (Mager and Sung, 2011).

Increase blood donation rate through recruitment and retention blood donors are totally depend on donors satisfaction regarding blood donation practices therefore service design approach represent an opportunity that can be helps in acquire holistic understanding of the whole blood donation and creating beneficial, usable and desired blood donation service from the perspective of donors , and at the same time efficient, effective and unique service from the clinics or hospitals point of view (Mager and Sung, 2011).

With service design, we can put the users (donors and blood banks employees) in the center of the design process regardless what is the type of service because people are always part of it (Polaine, Løvlie and Reason, 2013). According to (Moritz, 2005), service design can provide advantages when designing a service, where designers can establish a good understanding of the goals, motivations and the latent needs of the customer, and that lead to focus on designing the service based on organizations client instead of designing it from the organizations point of view.

In addition through service design, we are able to establish a good understanding of the aim, motivations and underlying needs of customers (donors) as well as not neglecting the service provider (hospitals and clinics) because customers, service provider and all other relevant stakeholders can be involving in the service development process early.

Furthermore, user satisfaction now depends on whether the user feels good about the blood donation service and the main challenge for any service design project in healthcare is to find a suitable design approach to overcome the complex nature of a blood donation and the problematic situations that occur today.

Although the service design can create many opportunities that can be a function to improve blood donation but many challenges may limit this opportunity. One of this challenge is to establish the strong and collaborative relationship among the participants of the project due to difficulty in understanding the complexities of healthcare and participants community beside the difficulty of proving the credibility, reliability, and

know-how of participants representing other fields (Keinonen, Vaajakallio and Honkonen, 2013).

In addition, motivating customer, service provider and all other stakeholders to participate in the design process require huge effort beside identifying the real problem and negotiating common targets among inexperienced actors that have little conception regarding design.

Moreover, service design projects struggling and suffering from lack of time and motivation from the side of the project participants as the result of organizations have limited resources (Toskovic, 2016).

In sum, understanding blood donation as a process or service provided by blood banks or hospitals to blood donors will provide the opportunity to use service design methods to improve blood donation practices, and in turn, make it more attractive to donate blood for the benefit of healthcare in the Khartoum- Sudan.

3.3 Service Design Models

Service design methodology has many models that can be used by the designer in the designing process but there are however some similarities between them.

According to (Moritz, 2005), Mager developed a model that consists nine segments: service environment analysis, customer typology, service testing, service performance development, service modeling, strategic positioning, service experience specification, service innovation process, and interface analysis.

Although this model provides a very useful and systematic view of the service design process but does not mandate how the various stages link into each other, which areas iterate and not easy to understand.

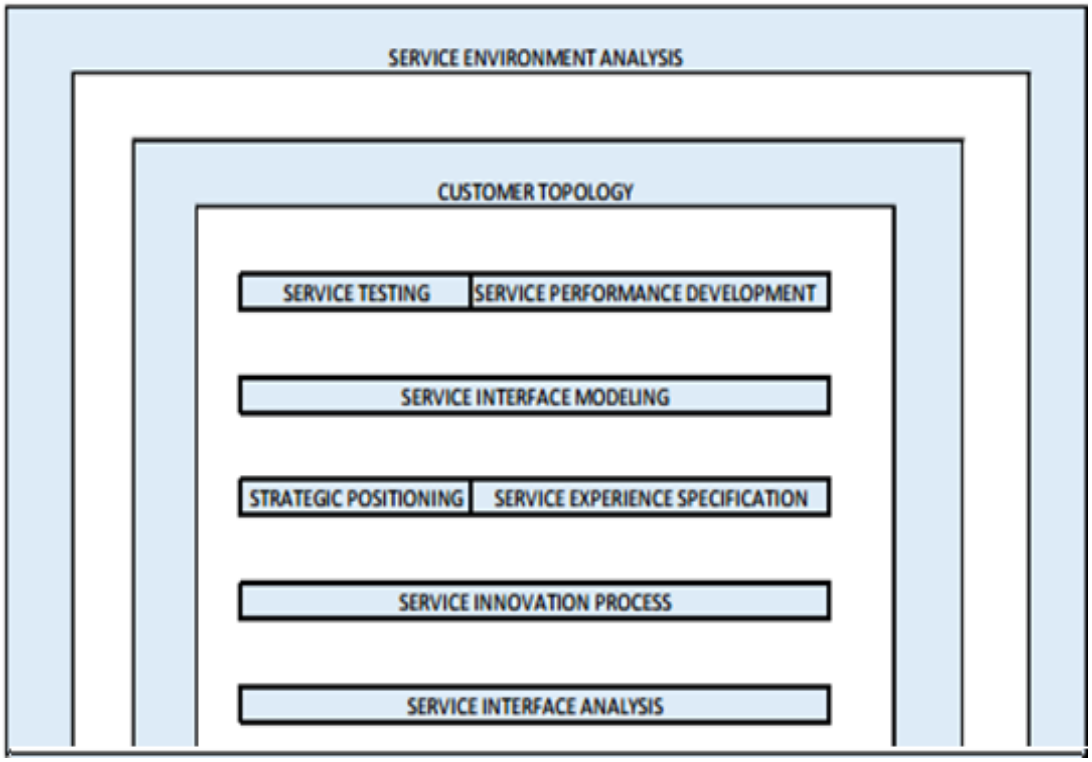

Figure 3. 1 Mager Service Design Methodology (Moritz, 2005).

Also, IDEO's firm has developed an innovation model that divided into three main stages. The first stage covers observing and understanding people, business, and technology. Insights from the first stage go into developing a strategic framework for the second stage. The second stage includes the principle of the iteration and then Ideas are developed and prototypes are made to help to develop the final concept. The third stage is concerned with translating the outcome of the second stage into the service solution.

Although this model was very useful to gain what type of task needs to be accomplished it provides working process tailored specifically to IDEO (Moritz, 2005).

According to (Moritz, 2005), there is an emerging pattern in the processes when these models are compared and this pattern is combined in the design council's double diamond structure, as is shown in Figure 2.3, Therefore in this thesis, we will focus on it.

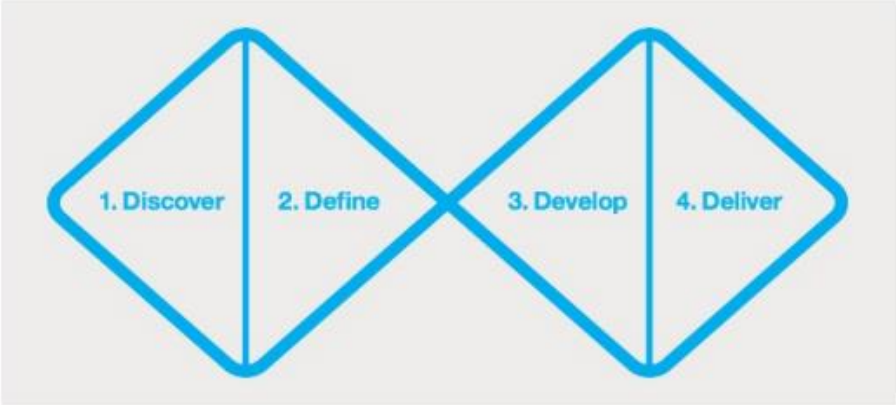

Figure 3. 2 The Double Diamond Design Process (Design Council, 2013).

3.4 Service Design Process

The double diamond model structure as a design process that consists of four phases (Discover, Define, Develop and Deliver) as is shown in Figure 3.2. Every phase of the process has its own purpose and gives input for the next phase. Each phase is briefly described below:

1. **Discover phase:** represents the start of the project and the most important phase of the service design process. It aims at looking at the world in a fresh way, gathering inspiration and insights on the project to identify user needs and problems, opportunities, defining the solution space and building a rich knowledge resource with inspiration and insights. The main focus of this phase is to innovate and gather inspiration. Furthermore, At this phase both qualitative and quantitative research methods and can involve both directly engaging with end users and analysis of wider social and economic trends (Design Council, 2013).

In relation to designing service for blood donation at this phase, in-depth interviews and observations are used to explore the current practices of blood donation in Khartoum-Sudan from the perspective of the blood donors first and foremost but also from the perspective of the healthcare professionals.

More specifically interviews are conducted with donors to understand the current blood donation service process from the donors perspective to identify problems

and needs as well as none donors perspective to discover the common factors that make them none donors. In addition, besides that in-depth interviews are aimed at exploring the perspective of healthcare professionals to identify the elements that challenge the blood donation process.

2. **Define phase:** seeking to make sense of all the possibilities identified in the discovery phase by analyzing the findings of the discover phase and translate them into a set of problem statements that are aligned with the organizational needs and business objectives to identify which to take forward. The main goal of this phase is to develop a clear creative brief that frames the fundamental design challenge that needs to be addressed through the design process (Design Council, 2013).

In relation to design service for blood donation, in this phase personas are created using the data that collected in the previous phase through sketching the actual users by describing characteristics, needs, attitudes, goals, and expectation for both customers (donors) and providers.

3. **Develop phase:** dealing with creating solutions and detailing all designed service components using creative techniques while ensuring that these components are linked together to form a holistic experience. The main focus of this phase is to work with the end user to improve and refine their ideas until a refined service concept is ready for implementation (Design Council, 2013).

In relation to this project user needs and goals that are identified by personas in the previous stage are used to conduct participatory design process with stakeholders of the blood donation process to suggest new IT-supported ideas for a better blood donation process. Also in this phase service blueprint is used to expose how a service provider (hospitals and clinics) support blood donation journey.

4. **Deliver phase:** represents the last phase of the design process where the resulting product or service is finalized and launched. The main objectives of this phase are final testing, approval and launch, targets, evaluation, and feedback loops and lessons from the process to colleagues and partners, making new knowledge, insights, tools and other ways of working available (Design Council, 2013).

In relation to the project at this stage scenarios for suggested ideas are generated and used to communicate preferred outcomes to all stockholders, helping them to understand service. Also at this stage, a prototype of a new IT-supported blood donation process is tested through field trials with the stakeholders and generated scenarios.

3.5 Service Design Tools

Service design has a wide range of tools and methods that can be used to visualize the service across the project phases. Furthermore, the tools and methods used in service design are mostly applied in other research disciplines (Segelström, 2013).

Due to a wide range of tools and methods of service design, designers have actually free hands to choose from them and find a workable combination that can lead to gradual improvement through the iterative process of SD (Schneider and Stickdorn, 2011). In regard to design blood donation service, the tools that have been used are described below.

3.5.1 Persona

Persona is a tool introduced by Alan Cooper in his book "The Inmates Are Running The Asylum" (1988), to model user experience where the development process devoted to focus on target users and their needs. Personas is a profile of a person that is a representation of a group of people with similar interests that has advantages and helps in identifying the user's needs and desires (Segelström, 2013).

The main goal of personas is to redirect the focus of the development process towards end users and their needs. The use of personas allows us to build empathy, understand behaviors and attributes of blood donors from a realistic archetype because it represents an aggregate of target users who share common behavioral characteristics (Chasanidou, Gasparini and Lee, 2015b). Furthermore, although personas do not communicate anything about the service but are considered stands out as the most realistic of service design tools (Segelström, 2013). In regard to this thesis, the researcher is used and analyzed the data collected through interviews and observations to create personas. The created personas include name, age, occupation, where personas live, the interests, the needs and quotes and so on.

3.5.2 Customer Journey Maps

A customer journey map is a tool that can be used to describes the journey of a user by representing the different touchpoints that mark his interaction with the service steps by steps. Furthermore, the customer journey map focus on how customers see the service rather than focus on presenting the actual structure of how the service works because the main goals here is to identify problems in current service and gradually generate suggestions for improvements where different stakeholders become involved (Lell, 2015).

In regard to this project, the researcher is asked and encouraged donors to imagine and generate suggestions for improvements through hypothetical service experience, and they think that the service really exists and then build a potential journey through some of its functions (Simsarian *et al.*, 2003).

In sum, customer journey maps are used to figure out the interaction between the user and the service through the touchpoints to identify problems and generate suggestions for improvements.

3.5.3 Service Blueprint

A service blueprint is a tool that gives a holistic representation of how the process of service is intended to work through a flowchart which includes the interaction with the customer in the front stage, separated from the backstage service production (Segelström, 2013). The blueprint includes representation of service process from the user perspective as well as actions and processes needed to support it from the provider's point of view.

With blueprints, we can be able to evaluate the existing service as well as design a completely new one through providing insight to what processes, resources, actions, and tools are needed to improve or implement the services (Lell, 2015). In addition, blueprint touchpoints and the back-stage processes can be documented and aligned to the user experience.

In regard to this thesis service blueprint are used to enhances customer satisfaction level regarding blood donation service at Khartoum- Sudan blood banks

with a newly designed service blueprint from a holistic viewpoint of both donors and service provider (blood banks).

3.5.4 Storyboard

A storyboard is a tool describes the interactions between a service and a consumer, and how interactions occur over time. The storyboard is the most case made in terms of images or drawings setting focus on the important aspects of service interactions (Lell, 2015), (Segelström, 2013). The main goal of the storyboard is to visualize interactions and relationships that might exist between a user and a solution in the context of the user's full experience. In addition, it helps to imagine future interactions as well as serve as the basis for creating a service blueprint (Lell, 2015).

3.6 Data Collection and Analysis

Qualitative research methods are considered common and suitable to obtain a holistic view of the subject of the research as well as understand user attitudes regarding it (Baxter, CourageC. and Caine, 2015). In this thesis, semi-structured qualitative interviews, observations, and the collection of documents were used to gather empirical data on the current blood donation practices in Khartoum, Sudan.

A total of 19 interviewers were conducted with 12 men and 7 women. Each interview lasted for an average length of 45 minutes. The interviews covered the reference blood banks (STAC), two blood banks of the public hospital (Khartoum Teaching Hospital and Ahmed Gasim Teaching Hospital) and tow blood bank of the private hospital (Asia hospital and East Nile Hospital). While other interviews were conducted in August 2017 in Khartoum, as part of a collaborative campaign between the STAC and a non-profit organization that donates blood to the children of cancer patients. The table below shows (Table 3.1) information about the interviewed individuals.

Table 3. 1 Individuals Interviewed Information.

Interviewees	Age	Gender	Occupation
P1	26	Male	Civil engineer
P2	30	Male	Student
P3	25	Female	Lab Technician
P4	32	Male	Teacher at Secondary Schools
P5	23	Male	Student
P6	29	Male	Architect
P7	35	Male	Web developer
P8	30	Female	Lecturer
P9	25	Female	Trainee(banker)
P10	33	Female	Doctor at STAC laboratory
P11	48	Male	Teaching Staff
P12	31	Male	Ticket Collector
P13	28	Female	Nurse At private hospital
P14	29	Male	Sales Representative
P15	26	Female	Graphics designer
P16	30	Male	Doctor at a public hospital
P17	27	Male	Electrical Technician
P18	29	Female	Human development coach
P19	36	Male	Lab Technician at STAC laboratory

The interviews started by asking the interviewee about his or her perception of the significance of blood donation, and his or her experiences with the process of donating blood. Next, the interviewees were asked about the methods used to notify them about the needs for donations to for example family members or as voluntaries. Then the interviewee and are asked to discuss the advantages and disadvantages of the

current blood donation process. Finally, the interview typically ended on the topic of motivations and barriers that lead to or prevent a donor from becoming a regular.

Furthermore, observations of the blood donation setting and process were also carried out. The author examined the physical settings for the blood donations in Khartoum and observed the process by which blood is donated.

Specific attention was paid to looks for the limitations of current practices that have a negative effect on donors' decision as well as elements that may motivate them. Finally, data generation included collecting documents used in the process such as forms and lists pertaining to the organization and administration of the process. Both blank and filled out forms where collected and analyzed.

In terms of analyzing interviews data, although there is a various method that can be used as data analysis methods, in this thesis thematic analysis has been chosen in order to conduct a data analysis of the interview findings. The analysis process started after conducting all the interviews, where the author read the notes taken during the interviews sessions and listen to the records of the interviews through multiple times and color-coded them according to the themes of the interview guide. In the end, the interviews data are divided into themes, and the results were coded again based on the themes in order to separate the differing answers from each other.

3.7 Ethical Considerations

All study participants recruited after accepting to be interviewed and gave free and informed consent to be interviewed, and questions were asked in the Arabic language as preferred by the most interviewee. Moreover, the interviewees were informed that he or she could retreat at any time during the interview. The data collected are confidential throughout the study and did not disclose or mixing with any other data. Finally, this project is in accordance with the guidelines of the Sudan University of Science and Technology.

CHAPTER FOUR ANALYSIS AND FINDINGS

4.1 Introduction

This chapter presents the analysis and finding of the data that has been collected based on the interview and observation methods to firstly explores and points the current practices of blood donation in Khartoum-Sudan, and secondly how such practices may be mitigated and supported with new information technology. In this chapter, first we will introduce the blood donation setting and process, and then we will account for the remainder of the findings under six analytical headings.

Finally, based on these findings and limitations of the current practices, design implication is presented as ideas to reduce them.

4.2 The Blood Donation Setting and Process

In Khartoum-Sudan, blood banks deal with both family replacement and voluntary donation in meeting high demands for blood. In family replacement type, required blood is collected from the patient's family, friends or relatives donors whereas in the voluntary donation, required blood is collected from volunteers' donors.

Donation place depends on hospital type (public or private) in which the patient admitted. In case of a patient admitted in public hospitals, usually, the donation is conducted at the blood bank of the hospital in which the patient admitted or at a specific bank customized to serve the hospital in case they have not a blood bank or has a blood bank unable to separate blood to its component and carry out homogeneity processes, while in case of a patient admitted in private hospitals, the donation is conducted at STAC laboratory building or at a blood bank determined by the hospital.

Besides the responsibility of meeting the needs of private hospitals, STAC laboratory also responsible for collecting blood as a voluntary donation from all society members.

In terms of the donation process, donors are asked to fill out forms of detailed information such as name, age, gender, date of the last donation, type of donation, qualification, chronic diseases, phone number, blood pressure and the desire of being a regular donor. After that donor who filled the forms stay to see doctors in order to get approval for donation(doctor's signature or stamp) after passing routine tests such as blood pressure and heart rate etc.

Approved donors are checked by a laboratory technician to determine their blood type group and ability to donate, and eligible approved donors are getting blood bags labeled with group type and directed to donation room for the process blood drawing or extract specific blood components such as RBC or plasma.

After the process of blood drawn, sometimes donors get juice before they leave the donation room. Finally, blood banks keep records contains information about the donors who will be a regular donor or donors with rare blood group.

4.3 Findings of Current Practices of Blood Donation

The analysis and findings of interviews and observation data are presented under the six headings below.

4.3.1 Blood Donation - Public Understanding and Behavior

From the viewpoint of all the donors interviewed, blood donation is considered a humanitarian act that contributes to saving lives. Since donating also renews a donor's blood cells, some donors view blood donations as a charity and believe they must be done regularly. For instance, a civil engineer said, "I'm donating blood to help and save the lives of others. Besides that, donation renews blood cells and makes me active."(P1);

While another donor, a lab technician said, "I think blood donation is a charity for our bodies and must be done regularly for as long as we can." (P3);

Furthermore, reciprocal feelings were noted between most of the interviewees, for some, blood donation is considered a debt that must be repaid. On one hand, a lecturer as one of the interviewee said, "I think if we reverse the positions, I'm sure those who need blood now would donate to us if we were in need." (P8);

Whilst, a teacher said, "Thanks to the donation of a stranger, I am alive now. I promised myself that I would give blood for as long as I could." (P4);

Moreover, although most of the donors interviewed at the campaign site were happy with their decision to donate, they expressed less satisfaction with some elements of the event, such as the late start and the location change from one hall to another.

"At least tell us when the place is changed." (P1);

On the other hand, a student as one of the interviewee said, "I think they failed to start at the time they announced in the campaign poster." (P5);

In sum, we may say that although reasons for individuals to be a blood donor were differed most of the interviewed understand the importance of blood donation to help in saving human life. In addition although donating made them feel good but few of them are frustrated regarding campaign coordinator due to they are unannounced when location changed.

4.3.2 Sources of Information and Blood Donation Awareness

According to most interviewees, the primary sources of information regarding blood donation is family, friends, and social media. This situation is probably partly due to the fact that in Sudan family replacement makes up the highest portion of blood donations.

In addition, many people had not received any information regarding blood donation from e.g. government agencies or NGOs, especially in rural areas where much of the population is illiterate.

"Today, social media is considered a valid environment to disseminate information regarding blood donation." (p1);

Voluntary blood donation in Sudan is mostly dependent on educated people, such as students, employees, and those advised by their doctors to donate frequently in order to refine their cells or fix problems in their blood. While family replacement donations are considered a moral responsibility, individuals must be given more knowledge about blood donation.

As it can be seen clearly in some of the opinions of the interview such as an architect who said, "My first donation happened because the doctor said: ‘to be healthy you need to donate blood every three months." (P6);

Another interviewee, a doctor at STAC laboratory said, "Many family members of patients are told to donate to their relatives, although they have medical issues that prevent them from doing so." (P10);

Furthermore, there was a consensus among all interviewed donors that misconceptions regarding blood donation pervade the population particularly, especially within the illiterate community. Some tribes in parts of rural Sudan see blood donation as a difficult ordeal and will only do it for their family.

"(….) In east Sudan, the El-Bega tribes consider blood donation to be an act that is rarely done." (P10);

In regard to awareness of the constant need for blood, most interviewees revealed that blood banks typically only advertise their continuous need for blood by asking family members of patients to bring additional donors. Sometimes, blood banks will broadcast their needs on social media to catch the attention of some volunteers.

To spread awareness about the massive need for blood, organizations seem to rely on social media, television, and posters alone. In the case of blood donation campaigns, they largely depend on reposting or retweeting through social media (Healy and Murphy, 2017). Furthermore, although social media have advantages of reaching and raising the awareness or disseminate the right information about blood donation community with illiteracy and digital divide may challenge the roles and opportunities offered by social media.

In regard to digital divide, find specific methods to reduce these challenges or bridge this gap are feasible and require participation and efforts not only from governments but from all organization in Khartoum particularity those who are concerned with ICT such as telecommunication companies through expanded their networks or facilitate through broadcasting and free messages about the importance of blood donation and high demands for blood. In addition, health convoy or free

treatments that are implemented periodically by medical colleges can be used to target areas of illiteracy and the digital divide in Khartoum.

4.3.3 Current Approaches to Promote and Stimulate Blood Donation

There are many strategies used to stimulate and promote first-time donors and regular, but these techniques differ from one blood bank to the other.

In STAC, complete blood count (CBC[1]) analysis is the approach used to motivate volunteer donors. In addition, sometimes donors are given mango juice after completing their donation.

To some of the interviewees, CBC analysis and mango juice are inadequate incentives to become regular donors. This is because, in the case of regular donors, some of their family members may need a blood transfusion in the future. If these individuals commit to donate or bring volunteers, blood banks should ensure there is blood for their family members. Therefore, most interviewees believe that the process of obtaining blood needs to be better than the current methods used by the STAC blood bank.

For instance, as one interviewee, a web developer said, "When I need blood for some relative, STAC employees must remember that I am a regular donor." (P7);

Furthermore, only a few volunteer donors prefer CBC analysis, due to fears of discovering undesired problems in their blood, such as AIDS. In addition, the results of CBC analysis require a full day to be determined and these results may only be received by hand. Most donors can't return the next day, due to the high cost in both time and money, especially for those who live far from the blood bank.

While another interviewee, a doctor at a public hospital said, "Most donors are afraid of conducting CBC analysis or have no time to return and receive the results of the analysis." (P16);

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[1] Complete Blood Count (CBC): is a blood test that gives complete information about blood cells such as the numbers and shape of cells.

One way used to further motivate donors and grab the attention of a large number of potential volunteers is campaign events, which frequently feature entertainment programs featuring famous singers, poets, musicians, and other celebrities. While many donor candidates attend such events, some have noted that the donation locations are not as comfortable as the locations where people are celebrating and having fun. Donor queues are frequently situated in hot, uncomfortable locations, while other parts of the event have air conditioning and luxurious seating.

Furthermore, a student as one of the interviewee at campaign said, "As you see, we sat in the heat, while others enjoyed comfort." (P2);

Some blood banks and hospitals provide full meals to volunteer donors to ease their anxiety. In the case of family donation, blood banks do not use any kind of stimulus to elicit donations. Family, donations are also based solely on the moral responsibility of donors towards their relatives.

4.3.4 Assessment of the Current Services Provided to Donors

For most interviewees, the design of the STAC building was one of the most significant factors that held them back from wanting to become regular donors. Some donors had decided against giving blood because of the building's age and poor design. Many of the rooms and halls allocated to blood donation are inadequate and cannot accommodate a large number of donors.

This idea is supported by one of the interviewees, Sales Representative when he said, "I think the government should replace this old building because it has been there since colonial times and is always overcrowded." (P14);

In addition, P10 as one of the interviewed said, "(……) always, I see people standing."

Furthermore, the waiting rooms and hallways are narrow, hot, and furnished with uncomfortable chairs. The blood drawing room only has six beds and the room for donating specific components only has two Trima devices. The interviewed donors believed that the waiting rooms should be comfortable and contain some sort of entertainment, such as games or free Internet access, to ease their anxiety and boredom, especially for first-time donors. And that is represented by a farmer when he said,

"They should appreciate our visit, and at least offer simple things like drinking water and a comfortable environment." (P12);

While a STAC employee said, "I have visited many countries that provided more than the basic elements, such as comfortable rooms, games, and free Internet to reduce boredom as the result of waiting." (P11);

Some interviewees believe the current methods for recording donor information need to be improved, in order to maintain better blood donation historical records and deliver the best services to donors. Allocating adequate staff members and preparing materials for donors who are expected to arrive can achieve higher efficiency in the donation process. Many donors request specific times for their donations, but many leave without donating as a result of waiting too long.

The majority of the interviewed agreed with this point, for example, a trainee said, "Twice, I left without donating due to waiting too long. I have work to do." (P9);

Moreover, some interviewees were frustrated by non-compliance on the part of other donors when it came to maintaining the correct order to see the doctors, participating in routine tests, and entering the blood drawing room.

As one of the interviewed (P7) said, "It is shameful to see some donors when it comes to the correct queuing order."

In fact, the majority of interviewees revealed that they held negative opinions of waiting time and the methods used for queuing donors. Many donors believe that the method by which most blood banks document donor information (manually on paper) is severely limited and causes problems, such as increased wait times, difficulty when searching for information, and errors mistakes in the queue order.

Which can be seen in what is said by (P12) that "We filled out the same paper again, which took time, especially since they did not offer pens."

"(….) Identifying which donors must donate soon is time-consuming and requires them to stop everything to figure out." (P3)";

Most interviewees were unsatisfied by the lack of signboards that could be used to guide first-time visitors. For instance, STAC building consists of many departments, such as the blood laboratory and blood distribution center, which makes it easy to get lost.

Some of the interviewees strongly support this opinion such as (P7) when he said, "A lot of time is wasted trying to reach the donation room. Putting up some signboards is an inexpensive way to guide new donors."

In regard to the blood drawing room, besides being narrow and only able to accommodate six donors, most interviewees and doctors consider the rooms uncomfortable and inadequate to accommodate both doctors and donors at the same time. Moreover, the rooms suffer from a lack of the most basic facilities, such as clean water and sufficient chairs. In addition, it is located on the top floor of the building and there are no elevators.

This is been reflected in many interviewees comments such (P16) when he clearly said, "As you can see, the bed and chairs are old and uncomfortable.

While another interviewee (a nurse) said, "I think putting all the donation rooms in one place is more feasible." (P13);

In addition, none of the rooms can be customized post-donation to avoid unforeseen consequences or deal with complications during or after donation.

Regarding this point, a lab technician at STAC laboratory as one of the interviewed, said, "Due to insufficient beds and chairs, donors must leave immediately after their donation is complete, which is dangerous when there are complications." (P19);

The STAC laboratory and other blood banks, record blood distribution and delivery on paper forms which provide challenges in terms of remote access to information, and in terms of anticipating future demands and exploring the current blood stock at the STAC laboratory. This method has been criticizing by most of the interviewed, as of the interviewed, a lab technician at STAC laboratory said, "We've only used the manual recording for all processes up to now." (P11);

As a result of the information being recorded manually, the STAC laboratory and other blood banks have trouble preparing lists of donors whom they should stay in contact with and remind about future donations. Also, the current methods of recording make the process of identifying donors, searching for donors, and determining which donors belong to rare groups difficult and time-consuming, as all existing donors are listing in paper notebooks.

In relation to this point, P11 said, "I think donors with rare blood types should be able to donate based on the needs of specific locations, which can be achieved by sharing donor information between blood banks."

In sum, most of the interviewed donors are believed current service provided to donors needs improvement including adequate staff members and preparation of adequate and comfortable rooms and halls that accommodate a large number of donors. In addition, the current methods used for both recording information and queuing donors are main reasons for them to bee unsatisfied regarding blood donation process due to time waste or non-compliance with ordering queue especially for those connected with other work.

4.3.5 Professional-User Relationship and the Recruitment of Regular Donors

Most interviewees stated that receiving professional treatment during and after the donation is one of the essential factors that greatly influenced them to give blood more frequently. In addition, this factor also motivates and stimulates first-time donors to become regular by positively affecting their decision to return to the service center and voluntarily donate again.

In terms of positive motivations, P4 as one of the interviewed said, "I believe professional treatment from blood banks staff will encourage donors to donate frequently and help recruit new donors."

Although most of the donors positively assessed their relationship with the staff, improvements are still necessary. This includes being attentive and caring towards donors during the blood drawing process, encouraging donors to give blood more frequently, and motivating donors by providing them with more information about the process.

Furthermore, in regard to improving the relationship with staff, a graphics designer as one of the interviewed said, "Although most staff members are professional in their work, some of them are busy with their phones while drawing blood." (P15);

The interviewees considered the current methods of communication between donors and blood banks to be in need of improvement. The practice of recording phone numbers on paper documents is inadequate because a specific donor's phone might have no service when the blood bank calls to request a donation.

Furthermore, some donors live far away from their blood bank and may be unable to attend at the desired time. Most donors prefer to make donations at the nearest blood bank to their current location, has been said by an electrical technician that "Sometimes, it is difficult for me to attend, because STAC employee contacts me for donations at inconvenient times." (P17);

As Sudan is suffering from a lack of Rh-negative blood, some interviewees suggested making donor information available to all blood banks. This would allow donors to give to any blood banks in need of blood for transfusion services, which would be especially beneficial for banks in need of rare blood, which is always in demand around different parts of Sudanese cities. Blood banks not only need a minimum number of regular donors but also must translate existing donors into active donors that can be used to recruited new donors and disseminate information about blood donation throughout the population.

In regard to donor motivation, interviewees mentioned that, with the exception of CBC analysis, blood banks do not use any form of motivation to inspire regular or first-time donors. Furthermore, donors suggested positive motivators that should be increased and negative stimuli that should be eliminated or reduced. In terms of positive motivation, most interviewees believe that giving donors an award letter, one day off work, a t-shirt, being listed on a social media honor board, and/or free Internet access can provide incentives to donate more frequently.

For instance, P15 said, "I think blood donation organizations should use different motivation methods other than CBC analysis."

Furthermore, some donors believed that building a donor database and creating an appointment system could be used to sort donors based on location and direct blood donation vehicles to those places. Doing so will likely stimulate additional donations, especially from those who are unable to visit the blood banks directly due to a lack of money and time.

As a suggestion to support this idea and motivate donors P7 said, "I think transferring services based on donor locations will greatly motivate donors." P12 also tackled this point by saying, "My desire to donate is challenged by the cost to reach blood bank because I live in a rural area of Khartoum."

In terms of negative stimuli that make donors unlikely to return for frequent or second donations, staff members must eliminate the following issues to attract more donors: impoliteness, carelessness, moodiness, and a lack of sympathy. Which been expressed by many interviewees such as P16 said in his critical point of view, "I think all staff members are good at treatment and communication, but the employees at reception must be trained."

In sum, a professional and good relationship between staffs and donors are essential factors that greatly influenced them to give blood more frequently. Furthermore, using appointment service or allow donors to make a donation based to the location are positively stimulate them while staff impoliteness, carelessness, moodiness, and a lack of sympathy are negatively reduced their desire to return.

4.3.6 Barriers and Obstacles to Blood Donation

Based on observations and interview data, blood donation in Khartoum- Sudan is limited by many factors and faces many challenges. These factors can be divided into two sections: (1) blood donation organizations and staff members and (2) donors.

The interviewees suggested that blood donation organizations should provide services to donors both at the moment donors arrive and during/after donation. For instance, some donors believe the design of the STAC building is a major barrier to increasing the number of donations. Many believe the building should be replaced or altered, as the blood donation department is often congested the waiting rooms are extremely uncomfortable.

For instance, as one of the interviewed, P5 said, "The government must take care of this old building, replace it, or at least customize more rooms to be functional for the donation department."

In addition, blood donation organizations often do not know how many donors will make appointments, which makes it difficult to provide sufficient staff members and may lead to increased wait times. Some donors have an exact time at which they would prefer to donate, which cannot always be respected by donation organizations.

As one of the blood donors, P7 explained this difficulty when he said, "I think that the low number of doctors per donors will lead to many donors being late to work or leaving donation centers without making a donation."

While in terms of raising the willing to donate regularly, P6 said, "If I know that there is an exact time reserved for me, I will donate regularly."

When it comes to issues with donors themselves, all the interviewed donors believed that a fear of needles, medical issues, and misconceptions about donation are the main barriers, while bad treatment and a shortage of time to donate were noted obstacles as well.

As an idea to reduce these problems, P9 as one of the interviewed said, "I think a lot of work is required from blood banks to make people aware of the importance of donation and to eliminate misconceptions."

On one hand, P10 said, "Blood banks should directly contact individuals that have temporal problems preventing them from donating."

On the other hand, as one interviewee, a human development coach said, "To remove obstacles hindering increased blood donations, donors must be treated better and the number of staff members must be increased to reflect the number of donors (instead of using a fixed number of staff members)." (P18);

In sum, blood donation challenged with many barriers and obstacles that limit both donors decision to return and blood donation rates, and a huge work required to eliminate or reduce them. In terms of obstacles, bad treatment, the long waiting time to donate and poor design of the STAC building along with lack of adequate and

comfortable waiting rooms are cited as the main obstacles whilst fear of needles, medical issues, and misconceptions about donation are the main barriers.

4.4 Implications for Design

The advent of information and communication technologies has encouraged new and innovative approaches that can be used to improve these practices. The sections below describe potential ICT supported initiatives that attempt to improve the practices discussed above.

Having indicated the nature of the challenges for blood donation in Khartoum, Sudan, we will now in a preliminary manner point to some potential ways in which these challenges may be addressed, including a reward program, an appointment system, and mobile apps. These suggestions are as mentioned preliminary and therefore tentative in nature. Having said that, we believe that the ideas stated have potential and may serve as a point of departure moving towards an improvement of the current situation.

4.4.1 Reward Programs

As described above, the current approaches used by STAC (central blood bank) to promote blood donation are inadequate and do not raise donor motivation or persuade donors to donate more frequently. Potentially reward programs may provide incentives that can be designed to create loyalty among donors and motivate them to donate more frequently by providing the best rewards to both regular and first-time donors.

For example, a reward program may contain three modules. First, build and develop a database that aims to record the donation history of each donor and convert that record to a specific number of points. Second, use this database to issue rewards to donors or provide a report to private-sector organizations that can reward them directly for their social responsibility. Third, use SMS to send “thank you” messages to a donor, remind them of their next donation date, and notifying them of any rewards they have earned.

Through this updated system, donors can attend any blood banks in their area, which will now be able to retrieve the past information of existing donors and record

new donor information. Once all routine tests have been conducted and saved in the database, donors can make donations and their donation history will be updated automatically. Through SMS modules, “thank you” messages will be delivered to specific donors along with medical advice. When it is time for their next donation, donors will automatically receive reminder messages.

SMS modules can also send donors information about what type of reward they have earned, as well as the date and place they can receive their reward (if it is being offered by an outside organization and not provided at the blood bank).

This reward program can be funded by various social responsibility organizations and may offer prizes such as one day off work, award letters, t-shirts, being listed on a social media honor board, free Internet, or a training course. Using a reward program can create loyalty among donors and motivate them to give blood more frequently.

4.4.2 Appointment or Reservation System

As shown above, the current practices of blood donation in Khartoum are limited and negatively affect both donor satisfaction and donation rates. For individuals involved in the donation process, minimizing wait times and avoiding mistakes in queues are essential to increase satisfaction donation rates.

Most current donors are frustrated due to the long wait times and issues with queue orders that lead to noncompliance. Therefore, setting up a streamlined appointment system may potentially allow donors to select timeslots in which they are willing to donate.

The idea is that by implementing an appointment system that is shared among all blood banks, donors can explore more available timeslots and select their ideal time and location to make a donation. A new system would also make the overall process easier for blood donation organizations, as they will be able to arrange their facilities according to the number of donors arriving and make plans for future improvements. Furthermore, with an exact timeslot, donors are guaranteed not to be late to work or waste their time waiting around without making a donation.

In addition, blood donation organizations can select specific staff members to serve repeat donors, in order to ensure that the best possible service is delivered to those individuals that come to frequently donate blood.

Many potential donors live far away from STAC (central blood bank) and traveling to reach other blood banks cost both time and money. Therefore, if these individuals fail to make a donation due to long wait times, they will remember this negative experience and it will reduce their willingness to donate in the future. The appointment system will help satisfy donors' willingness to donate and motivate them to give their blood more regularly.

By setting up a reservation for a specific timeslot, donors can visit donation centers early to avoid road congestion. Moreover, based on the appointment system, blood banks can group donors based on location and send mobile clinics to specific locations with a high number of valuable donors, thus saving donors time and money.

In addition, appointment tickets can serve as receipts that donors can use as documentation to arrive late for work. Finally, an appointment system can be used to shift staff members between multiple locations based on the number of donors expected to arrive in a given day, while also notifying volunteers doctors and lab technicians about a large number of donors (such as those that come to blood donation campaign events).

4.4.3 Mobile Apps for Blood Donation Practices

The increasing popularity of mobile and handheld technology that combines powerful computing and communication into a single device, such as personal digital assistants (PDAs) and smartphones is a valuable asset that can be used to improve blood donation practices and help eliminate misconceptions regarding the donation process.

Smartphones have the capability to process a massive amount of data, which can be used in mobile applications to help complete important tasks. In addition, there is much open-source Application Programming Interfaces (API) available that can be used to design mobile applications that support and improve blood donation practices.

In Sudan, the number of mobile subscriptions and Internet users has increased substantially in recent years and most of the Sudanese population now have smartphones (especially the youth, which makes up a high percentage of blood donors), (ITU, 2018). These massive numbers of mobile subscriptions and Internet users have the potential to create an important opportunity to support and improve blood donation practices in Khartoum. Moreover, the Sudanese government's development and implementation of e-government programs and the success of existing mobile applications, such as Mishwar, Tirhal and lemon taxi (an e-taxi service) also indicate that mobile applications can be used to motivate blood donors and improve donation rates.

Designing a mobile app to support blood donation practices in Khartoum blood banks may potentially turn out to be a valuable idea because most blood donors are young people, who are more likely to own smartphones and have accounts on different social media platforms. Through these apps, organizations can disseminate the importance and urgency of blood donation, while dispelling misconceptions by spreading accurate information about the donation process. Furthermore, apps can be used to visualize the current bloodstock at blood banks and motivate donors to make donations to locations where low levels are noted. GPS systems can be implemented within these apps to help donors find the nearest blood donation centers based on their location, show them the exact path to get there and allow them to explore available donation times.

Mobile apps can potentially enable donation organizations in Khartoum to automate their blood donation process by making it simpler to manage blood donor records, find new donors, check donors' eligibility to donate, schedule donation times, and inform users of donation needs in nearby locations using geo-location services.

In sum, ICT presents many opportunities that can be used to support and mitigate the limitations of current practices upon blood donation. Using reward programs donors can be motivated to donate more frequently through many incentives based on the individuals preferred. In addition, in regard to the donation process, appointment system and mobile apps are feasible and valuable to improve the weak points throughout blood donation journey because these points are tightly connected with donors' satisfaction and wiliness to retune and make the second donation.

CHAPTER FIVE DESIGN AND IMPLEMENTATION

5.1 Introduction

This chapter presents the service design artifacts and implementation of the new blood donation service based on the perception of both service provider and service consumer that are gathered from the data that has been collected and analyzed in the previous chapter.

In other words, the data gathered during In-depth interviews and observations are analyzed in order to develop the foundation to create personas and map their current journey of blood donation and practices. Moreover, in this chapter, a service blueprint of the new suggested service is presented.

Although service design has many methods that can be used in this study the researcher chose personas, journey maps, and blueprints. We use personas and customer journey maps in order to be able to differentiate between different kinds of people and their different experience of the process of giving blood as well as consider their different perspective of the imagined service.

On the other hand, this chapter presents the implementation of a prototype for suggested blood donation service is.

In sum, the designed artifacts are includes personas, customer journey map and blueprints of the new service, in relate to personas we will present five of them in more details to accommodate the diverse categories of blood donors, and to be used in documenting current practices of blood donors in which to identify weak points that need to be improved as well as depicting the future service.

5.2 Creating Personas

The data gathered during In-depth interviews and observation were analyzed in order to develop the foundation to create personas. Personas are imaginary characters generated based on actual users insights. In other words, a persona is a rich description of one fictional person that represent a specific group of people, and they help us achieve empathy, create better ideas and challenge them (Design Council, 2013).

In related to this study, the persona profile describes the blood donor's characteristics, goals, motivations, and frustrations in the context of the blood donation service. As the results of diversity of blood donors or donors community, in this study the researcher sought to represent the diversity of the blood donors backgrounds as well as their different journeys in the blood donation process, Therefore, personas were classified based on five groups (Youth, old, educated, illiterate and gender), and each group represented by one persona.

Personas are fictive but not fantasy, and should be based on data from fieldwork therefore based on our observations and In-depth interviews data, we build a five persona profiles that seeks to represent the primary consumer or user of the services related to blood donation. These personas were selected by the researcher because they are aims to accommodate different personas of blood donation.

The first persona was a blood donor who is an educated man from Khartoum belongs to both the youth category and voluntary donors (as is shown in Figure 5.1).

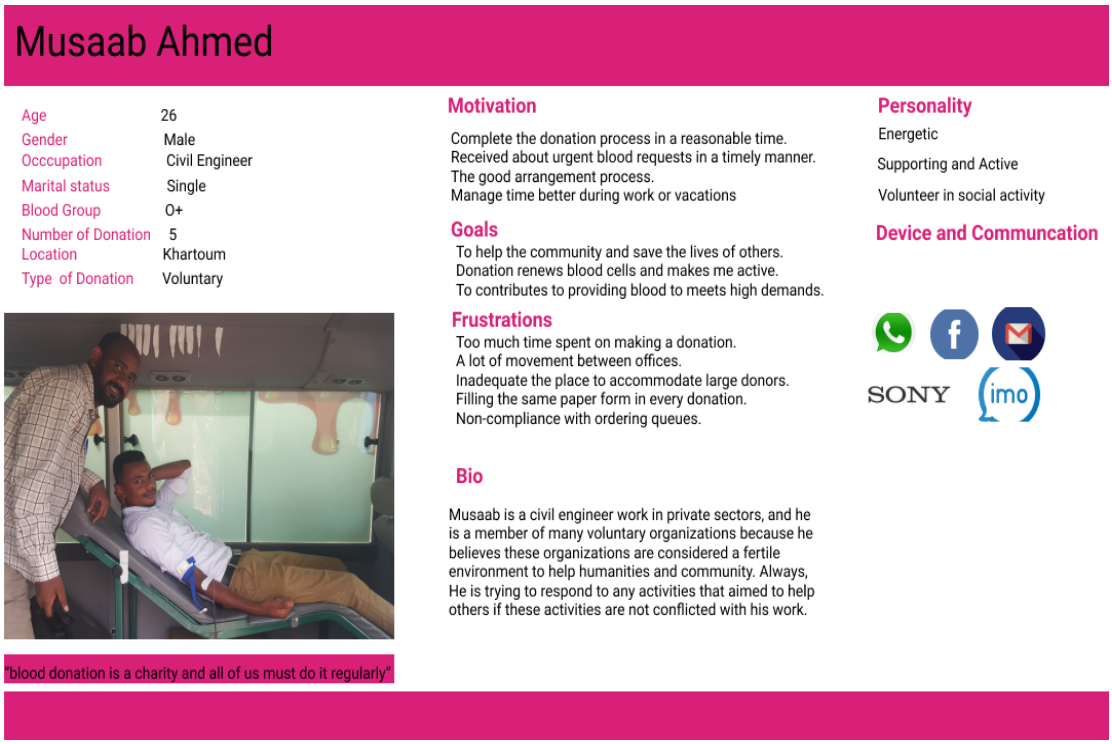


Figure 5.1 The Persona of First Donor

The second persona was a blood donor man who did not complete his education from Khartoum belong to the youth category as both family and voluntary donors (as is shown in Figure 5.2).

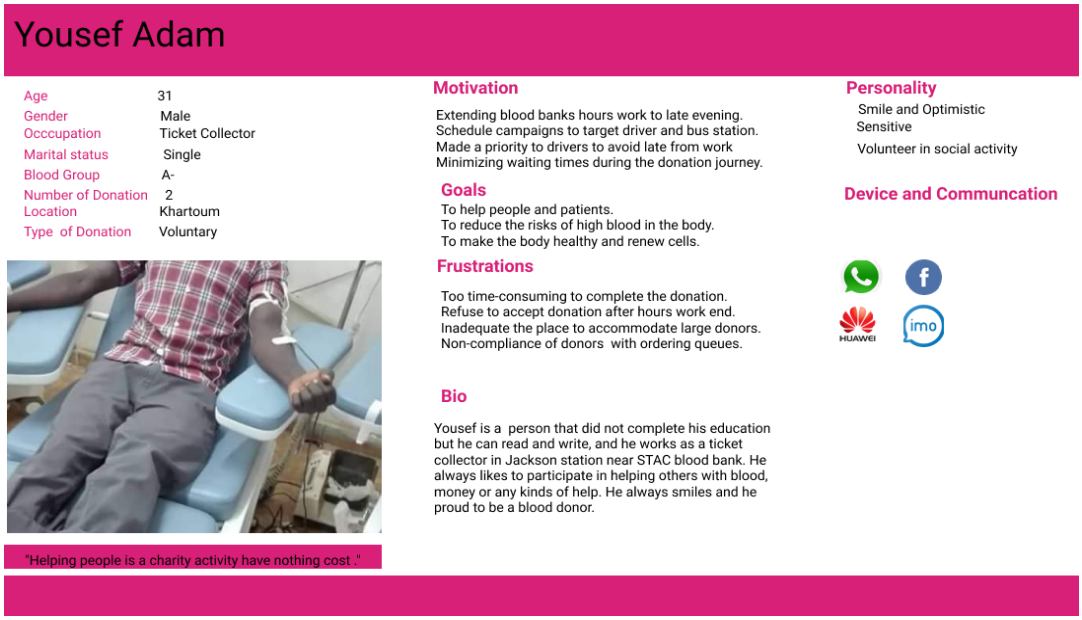


Figure 5.2 The Persona of Second Donor

The third was a blood donor who is an educated man from Al jazirah state belong to the youth category as both family and voluntary donors (as is shown in Figure 5.3).

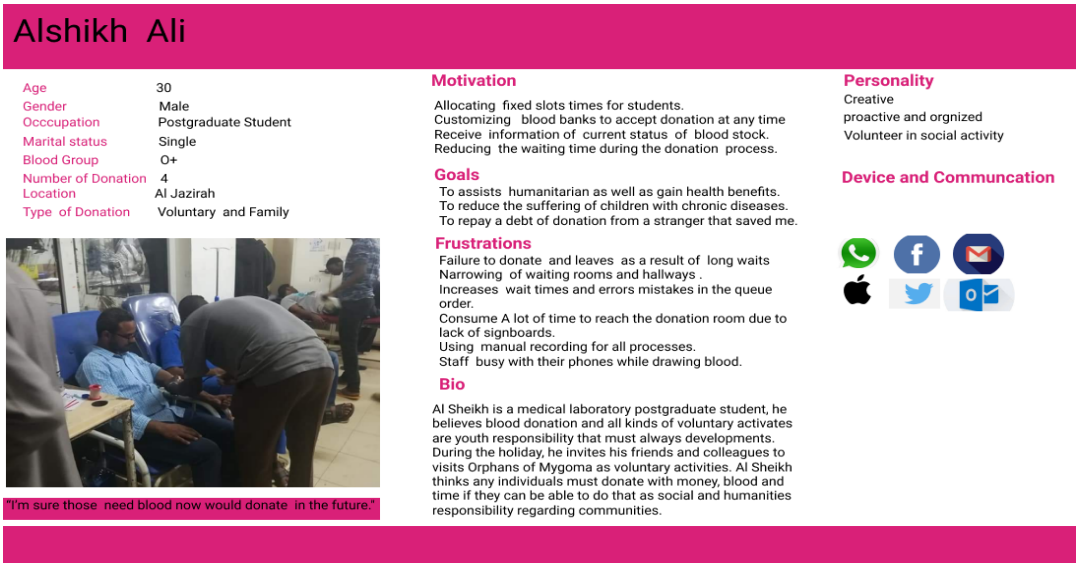


Figure 5.3 The Persona of Third Donor

In addition, the fourth persona was a blood donor who is an educated female from Khartoum belong to both the youth category and voluntary donors (as is shown in Figure 5.4), while the fifth persona was a blood donor who is an educated man from Sennar state belong to the old category as both family and voluntary donors (as is shown in Figure 5.5).

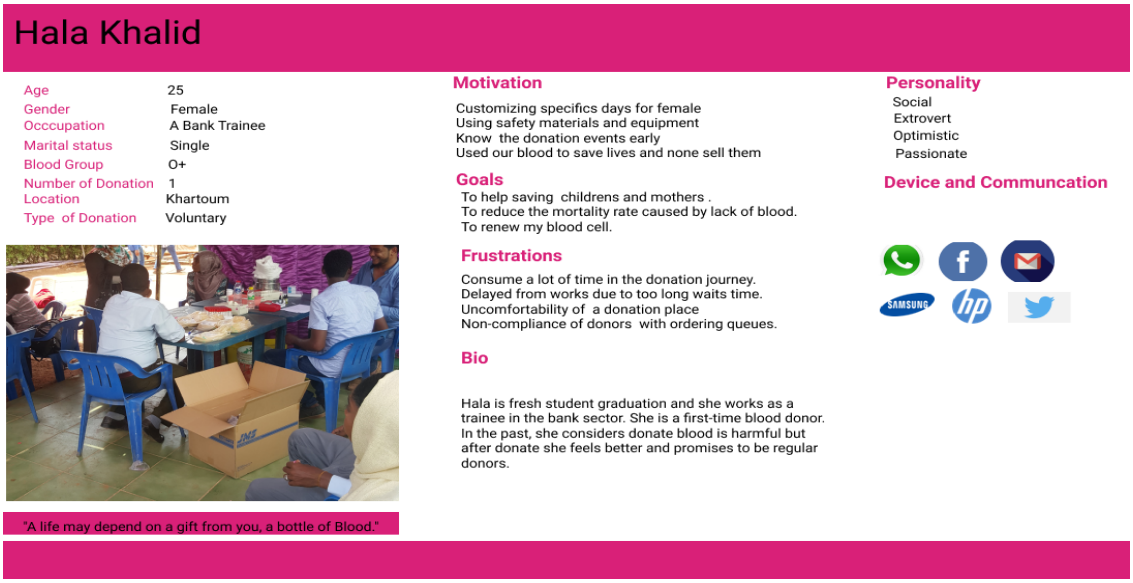
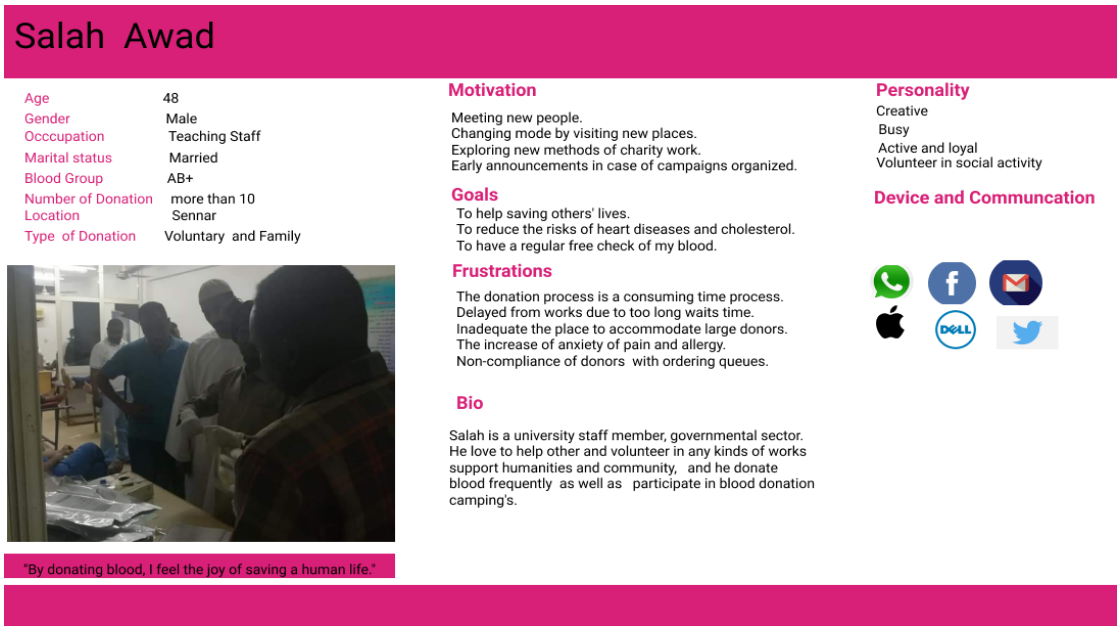


Figure 5.4 The Persona of Fourth Donor



5.5 The Persona of Fifth Donor

In sum, based on the findings illustrated in the previous chapter, a personas profile representing the primary user of the blood donation services was created.

5.3 Creating Donor Journey Maps

Customer journey map is a tailored graph that aims to describe the journey of a user regarding the target service by identifying and representing the different touchpoints that mark his interaction with the service, and this interaction is described step by step and with strong emphasis on some aspects depending on the activities (Chasanidou, Gasparini and Lee, 2015), (Antwi, 2015).

Furthermore, representing and analyzing the journey of an existing service is usually the first step in the service design, and hence it possible to explore and identify the weak areas or pain points within the service sequence that frustrated or lead to minimizing the satisfaction of the users (Lell, 2015).

The researcher used a customer journey maps in order to be able to represent the different kinds of blood donors and their different experience in the process of giving blood to highlights the main points caused problems in the donation journey and use them as guidance in order to make improvements that truly satisfy the blood donors.

A journey map has many elements or components depend on the purpose, in this study we are aimed to presenting or documenting donors experience steps by steps and discover moments of excitement and pain points (Smaply, 2016). Below are more details of the major's components of the journey map were used:

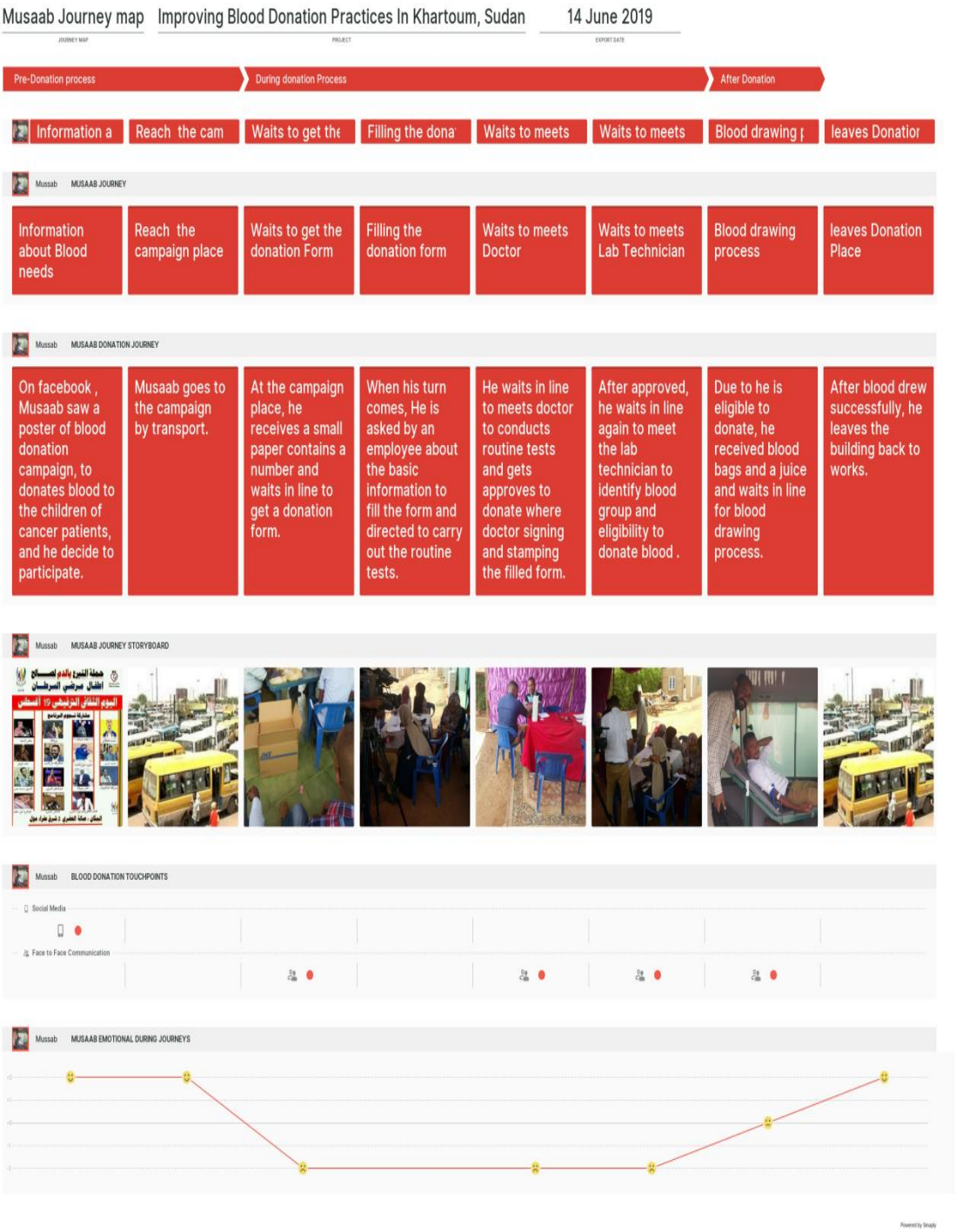
- **Stages:** represent the general phases of the journey map, such as Pre-donation, During Donation and After Donation. Stages help to give structure to a journey map and allow easier orientation.
- **Steps:** is a sequence of steps illustrates the experience of a persona through a sequence of steps, touchpoints, interactions, or activities.
- **Text Lane:** is a simple text lane that allows describing each step in more detail.
- **Storyboard** Lane: Storyboards visually represent the sequence of steps through icons, photos of real-life situations or other visuals.

- **Channel Lane:** are icons help to visualize the interaction channels that the persona uses or could use for each step.
- **Emotional Journey:** Emotional journeys are graphs representing a persona's level of satisfaction at each step and reveal obvious gaps with the customer experience. Where it uses a simple 5-point Likert scale from –2 (very negative) to 0 (indifferent) to +2 very positive.

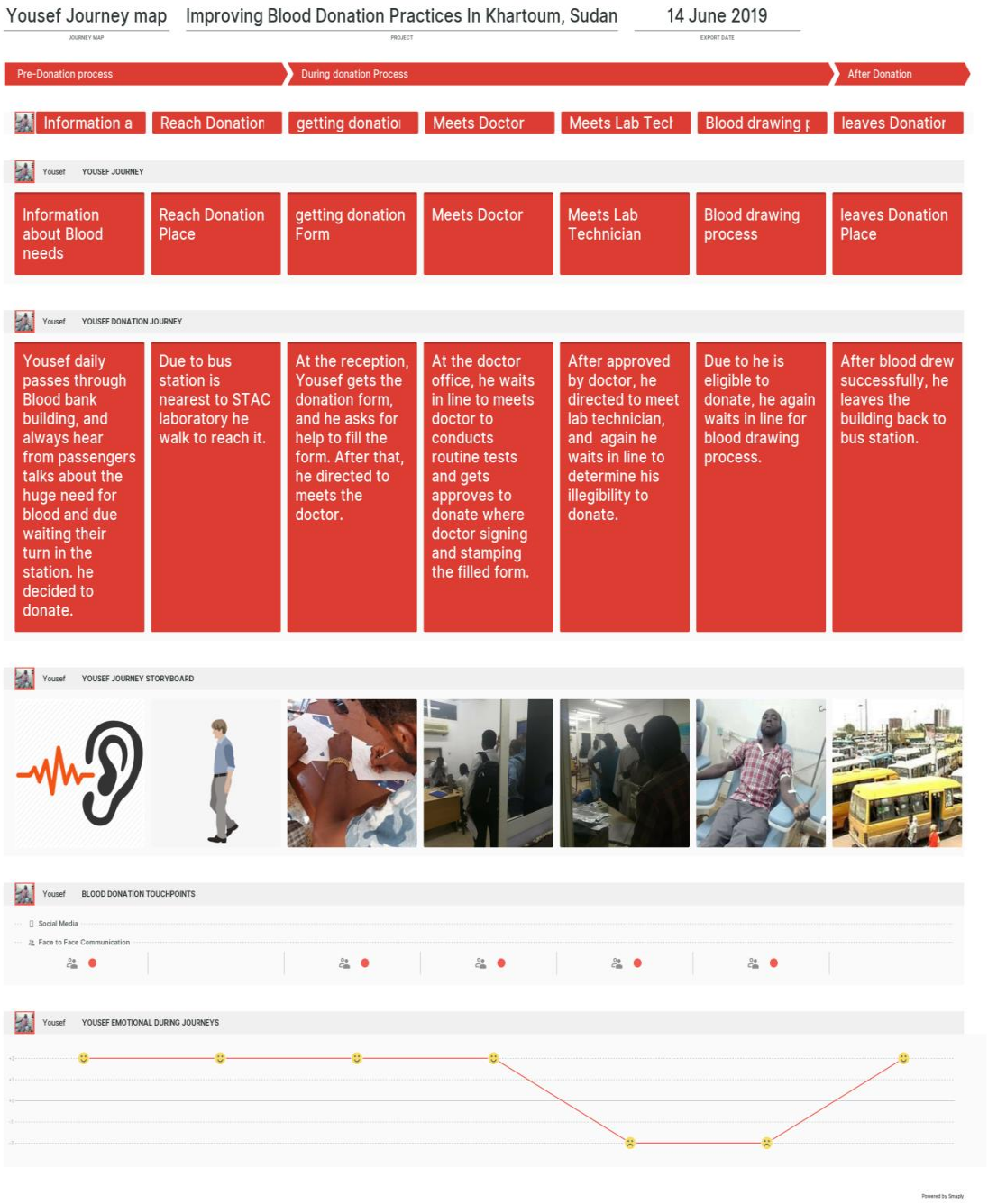
Based on the data collected by the in-depth interviews and observation, the process of donating blood was visualized into a five donor journey map to represent blood donation service steps by steps as well as documenting different journey and experience of donating blood.

For most of the personas, social media is considered the main channel or the source of information about blood needs while for some personas face to face and phone call is the source of blood needs.

For the first and second persona, as is shown in Figure 5.6 and Figure 5.7 respectively, the donation journey started very positively but in the middle and due to long waiting, inadequate of the place to accommodate large donors, a lot of movements between office and noncompliance with order queue, they had a very negative emotional journey. In addition, the second persona has found some difficulties in filling out the forms of donation and these difficulties eliminated after getting help from one donor.



5.6 Donor Journey Map of the First Persona



5.7 Donor Journey Map of the Second Persona

While for the fourth and fifth persona, as is shown in Figure 5.8 and Figure 5.9 respectively, also the journey started very positively to help others but elements such as filling a long form in each donation, increase wait times and mistakes in the queue order, narrow of waiting rooms and hallways, was cited as the main points leads to turns the journey to be very negative in the most period.

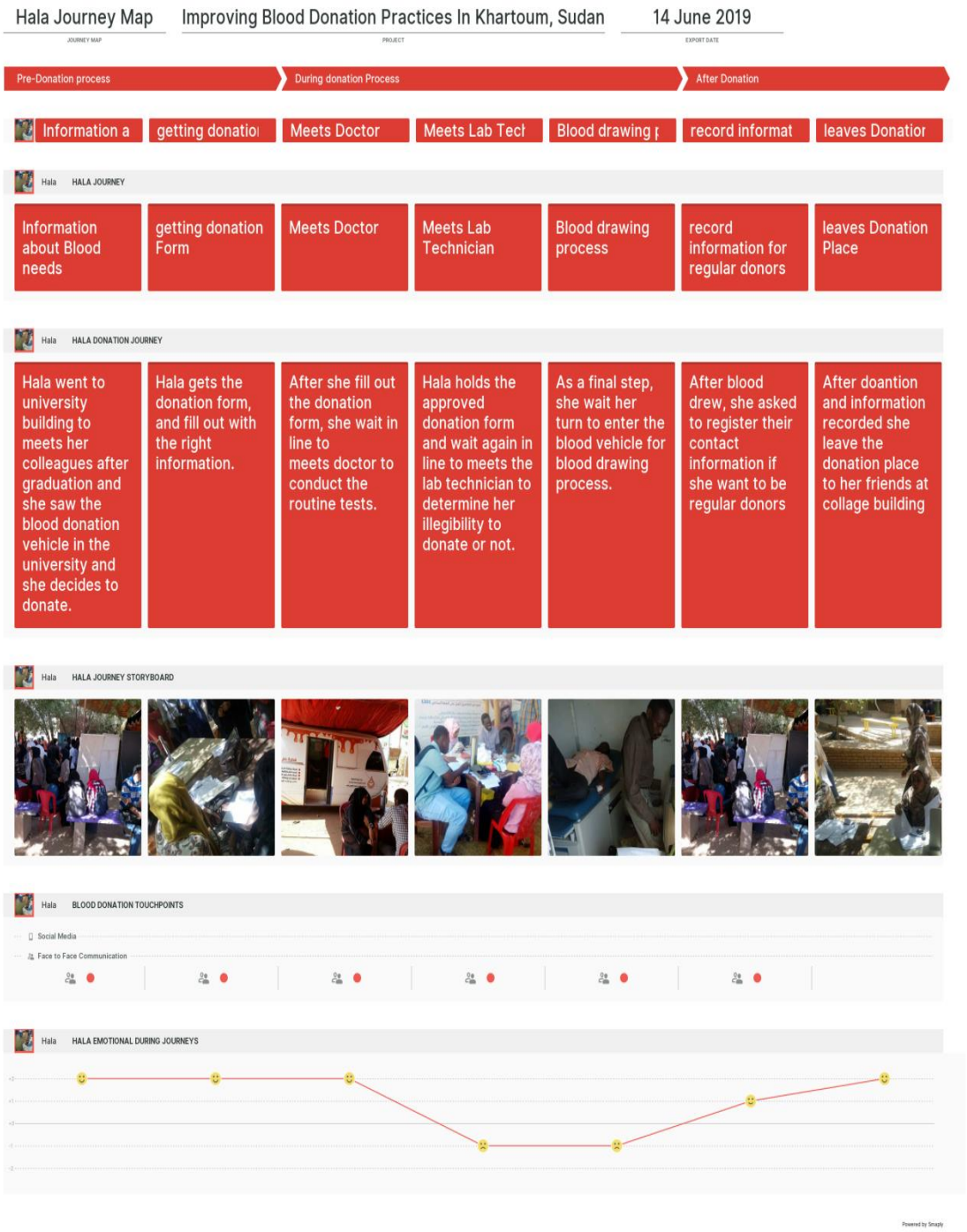


Figure 5.8 Donor Journey Map of the Fourth Persona

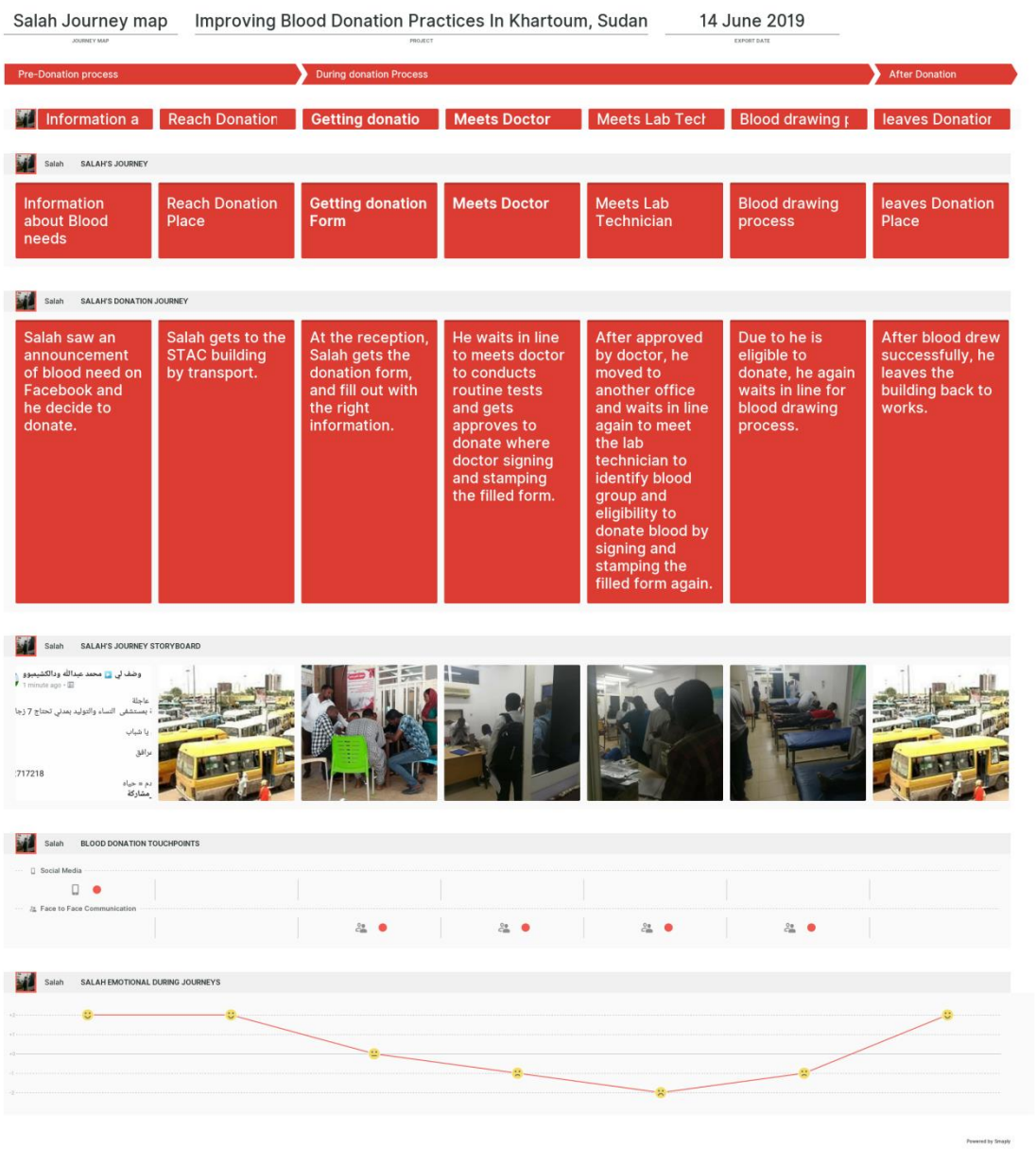


Figure 5.9 Donor Journey Map of the Fifth Persona

As is shown in figure 5.10 below, for the third persona, although the journey seems to very positively at the most periods but he consumed a lot of time in the donation journey and delay from works because due he afraid of needles faced a hard time during drawing blood. And this considers a weak point may turn the donation journey from positive to a negative experience.

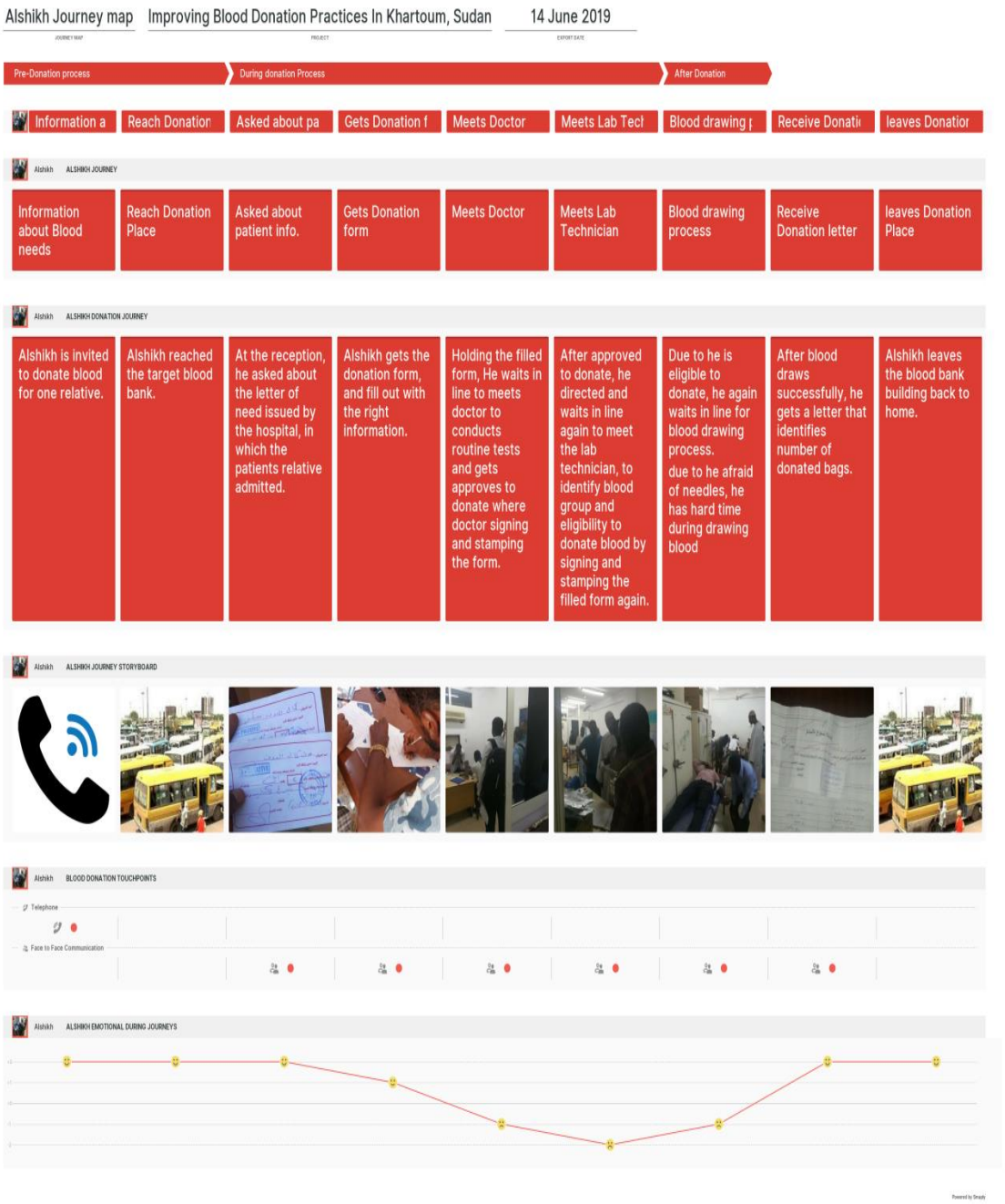


Figure 5.10 Donor Journey Map of the Fifth Persona

Based on the above five donors journey, minimizing waiting time or keep queue order corrects can raise their positive as well as motivate them to repeat the donation. Furthermore, these elements frustrate or reduce donors willing to donate need to be improved by fixing or enhance the weak points in the donor's journey. In the paragraphs below service blueprints are illustrated as a method to improve the current donor's journey map.

5.4 Creating Service Blueprints

Service Blueprint is a diagram or tools that can be used to depicts or get an overall picture of the service including both direct onstage and backstage events (Bitner et al., 2008). Furthermore, blueprinting is a key tool used to design new service from scratch or to redesign an existing service where the target service is depicted in more details of how the service process should be constructed.

In addition, devolving service blueprint must be done with customer collaboration to become an enriching service innovation (Lynn Shostack, 2004). On other hand compared to journey map, service blueprint is considered similar to the customer journey in terms of showing the service path, but in addition to that service blueprint also shows the essential parts of the service that are not visible to customers and it important for running the service smoothly. Blueprint shows how different parts of a service, action, and processes are connected to each other and support the whole course of service (Lell, 2015).

The researcher used these tool for both blueprinting current blood donation service as well as depicting how the donors they see the service in the future.

Analyzing blueprint of the current service lets us identify the weak points or pain points within the service sequence and with customer collaborate we highlight the potential points for improvements as they are seen by donors.

According to (Wirtz *et al.*, 2016), service blueprint consists of five key components that can be used in the process of design or redesign a service, these components can be explained as follow based on our theme or blood donation service:

- **Customer Actions**: all the actions that donors must follow to donate blood.
- **Onstage/Visible Contact Employee Actions**: face to face interaction between the donors and employees of the blood bank.
- **Backstage/Invisible Contact Employee Actions:** all the actions conducted by employees of blood bank but invisible to donors.
- **Support Processes:** all the tangibles that donors are exposed and influence their satisfaction or quality of service.

- **Physical Evidence:** the physical evidence that donors come in contact with is described at the very top of the blueprint.

Based on the analyzed data in previous chapter, personas and donor journey, the researcher along with some donors they created a service blueprint of the current blood donation service based on the generated journey maps above to identify the fail points in the existing service and explore the potential ideas for improvements, as is shown in Figure 5.11.

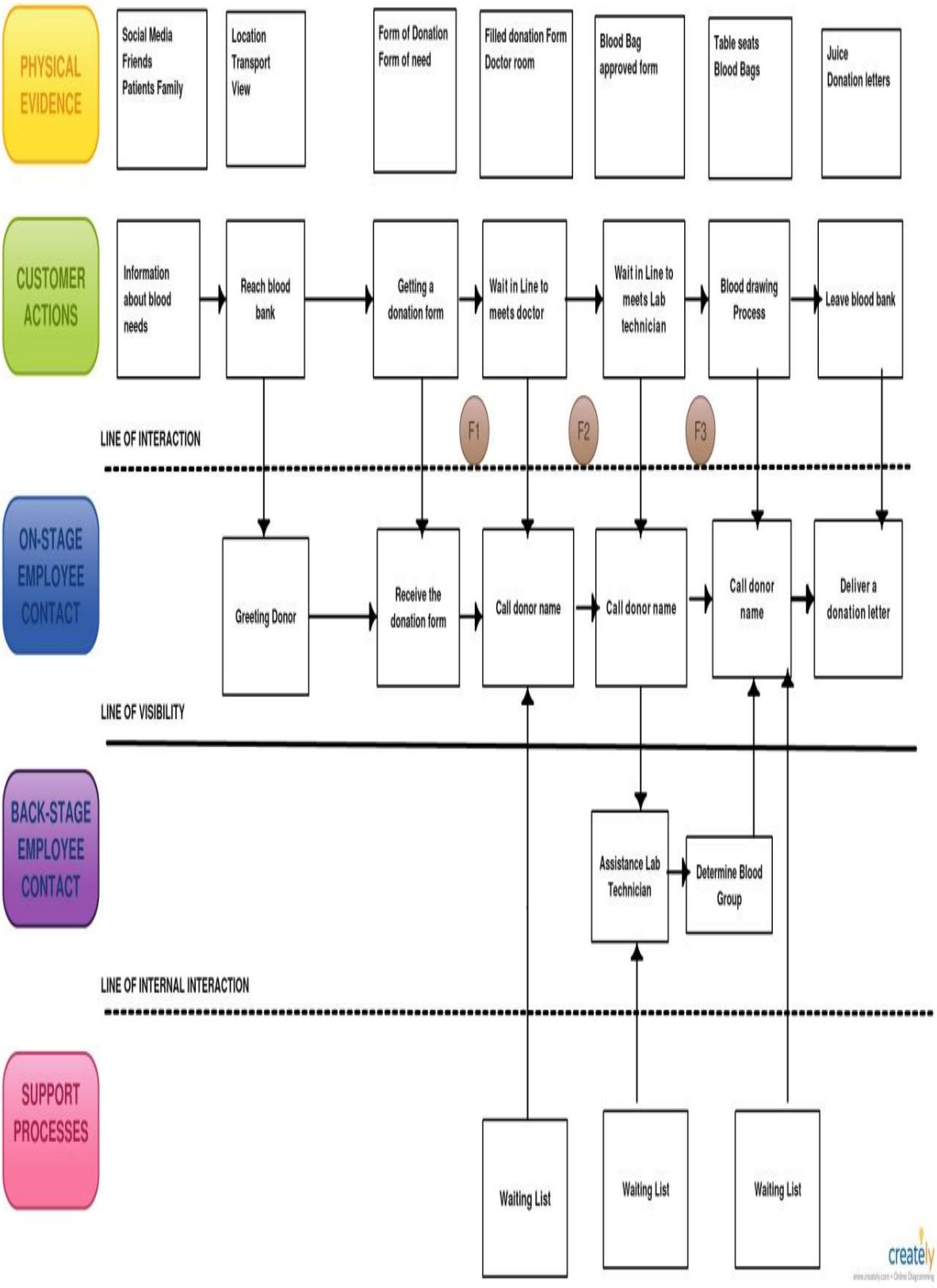


Figure 5.11 Service Blueprint of Current Blood Donation Service

As is shown in Figure 5.11, based on donors journey map and participants viewpoint three main failure points were recognized, F1, F2, and F3 respectively and explained below:

- In relates to F1, after donors get the donation form and fill it out, they are waiting in line to meet the doctor, the queue often gets quite long without enough seats to stand as well as noncompliance with order queues, these elements may cause donors dissatisfaction and make them leave without donation especially for those connected with work or may negatively affect their decision to be regular particularly for voluntary donation.
- In relates to F2, after donors approved from doctor, they moved to another office or a lab and they wait in line again, also these queue often gets quite long (particularly in case of lower workforce with some laboratory tasks) without enough seats for donors stand, and increased waiting time and mistakes in order queue as the result of using manual methods in recording as well as a lot of movements between office without signboard or marks to identify the targets place.
- In relates to F3, the blood drawing rooms have not enough beds or device to start the drawing process for many donors synchronously and require donors to join again to queue and wait for their turns. Moreover, for technical reasons, the blood drawing process may consume a lot of time and that is tightly connected with increasing the waits time for the donors in the queue. Also, waiting time for donating with specific blood components through Apheresis device rather than whole blood, donors have to wait too long. On the other hand, narrow waiting rooms and no room customized to accommodate donors that have a reverse reaction from the donation lead their experience to be negative that truly have negative impacts of future donation. Furthermore, the environments of the donation rooms are lacking from the essential facilities such as water, good ventilation.

In sum, Figure 5.11 above was illustrated the current blood donation service and highlight the main fail points in the existing service that may potentially lead to blood donors and blood banks were unsatisfied with the current service, and these will directly

effect on the rate of donation and willingness to be a regular donor. In addition, the paragraphs below will present the new suggested blood donation service which explains how to mitigate these main fail points.

5.4.1 Possible Solutions to Mitigate or Remove the Fail Points

As illustrated in the previous chapter under the heading implication for design, donors really valued the use of ICT to support the blood donation process. In addition during the interviews, donors are asked to suggest solutions as well as their opinion if the donation practices supported with ICT and made some of the pre-donation process to be conducted over the Internet.

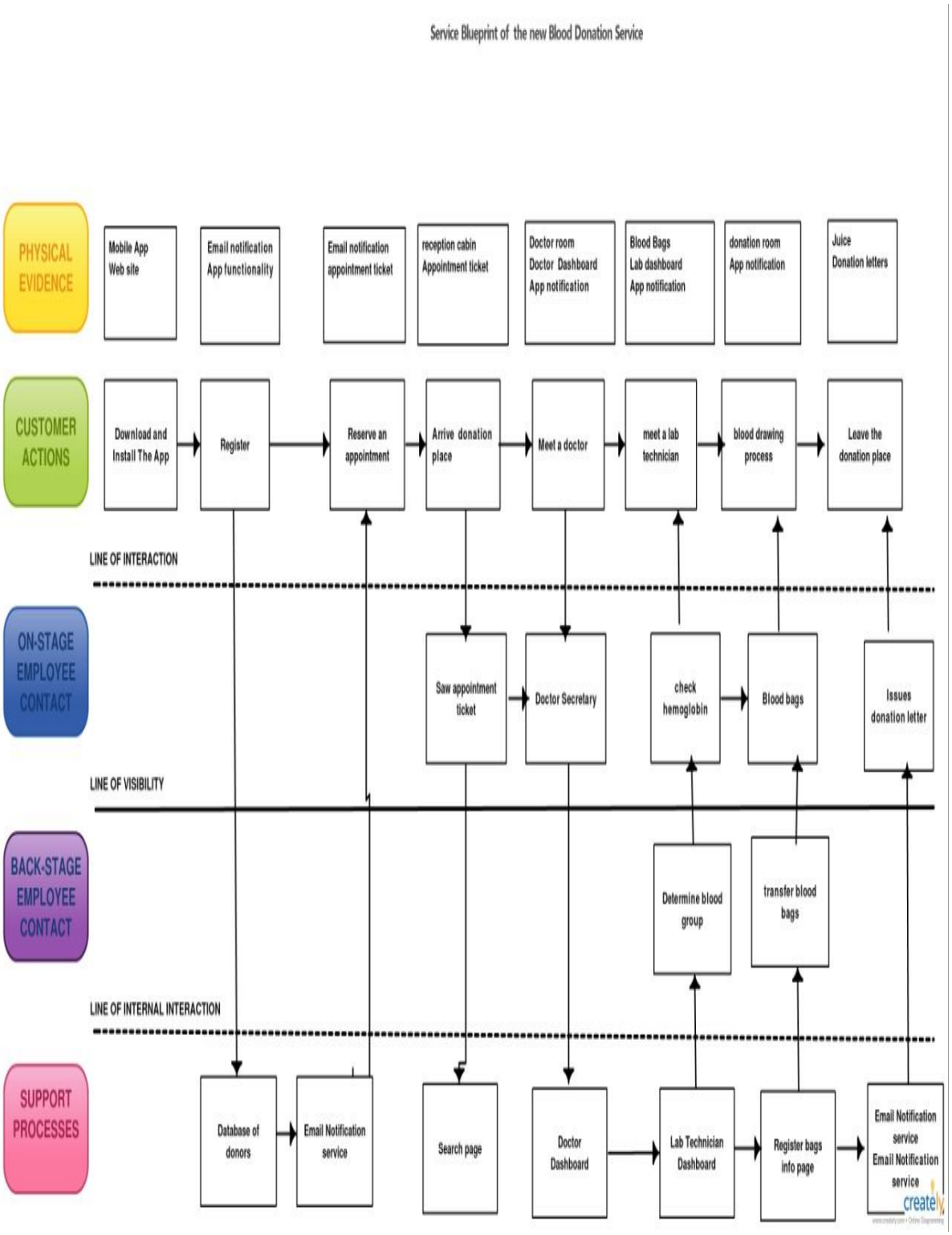


Figure 5.12 Service Blueprint of the New Blood Donation Service

Based on both data of in-depth interview and participants viewpoints, Figure 5.12 shows the new suggested blood donation service and how the above-mentioned fail points may mitigate or reduce the fail points as follow:

- In relates to F1, minimizing wait times and avoiding mistakes in queues are essential to increase donor satisfaction as well as mitigates the elements that make their experience negative. Therefore, setting up a streamlined appointment system may serve the purpose and potentially allow donors to select timeslots in which they are willing to donate as well as the doctor gets initial information about the total number of expected donors of the day. Furthermore, blood banks can adjust the maximum number of reservation based on their hour's work and workforce.

Give higher priority to donors have tickets appointments or serve only those have appointments have a big chance to make the rate of donors leave without donation at the lowest level as well as positively effect on their decision to be regular donors.

- While In relates to F2, keeping the donor's list based on their meet the doctor or arrival as a priority queue to meets a lab technician have greats impacts to kept donor emotional positive. To serve this purpose, only a list of donors that passed the routine test can be displayed to the lab technician to complete the remains test. In addition based on the number of forwarded donors, a lab technician employee can conduct their other tasks. Moreover, donors aren't standing if a feasible number of seats are provided, and donors waiting time is minimized as well as mistakes in the queue are prohibits. On another hand, put all parts of the service close, along with signboard is an important factor to the commitment with appointments slot time.
- In relates to F3, due to fixed beds or Apheresis device of the donation rooms, enough time can be estimated for both whole donation and component donation (Apheresis) and hence this information can be used in adjusting shifts for appointments to keep a balance between donors in progress and donors start drawing blood process because unbalance leads to same problems such as increasing waiting time.

Furthermore, in case of vacations, minimum available beds or maintenance of an Apheresis device, blood bank can position this information in adjusting the maximum number of the reservation and hence donors consume feasible time to complete donation journey, and employees of the blood drawing room can get initial information about the total number of eligible donors that directed to donation.

Finally, to keep donors satisfied, a higher priority can give donors list directed from lab technician also this is a big chance to make the rate of donors leave without donation at the lowest level as well as positively effect on their decision to be regular donors.

In addition, after donors donate and left the donation place the new blood donation service has many users to complete the journey of the drew blood and each of them have a role and need a resource to conducts their duties or task. The users of the new blood donation service can be summarized in the table below.

Table 5. 1 User of the new service roles, resources and their duties.

Actor	Resource	Tasks/ Roles
Doctors	Lists of appointments on his dashboard.	Approved or rejects the donors.
Lab	Lists of approved donors by the doctors on his dashboard.	Checks the hemoglobin level. Drawing blood and ship the bags to derivatives section.
Derivatives	List of blood bags from the lab.	Weight and register the bags info. Extracts blood components and label the blood with the barcode.
Viruses	List of serums passed from derivatives dept.	Register the detected viruses on each serum.
Serology	List of serums passed from derivatives section. List of blood needs requested by the hospitals	Confirm the blood group of the serum. Approving the blood needs.

Cashiers	List of blood components that have serum with negatives viruses' results and confirmed blood group. List of approved blood requests by the serology dept.	Meets the blood needs from available stocks and issues the form of shipment.
Data entry	Document of blood need and donors name or id	Requesting new blood or tracking existing requests. Issuing the donation statements to donors
Donors	Smartphone, Installing the app or using the web browser.	Booking appointments and update them. Show Blood status per banks. Tracking the donation journey during and after donation.

Moreover, the new blood donation service can be integrated with taxi app service to provide free or low cost of transport for donors, and these can be used as incentives provided to donors particularly for those have the willingness to donate but they challenge with costs of reaching the blood banks.

Finally, the blood banks can position the appointment service to customize specifics blood banks and time slots to serve those must donate regularly due to problems their blood and blood banks wasted their blood and any user can be acknowledged the donated blood is invalid such as derivatives section. or viruses department and hence these blood are not available to cashier in meeting the blood needs because the cashier only sees valid blood without viruses. In addition, to support the type of donation that depends on storing blood on the donors body rather than keep them the blood banks to minimize the cost of storing as well as increase the expedite of the blood, the donors can book an appointment to donate as family replacement because in this type the new service linked the donors and beneficiary and in case of blood needed beneficiary can book an appointment to donate for the donor.

5.5 Prototype Implementation and Main Features

The paragraphs below are aimed to describe the prototype of the new service implemented in more details. Firstly, an architecture and block diagram of the new suggested service is explained. Secondly, the most significant features of the prototype explained in more details.

5.5.1 Architecture and Block Diagram of the New Blood Donation Service

The suggested new blood donation service is built around two core components, An Android app and web-based application system as shown in Figure 5.13.

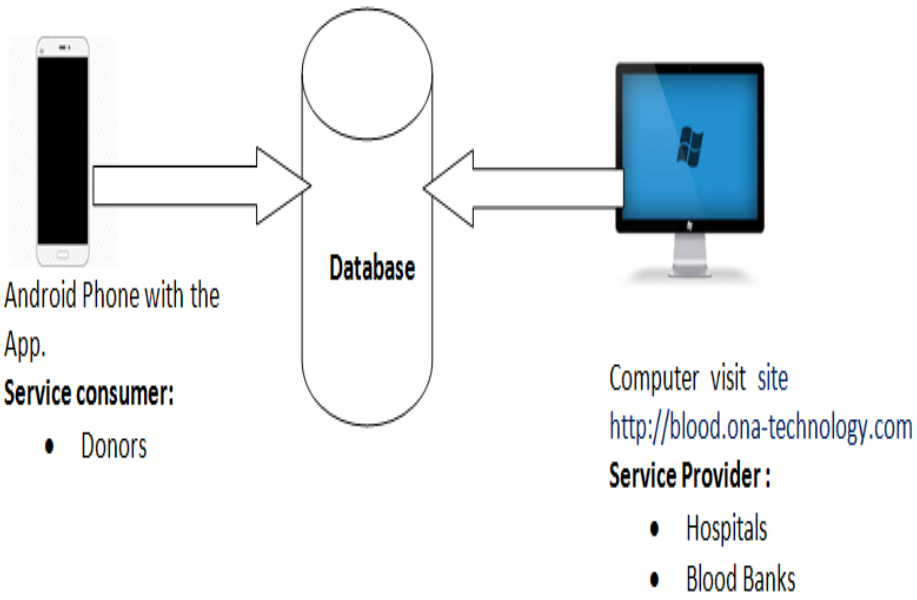


Figure 5.13 Architecture of the New Blood Donation Service

Furthermore, as is shown in Figure 5.13, based on the type of component or users, different functions can be carried. The web-based application system component is aimed to carry out all services or functions of the service provider (blood banks) including duties of data entry, doctors, and employees of the laboratory while donors use the mobile app component to conduct all functions of the service consumer.

Furthermore, based on the blood bank, as is shown in Figure 5.14 below, each one has many users depends on their different jobs, and the creation of these users it is only responsibilities of administrator user as well as adding new hospital or blood bank.

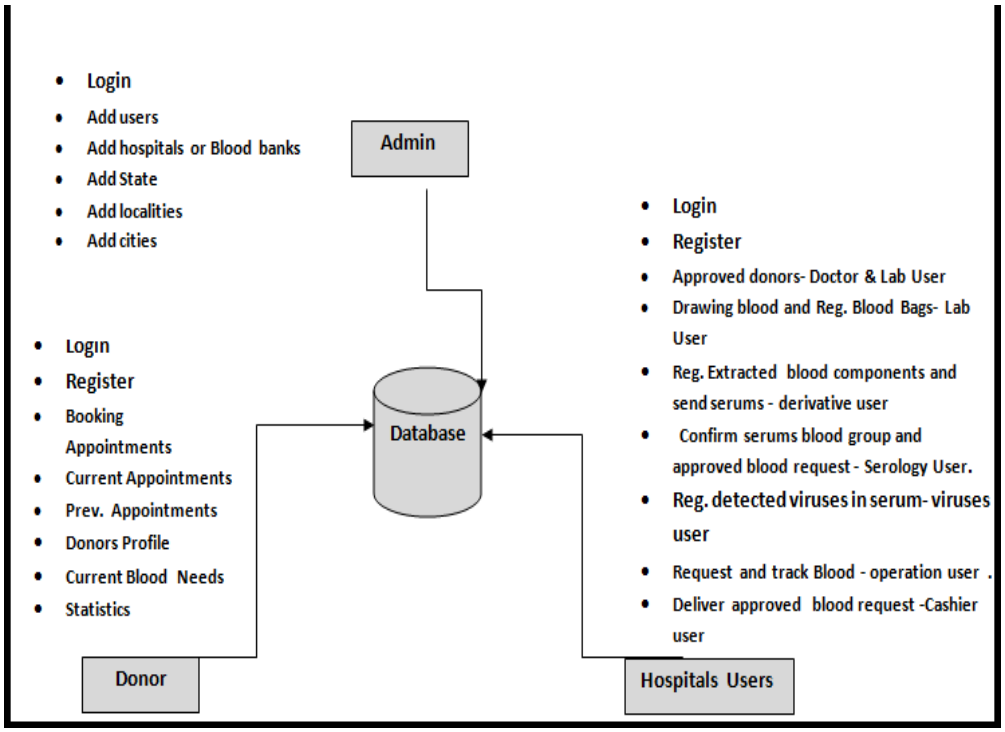


Figure 5.14 Block Diagram of the New Blood Donation Service

5.5.2 Prototype Documentation in Details

The process of documenting the prototype of the newly implemented service to support blood donors' practices and donation process can be described based on the service consumer and service providers as under the heading below.

5.5.2.1 An Android App for Donors- Service Consumer

The donors firstly must download the application or received from friends through any media of transmission, and installing it. After installation is done successfully, app Icon "Blood Donation" appears on the mobile screen as shown in Figure 5.15.

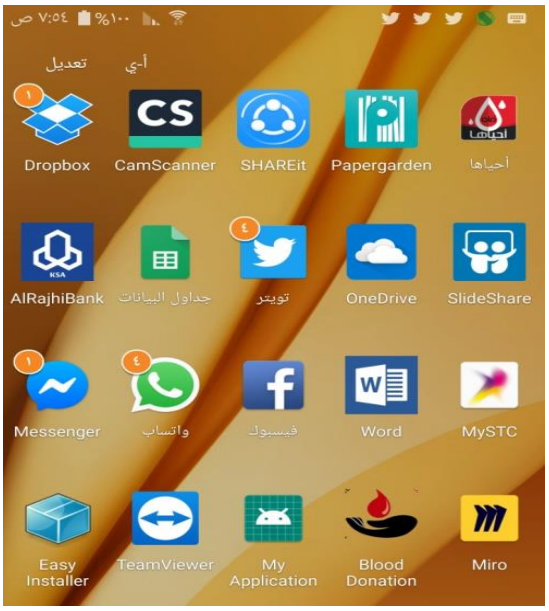


Figure 5.15 App Icon after Installation Successfully

To use the app functionalities or services, once is launched, donors asked to select in which language they are want to consume the service (Arabic or English), and a login screen with two options are provided to donors: Login and Register, As shown in Figure 5.16.

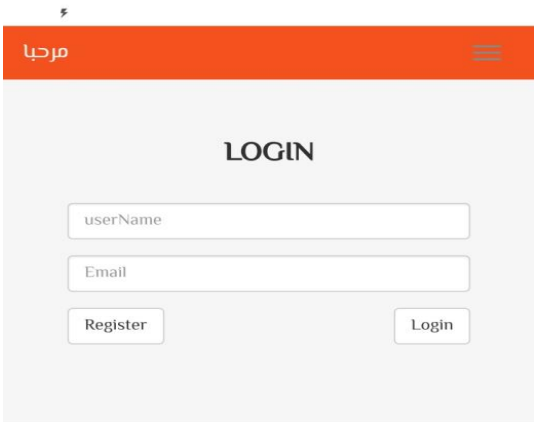


Figure 5.16 The App Login Screen

Furthermore, If the donor has already registered, then the right information is used to login (Email and Password), whilst if donor has not an account must go to register, as is shown in Figure 5.17, and fill the basic information such national id number, name, place, date of birth, blood group,.....etc.

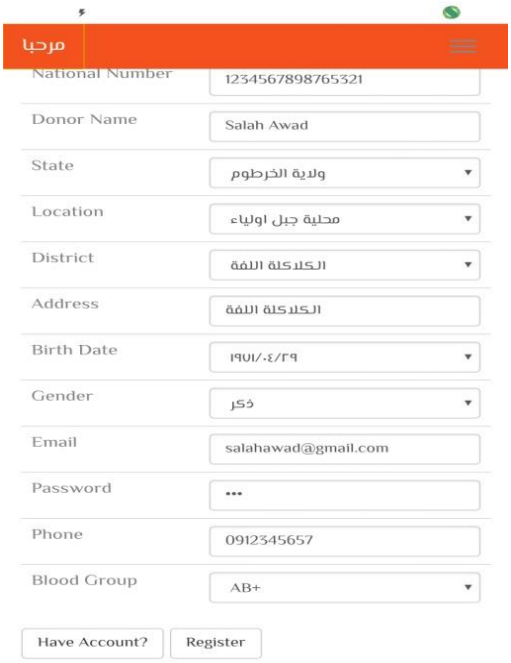


Figure 5.17 The App Registration Screen

In addition, a welcome message sends to the donor email when they register in the app for the first time, as is shown in Figure 5.18.

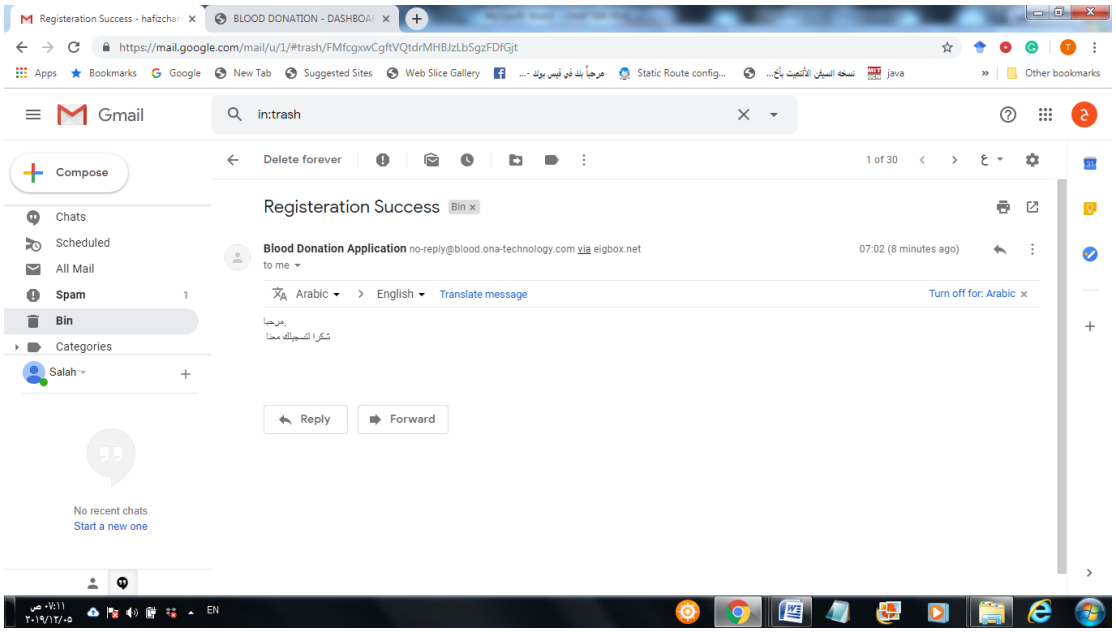


Figure 5.18 A welcome Message Received at the First Time Registration

Once the donor has successfully login, as one incentive to motivate them, the app shows the current blood needs requested by hospitals which are compatible with the donor blood group (as is shown in Figure 5.19), in addition, the app provides the donor with a menu that has the following option, As is shown in Figure 5.20:

- New Appointment, to book an appointment for donating blood.
- Current Appointments, to display the current appointments or update them.
- Previous Appointments, to track the donation journey during and after donation where messages are passed to this panel in case of a transaction made on his journey or blood after drew such as when blood is checked for viruses, blood group confirmed, blood delivered or waiting to deliver and etc.
- Donors Profile, contains information about donation records of the donors such as the total number of donation, the number of successful donation, the number of failed donation, date of last donation and date of the next donation.

- Current Request, to shows the current blood that hospitals needy, and which are compatible with the donor blood group (based on blood compatibility).
- Statistics, to display graphics charts about donation and donors, used as an incentive to motivate donors to donate as well as can be used by blood banks to plans for the future.
- Exit button, to close the app and exit.

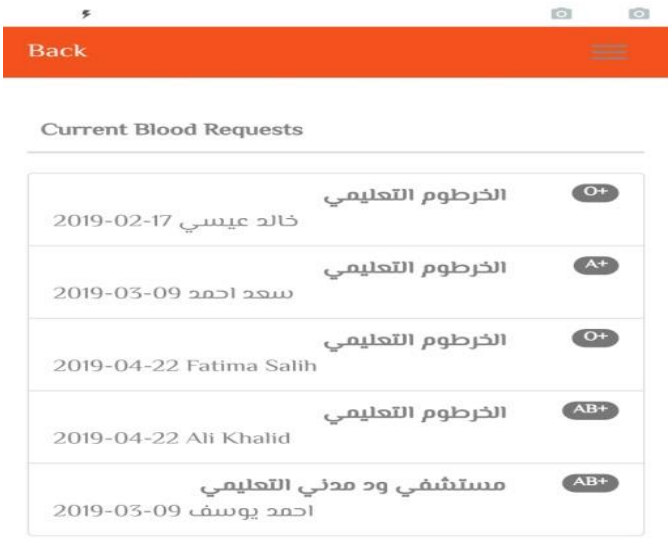


Figure 5.19 List of Current Blood Needs or Request from Hospitals

Figure 5.20 The App Functional Services Menu

The journey of donating blood in the new service start by booking an appointment based on the blood bank, date and time preferred by donors, where they select the "New Appointment" from the menu and filling the information, as is shown in Figure 5.21. In addition, the booked appointment is forwarded to the donor email, as is shown in Figure 5.22. On the other hand, donors can schedule many appointments, and the period between each donation or appointments must be three months.

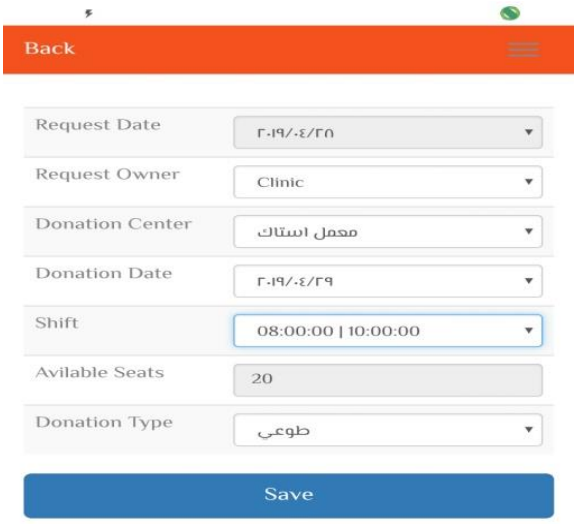


Figure 5.21 Booking New Appointment

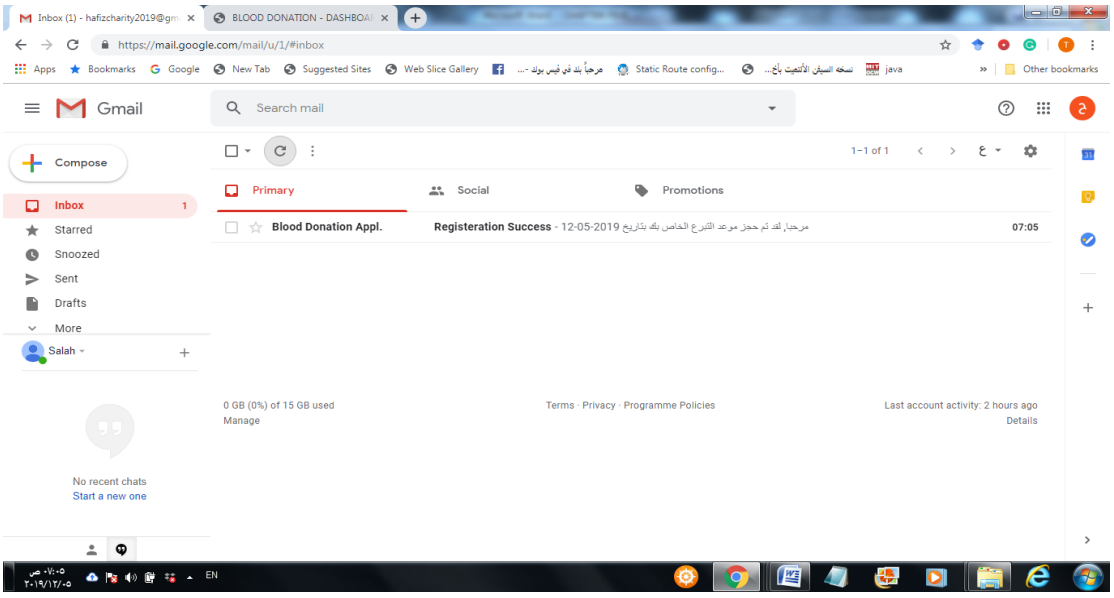


Figure 5.22 Email notification for booked Appointment

After appointments are booked successfully, donors have the ability to update or change them by selecting "Current Appointments" from the menu and update the information and save them, as is shown in Figure 5.23.

Figure 5.23 Update Current Appointments

During a donation journey, donors receive messages represent the decision made on his a conducted donation step such as when they are passed the doctor routine test and forwarded to meets a lab technician, shown in Figure 5.24, "waiting for blood sample drawing". Also, they receive messages when a transaction made on his donated blood such as when the donor blood was delivered as is shown in Figure 5.25, "Your blood delivered on 22-4-2019". All these messages showed on the app under "Previous Appointments" option as well as forwarded to the donor email.

Figure 5.24 Donor Notified for Blood Sample Drawing

Figure 5.25 Donor Notify His blood delivered

On the other hand, donors can view their donation profile by selecting "Donation Profile" from the menu, as is illustrated in Figure 5.26 as well as back again to explore the current blood needs issued by hospitals or blood banks from the "Current Requests" menu option, as is illustrated previously in Figure 5.19.

Figure 5.26 The Donor Donation Profile

Furthermore, as an incentive to motivate donors, the app provides " Statistics" menu option, to show many different graphics charts represent the information about both blood donation and donors, and partial set of these statistics illustrated in the Figures 5.27and Figure 5.28.

Figure 5.27 No. of Appointments and Registered Donors

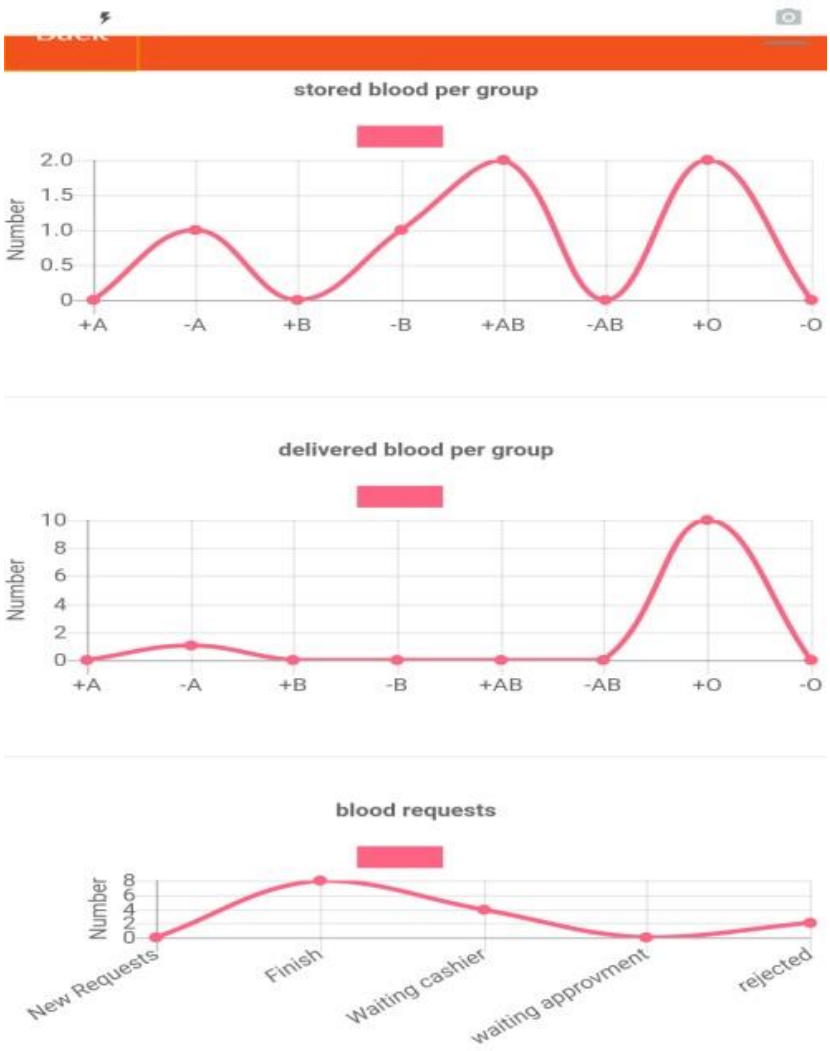


Figure 5.28 Stored, Delivered Blood per Group and Blood Request.

In sum, the mobile app component provides many services or functionalities to support the donor's journey starting from booking appointments to know where their blood now after the donation. In addition, all the features mentioned above can be consumed as a web-based application system from the browser where the donors just login in the system using their email and password and directed to the same app functions as a web page.

5.5.2.2 A web-based Application System for Blood Banks - Service provider

The service provider component is implemented as a web page to support and facilities the different tasks carried in STAC blood bank or hospitals blood bank. As we knew, the blood bank has many departments and different tasks related to blood and donors. In other words, based on the different tasks of the blood bank departments, the new service considers each department has user or users to carry out their tasks and based on the user or department type the system directs them to different pages.

Moreover, each user has permission to only see the information of his relates blood bank or hospital blood bank excepting the serology and cashier department where they have permission to see all blood requests requested by hospitals as well as approving and delivering this requests because to make the process of delivering central as well as allow the nearest blood banks to meets the needs or to minimize the rates of blood out of expiring by using the oldest stocks.

On the other hand, to support the donor's journey and the sequence of the donation process correctly, the task of each user or department depends upon the task of another as in the sequence below:

- Doctors can only process or see the list of donors that have appointment identical to today date.
- The Lab technician user or lab departments only process or see the list of approved donors by the doctor to complete the other test and drawing the blood. That means refused or delayed donors can't be seen by the lab technician as well as those not met the doctors.
- The derivative user or derivation department only process the valid blood bags and list of donors those complete the process of drawing blood successfully to extract blood components, send serums to virus and serology departments and block blood until serums results received.
- The serology and viruses user or departments process the list of serums prepared and sent from the derivative section or derivation department.

- The cashier user or departments only see the extracted blood components that they serums have a negative result from the virus department and blood group confirmed by serology department.

To make the service provider component (A web-based application system) more useful and usable, the new service considers that any blood bank or hospital blood bank has an account to be used in requesting and tracking blood from the reference blood bank (STAC), and many sub-users to support the donation journey starting from donors meet a doctor until to their donated blood delivers.

In other words, based on the roles or duties every blood bank has many users including (data entry, doctors, Lab, serology, derivatives, viruses, and cashier), and the process of creating them is the responsibility of the administrator user.

The different types of users can be explained based on their roles in the blood bank as follow:

1. **Data Entry or Operation User**: Every hospital or blood bank has a data entry user to carry out many functions such as:
    - Registering a new donor in case of donors have not installed the app or they did not own a Smartphone (Particularly in emergency or family replacement donors). The registration page contains the same information of the App registration screen illustrated in Figure 5.17 but as a web page instead of the app screen.
    - Request and track blood from the reference blood bank (STAC), as illustrated in Figure 5.29 and Figure 5.30, respectively.

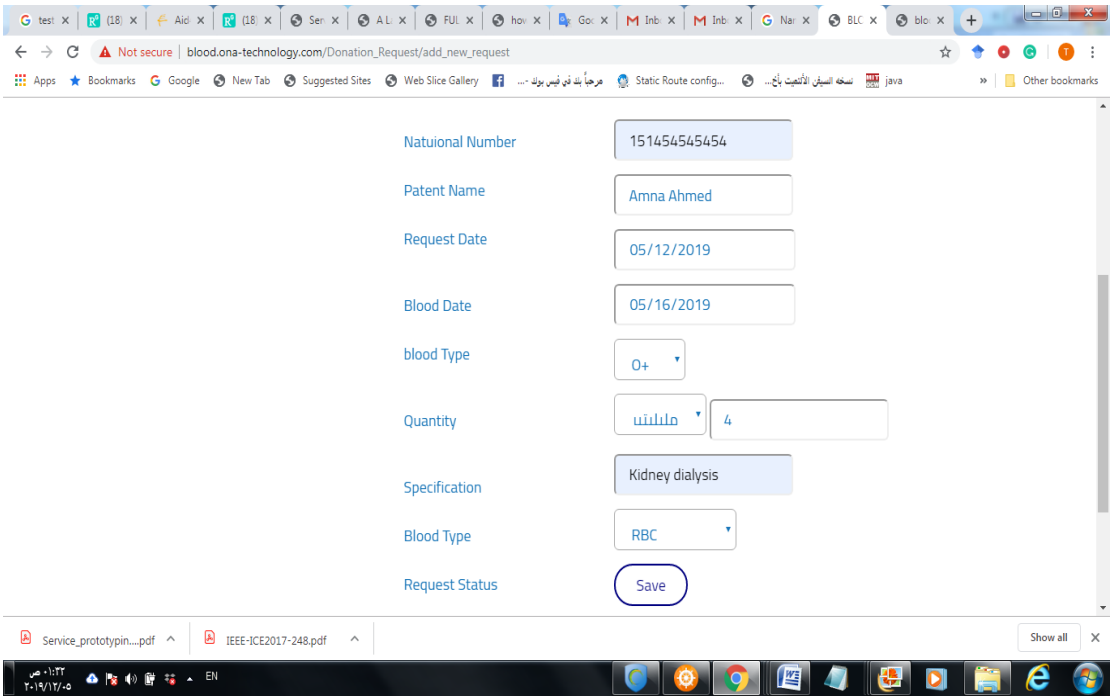


Figure 5.29 Blood Request Form Page- Data Entry User

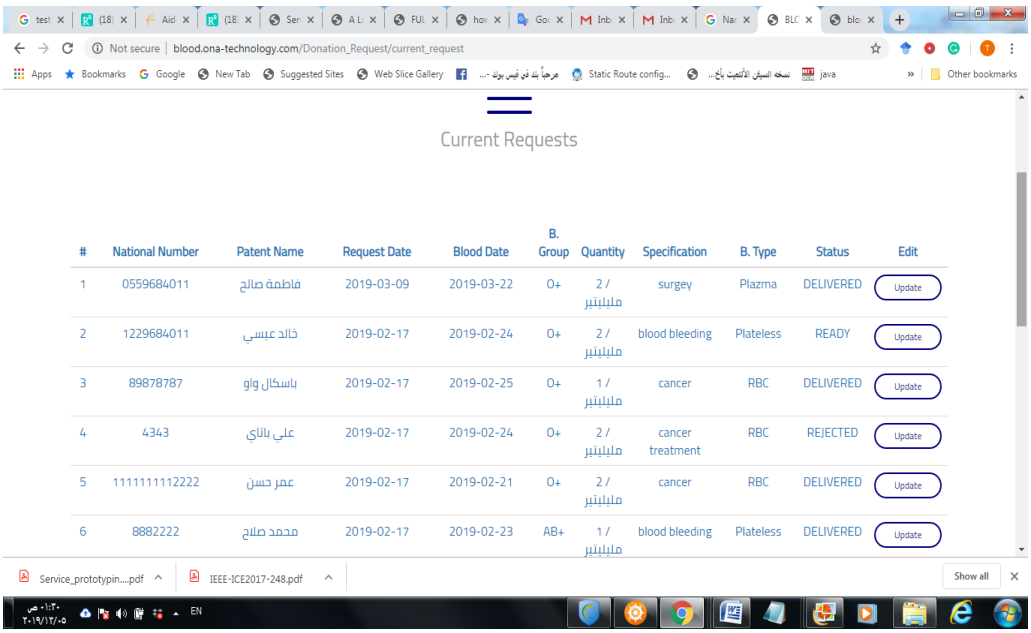


Figure 5.30 Tracking Request Blood Page- Data Entry User

- Issuing a donation statement for the donors to use as physical evidence of donating blood particularly in case of family replacement donation, as is shown in Figure 5.31.

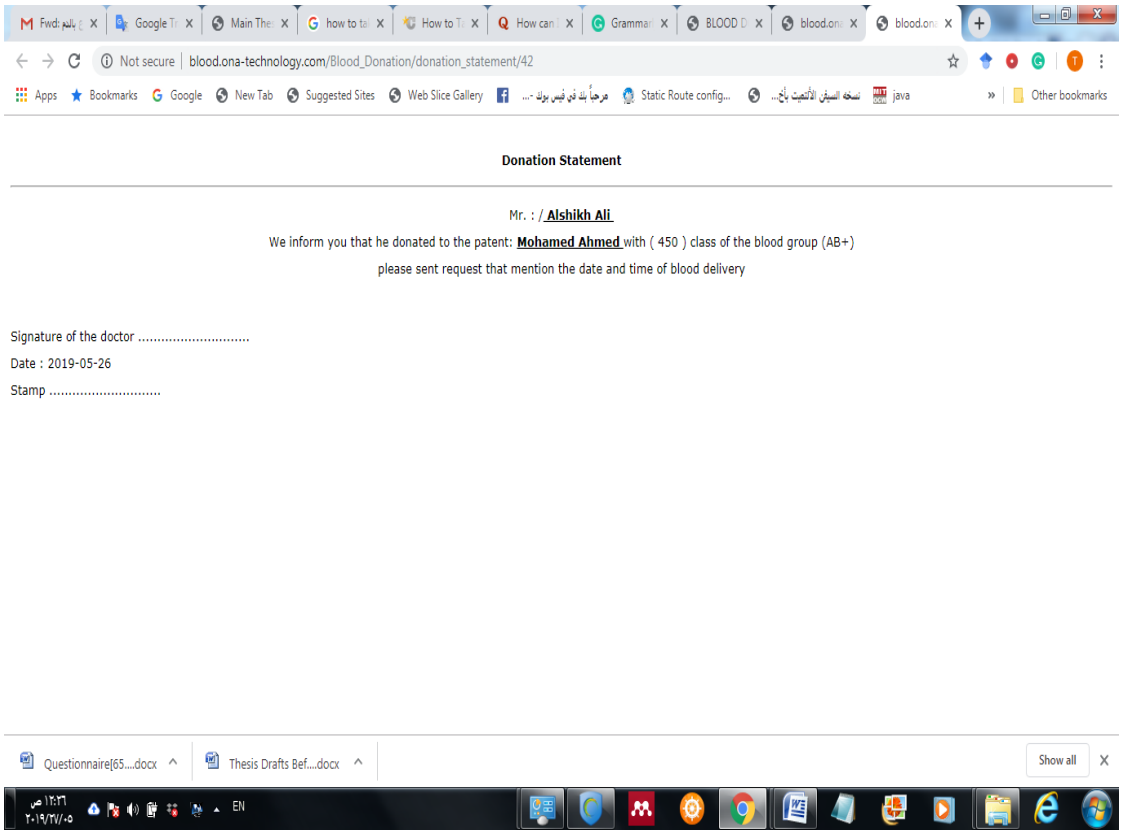


Figure 5.31 Statement of Blood Donation- Data Entry User

- Add shifts (splits working hours into periods or slots) and based on workforce blood banks can customize the total number of donors planned to be accepted in each shift, as is shown in Figure 5.32.

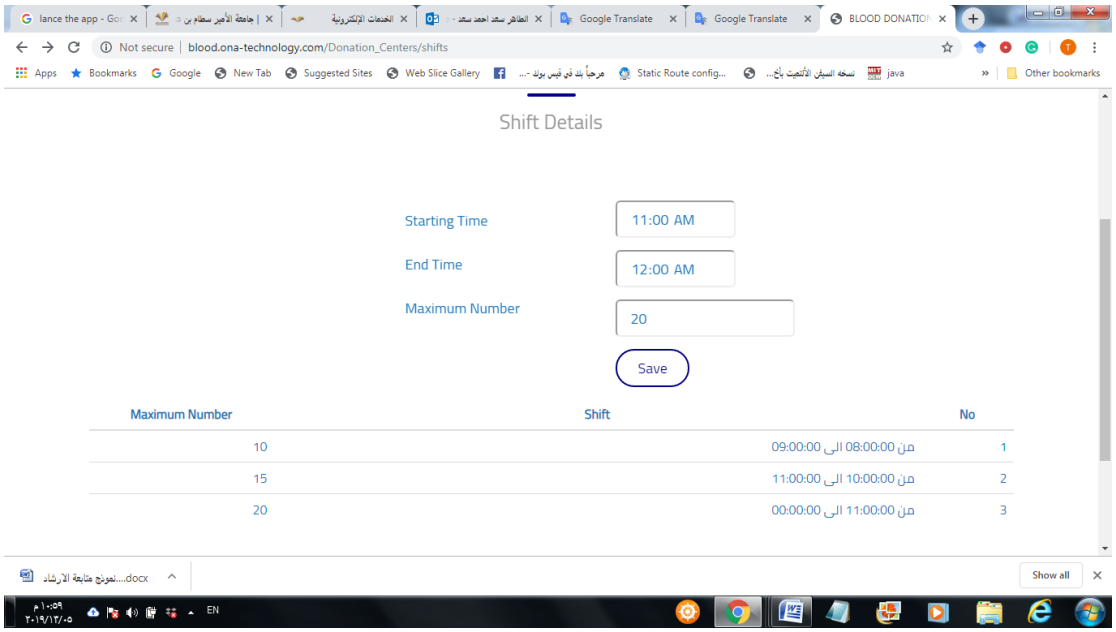


Figure 5.32 Add Shifts Page- Data Entry User

2. **Doctors Users:** Every blood bank or hospital have many users from the types or roles doctor to be used in approving donors before donation, where doctors see only the list of donors that have an appointment today (as is shown in Figure 5.33), and based on the conducted routine tests (such as weight, length, vital signs) donors are approved to donate or rejected or delayed (See Figure 5.34). Furthermore, only the list of approved donors is forwarded to next steps and message about the decision passed to donors through the app to be displayed in the "previous appointments" options menu.

Figure 5.33 List of donors to meets doctors- Doctor Page

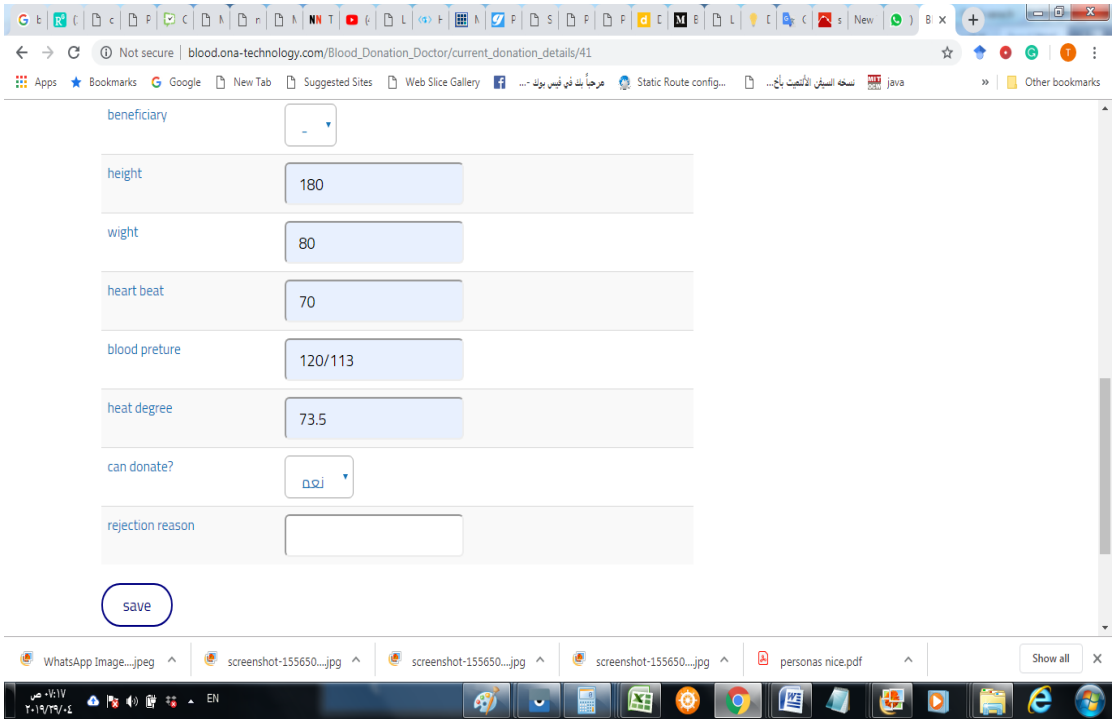


Figure 5.34 Recording Routine Test- Doctor Page

3. **Lab Users:** Every blood bank or hospital blood bank has users from this type to conducts two functions, one is used to completing the process of donors approving only for those the doctor decided they can donate, where other routine tests are conducted and recorded such as hemoglobin level as is shown in Figure 5.35. Second, as is shown in Figure 36, a lab technician then processed the final list of approved donors and start actual blood drawing process, and information about the process is registered such as drawing status(succussed, rejected or delayed), type of drawing (Whole Blood, RBC, Plasma or Platelets) and reason if the process is rejected or delayed, After that drew blood bags label with donor national number and moved to derivatives section, and here the donors journey is ends and they leave the donation place.

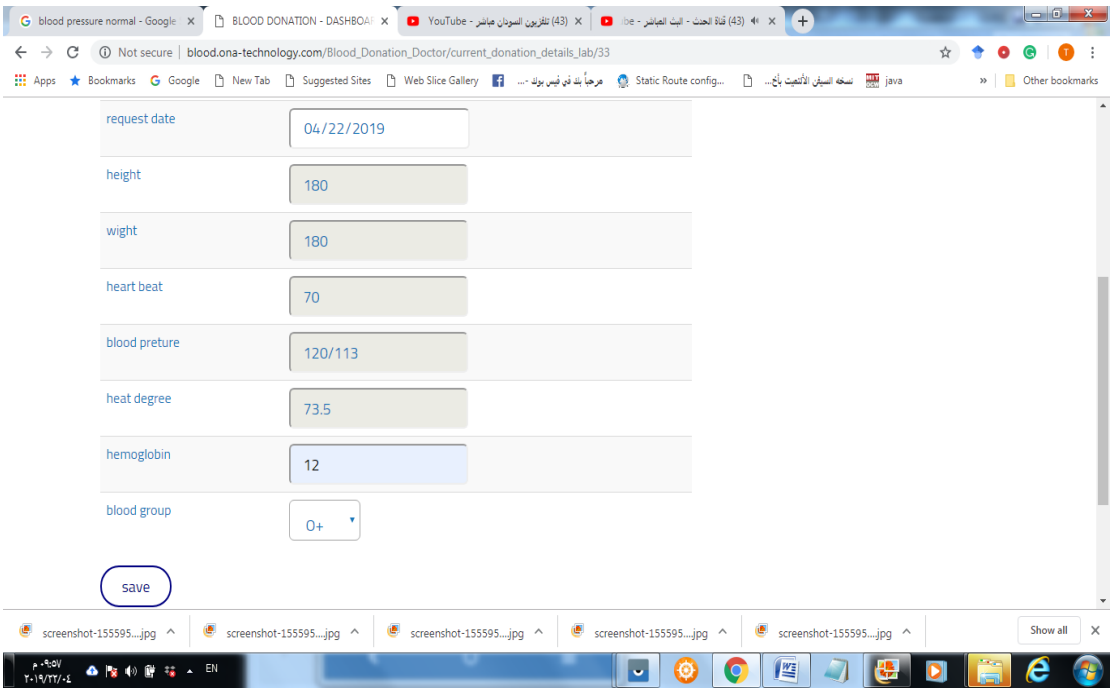


Figure 5.35 Recording Donor Hemoglobin Level- Lab Page

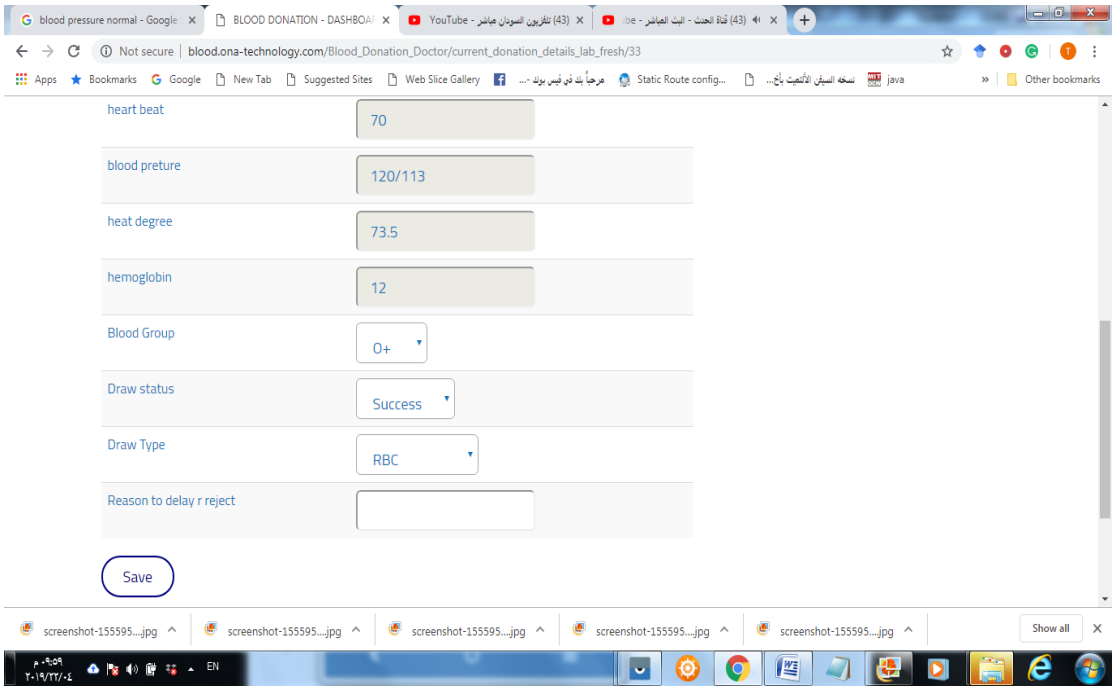


Figure 5.36 Recording the Drawing Process - Lab Page

4. **Derivatives Department Users**: Every blood bank or hospital blood bank has user or users from derivative type, this user is responsible for processing the blood bags forwarded from the donation department(Lab user), and has two functions, the one is weighing the blood bags or components, and then register the information of blood bags such as weight and status of the blood bags(Suitable for extraction or not) as well as determines if the serums are prepared and sent to serology and virus departments, as is shown in Figure 5.37. The second is extracts specifics blood components from blood bags and register the information of components such as type of derivative, the new size, date of expertise and generate barcodes to label them as a final blood components (as is shown in Figure 5.38 and Figure 5.39), and block them from use or delivery until the serum results are received from both serology and viruses department, and if it's positive then blood components are moved to the delivery section whilst in case of negative result blood components are burned or damaged. These components are actual blood to deliver to hospitals in needs.

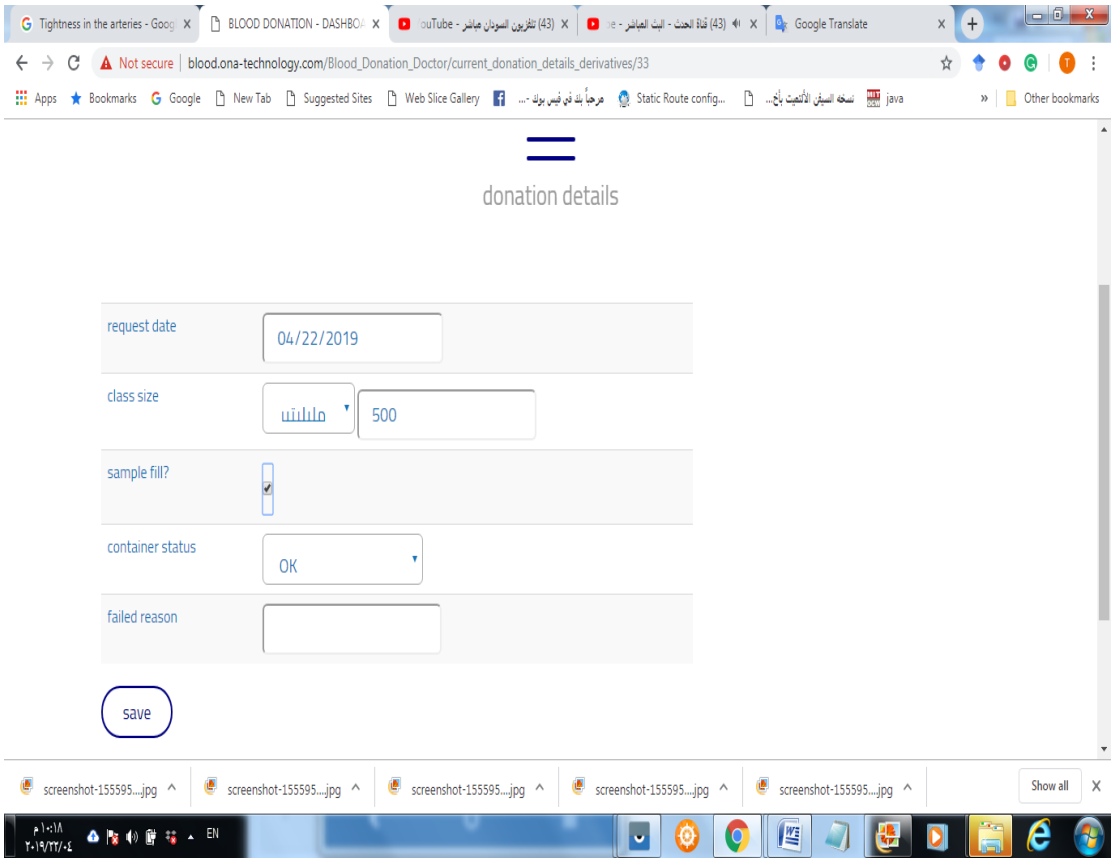


Figure 5.37 Recording Blood Bags - Lab Page

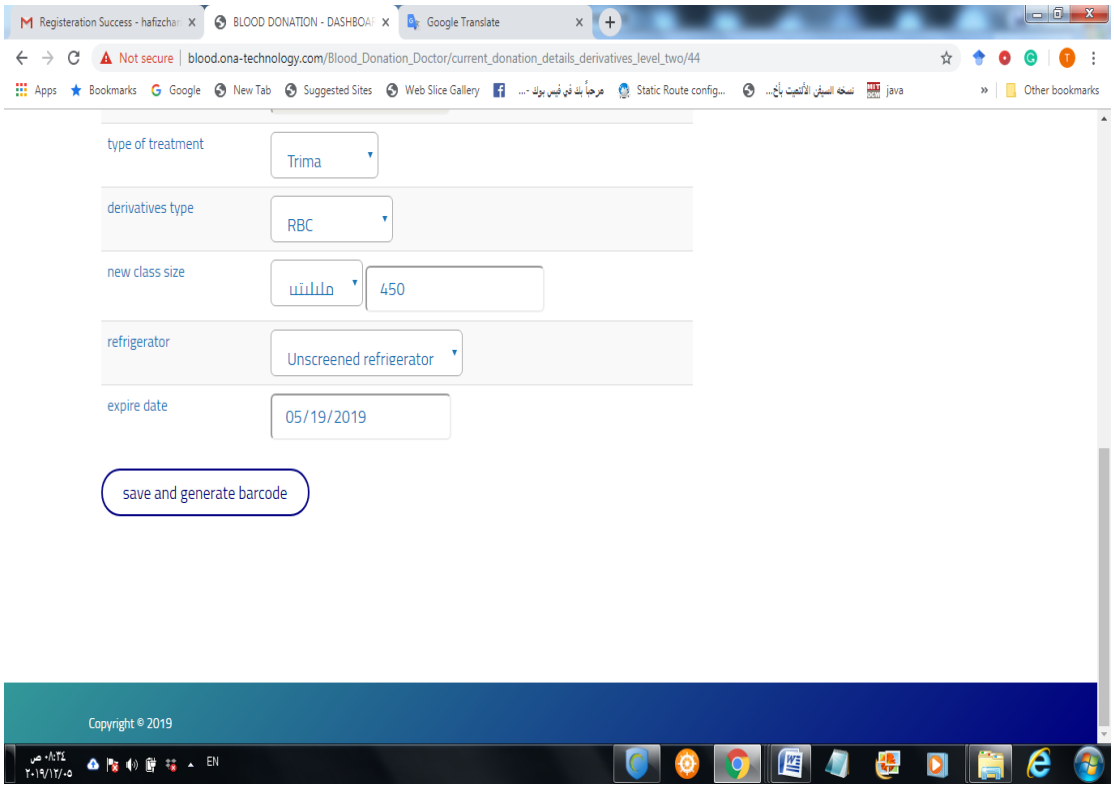


Figure 5.38 Recording Blood and Generate Barcode- Derivative Page

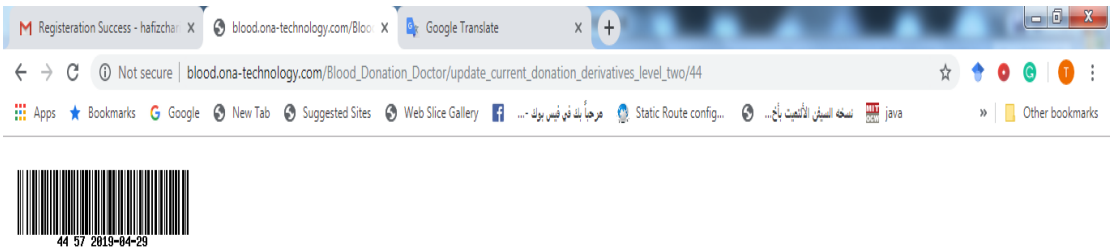


Figure 5.39 A Generated Barcode - Derivative Page

5. **Serology Department Users:** This department or users has two functions, the one is responsible for confirming blood group of each serum received as is shown in Figure 5.40, and the second is to processed the blood request made by the hospitals where the requests can be approved or rejected or delayed, as is shown in Figure 5.41. All the approved requests are directly moved to be processed by delivery section while the delayed requests remain in this section until it been approved or rejected.

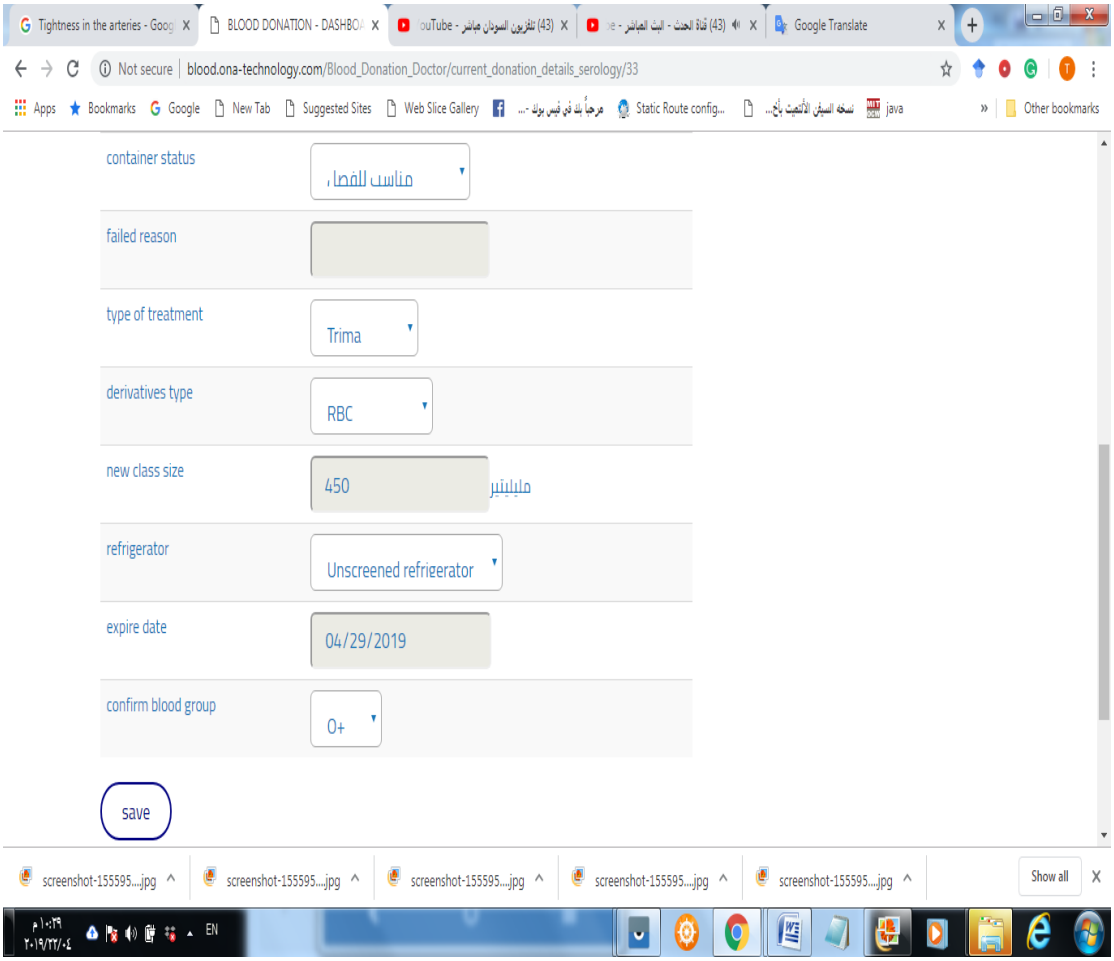


Figure 5.40 Confirm Blood Group- Serology Page

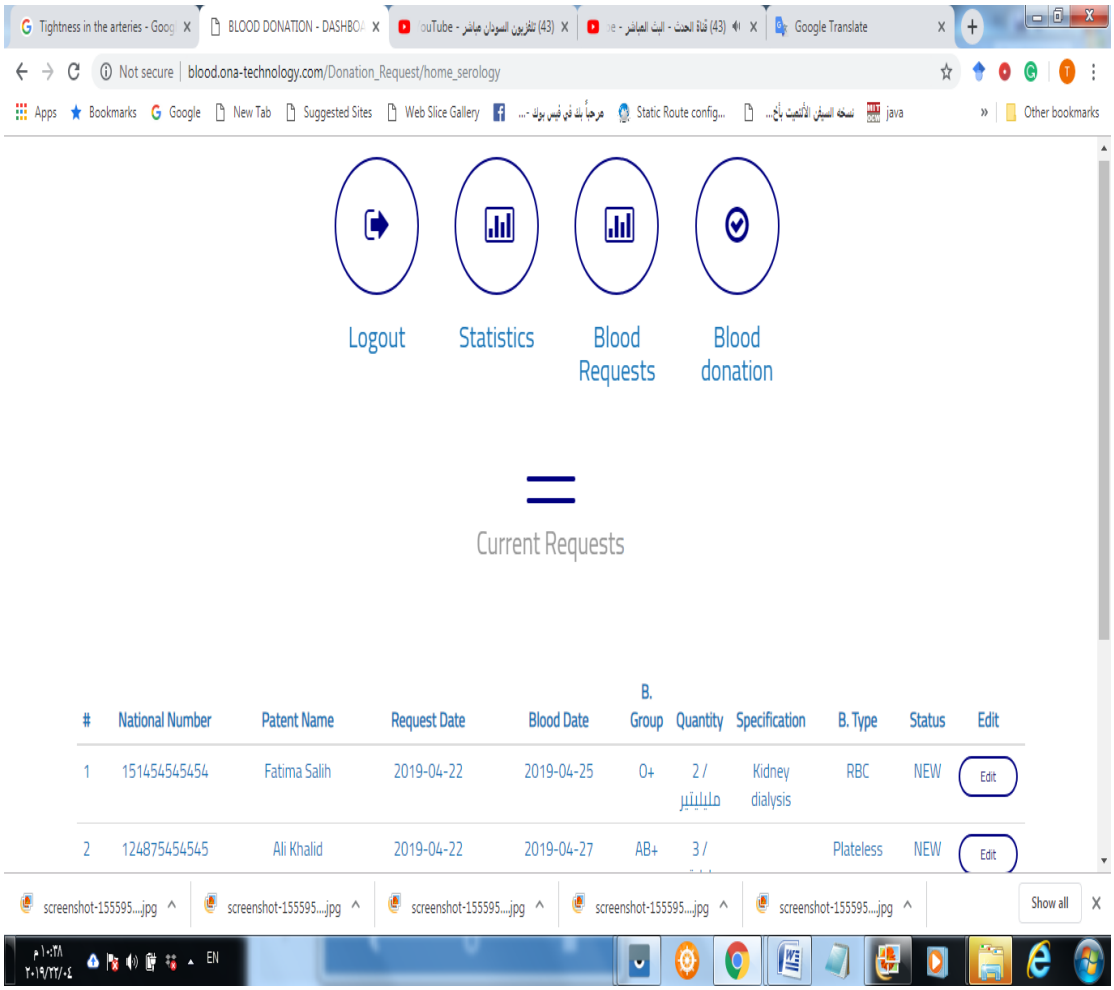


Figure 5.41 Process Blood Requests- Serology Page

6. **Viruses Department Users**: This user or department is responsible from processed the list of serums and identify the viruses that are detected in serums or notify there are no viruses, as is shown in Figure 5.42.

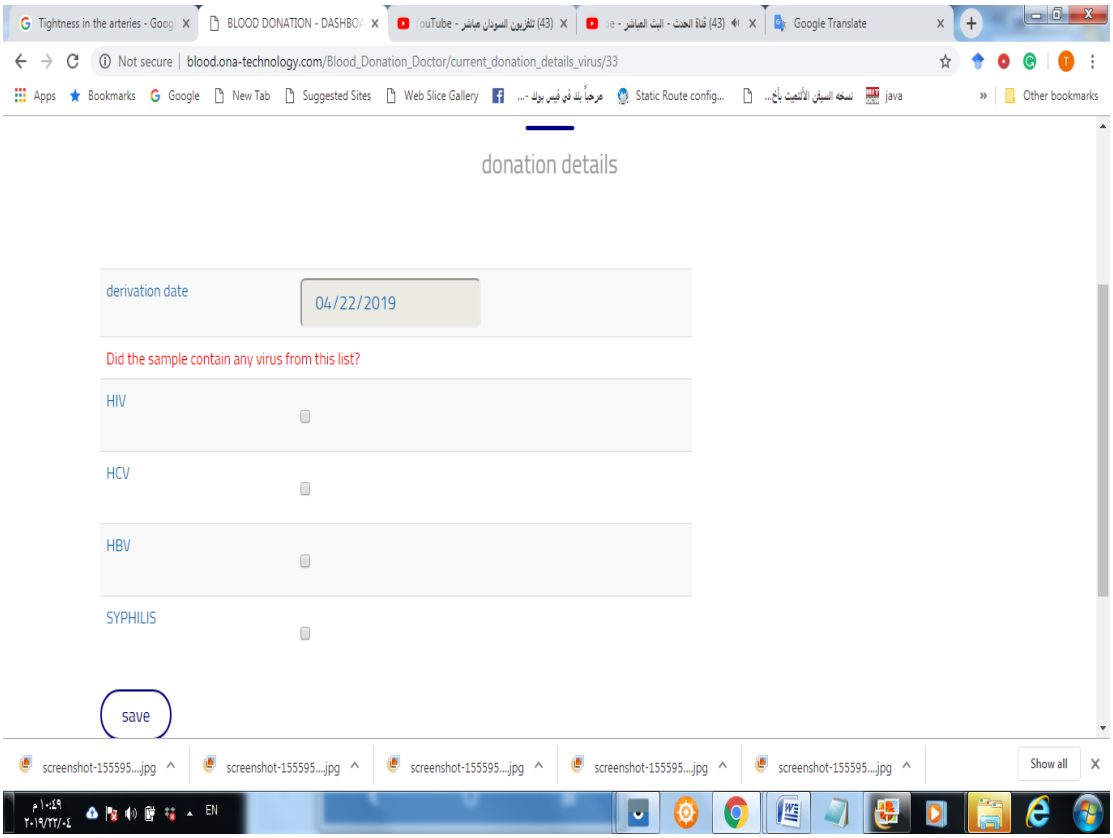


Figure 5.42 Recording Viruses Detected in Serums- Viruses Page

7. **Cashier** Department **Users:** This department or user is responsible for processing the list of approved blood requests from serology and use the available blood stocks to delivers or meet them, as is shown in Figure 5.43, and to facilitate the process and avoid mistakes based on both type of requested components and blood compatibility, the system ordered blood components matched the request according to their expiry date(as is shown in Figure 5.44), and a cashier can choose from them based on the requested quantity to meets the needs and issuing the form of a report contains information about the request and blood components used in meeting the need (See Appendix C).

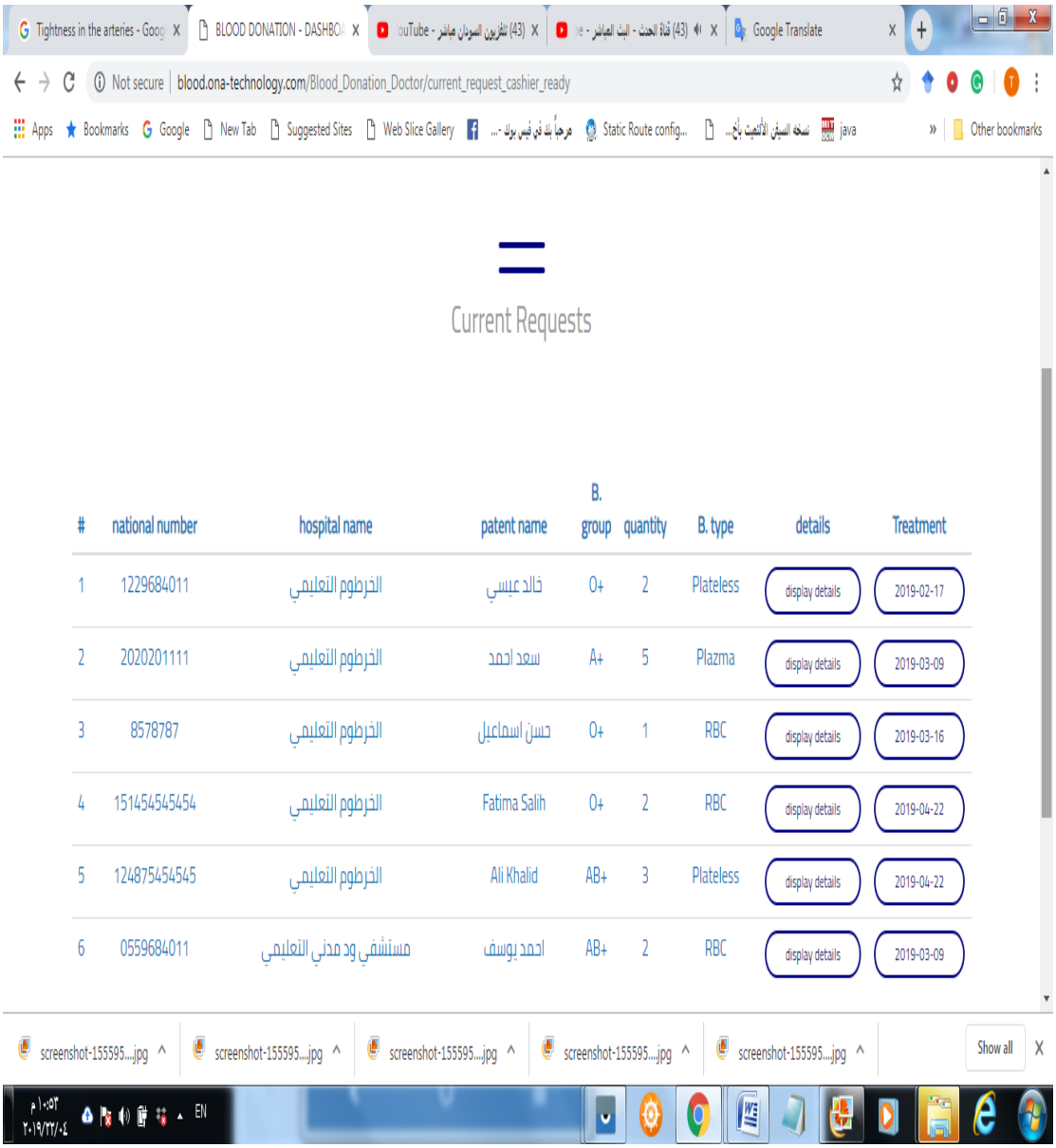


Figure 5.43 List of Approved Requests - Cashier Page

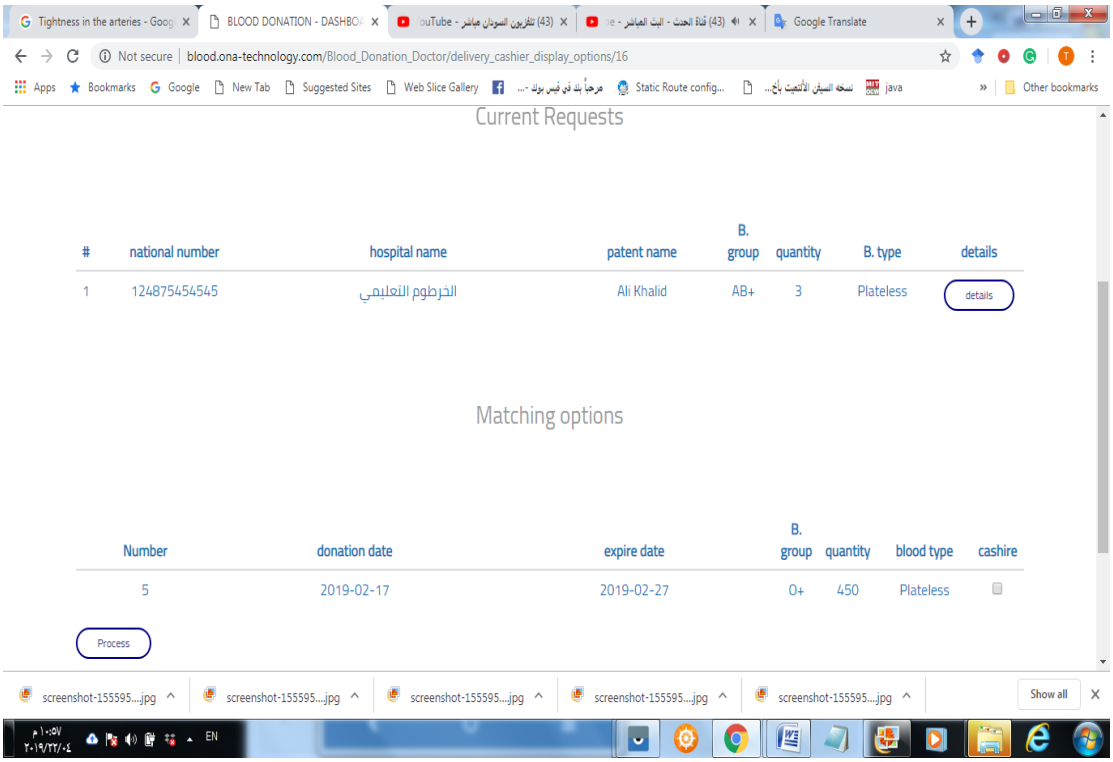


Figure 5.44 Deliver a Blood Request - Cashier Page

Furthermore, besides the functions or service to support the different department tasks, every user or department dashboard contains many statistics about the donation process and donors, for instance, Figure 5.45 shows one of the statistical information relating to doctor dashboard which is the rate of donation between voluntary and family replacement donor whilst Figure 5.46 shows one of the statistics information relates to virus department or user dashboard which is the rate of blood sample or serums with and without viruses.

In addition, the statistical information related to blood requested by the hospitals can be used in developing and forecasting model to forecast the amount of the blood that hospitals may need in the future, in a simple way the blood banks can consider the higher hospitals requested blood as a base for the forecasting model.

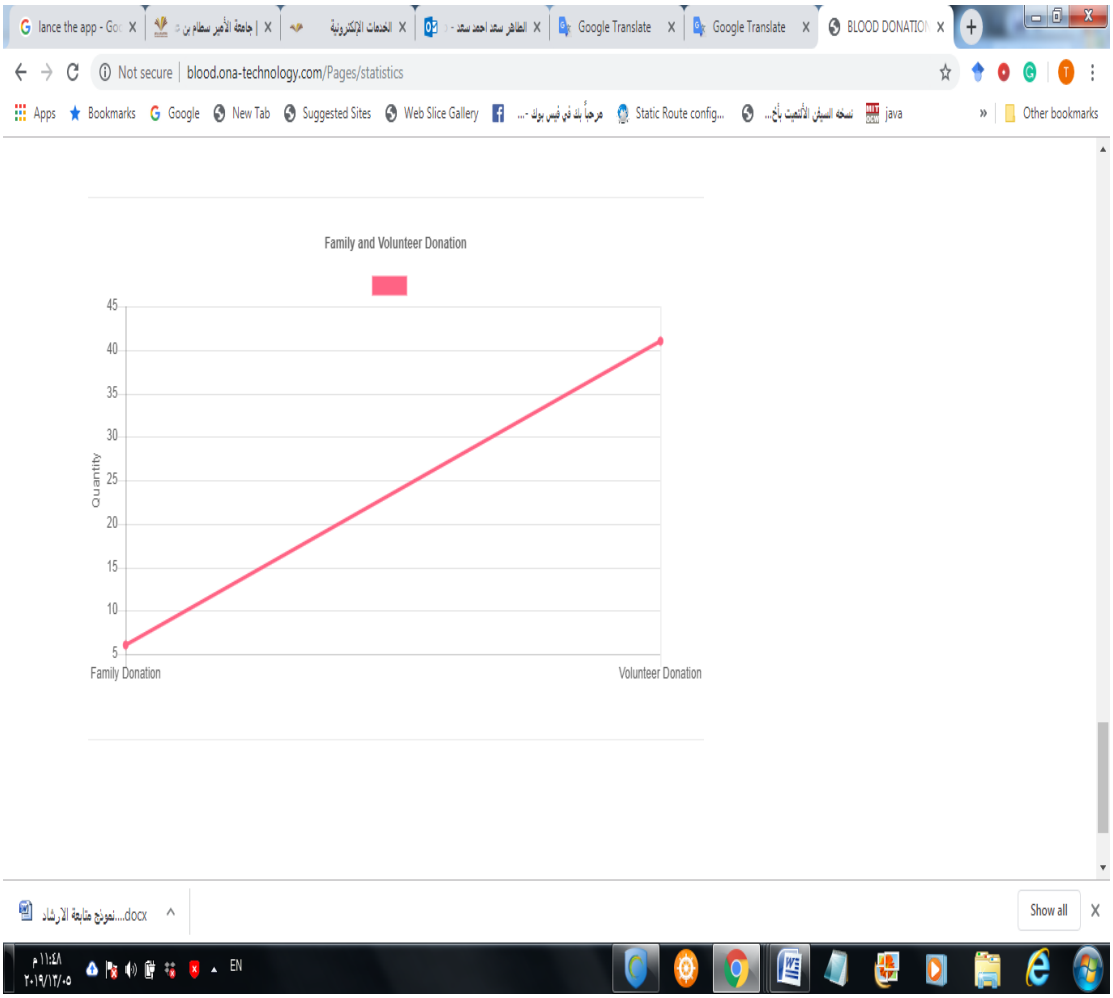


Figure 5.45 Rate of Voluntary and Family Replacement –Doctor Page

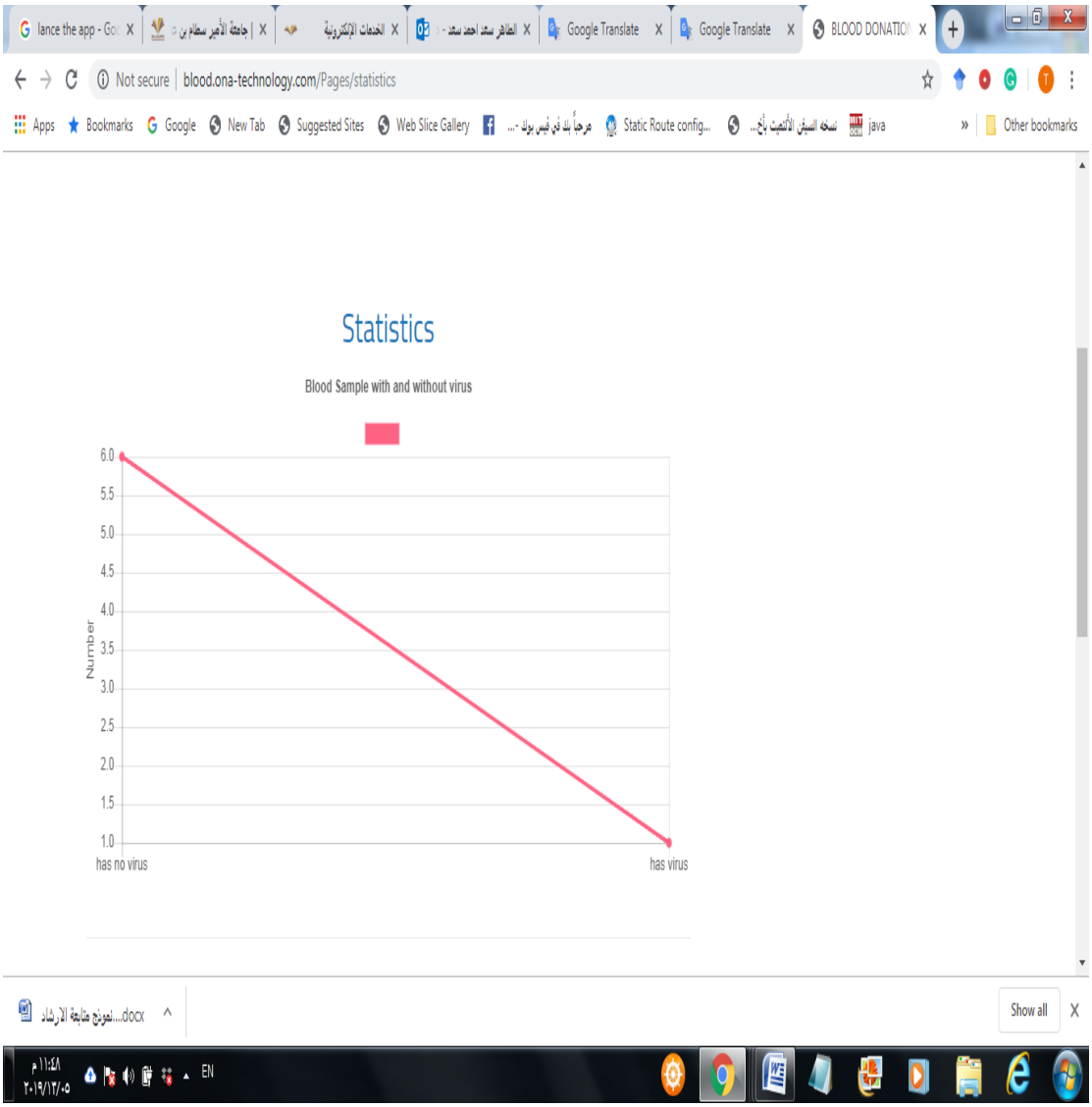


Figure 5.46 The Rate of Blood Serums with and without Viruses.

In conclude, the prototype of the implemented new blood donation service is documented and illustrated which has consisted of two components: a web-based application component and android app component, and they are aimed to mitigate the limitations of the current practices of blood donation in blood banks of Khartoum-Sudan as is designed and proposed in the previous chapter, and the prototype can be customized for all Sudanese blood bank or hospital blood bank. Using a web-based components, the hospitals or blood banks can carried out their various duties in a manner that will increase motivation or reduce frustrations between donors and employees of blood banks whilst the app component allow donors to avoid the problems of long waiting time, select they preferred slots time to donate and tracking the journey of donation as well as levels of blood stocks in the bank.

CHAPTER SIX RESULTS AND DISCUSSIONS

6.1 Introduction

This chapter presents trails or experimental study that aims to firstly validate the effectiveness of the implemented prototype on mitigating, supporting and improving current practices of blood donation and donor in Khartoum, Sudan blood banks from perspectives of service providers (blood banks) and service consumer (donors), and to do that the researcher explained the use and purpose of the prototype for the stakeholders firstly and after the actual and trials use or test, the participants are asked to fill out a designed questionnaire that aims to measure the satisfaction among the prototype that suggested as a new blood donation service in order to mitigate, support and improve the current practices of blood donation as well as motivating an individual to be a blood donor or become a regular donor.

In addition to the questionnaire, participants are invited to comments on the prototype or suggest a modification. The filled questionnaires are statistically analyzed to test and validate the satisfaction among the prototype using the SPSS package as well as comments or suggestion on the prototype was obtained from the interview data.

Secondly, this chapter presents the discussion of the obtained results from the experiments study and comparing them with the situation before the solution applied which was illustrated in Chapter 4.

In sum, to evaluate our work we used the questionnaire as methods to checks the satisfaction upon the prototype as well as using an interview to obtains comments or suggestion on the prototype because many years required to obtain accurate results.

6.2 Study Tools

Due to gets accurate results requires years and years, based on the potential benefits and the research questions of the study, a questionnaire was developed to measure the service consumers (donors) and service providers (blood banks) satisfaction among the prototype of the new blood donation service supported through ICT, where the service providers viewpoints were included employees, doctors and laboratory technicians with their different tasks related to blood donation process.

6.3 Study Population

Although, the original population of the study was consists the Khartoum, Sudan blood banks as well as the blood donors, our study sample in total consist 40 participants, where 15 participants as a service providers or blood banks stakeholders from STAC laboratory, blood bank of Khartoum Teaching Hospital and blood bank of Ahmed Gasim Teaching Hospital, and 25 participants as a service consumers including 20 participants as a blood donor and 5 participants from private hospitals (Royal Care hospital and Asia hospital).

The service provider or stakeholders participants sample were included employees of the reception at blood banks, doctors, a lab technician with their different duties such as blood drawing department, viruses department, serologists department, and derivatives department while the participants from private hospitals included nurses, doctors, and blood bank lab technicians.

The researcher prepared the questionnaire in two languages (English and Arabic) and the participants especially the donors are free to select from them.

6.4 The Results

The results of the measured satisfaction upon the prototype were showed below and these results will be discussed with the current practices in the discussion section.

Table 6. 1 The Respondents of Question One.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	6	15.0	15.0	15.0
	Agree	14	35.0	35.0	50.0
	Strongly agree	20	50.0	50.0	100.0
	Total	40	100.0	100.0	

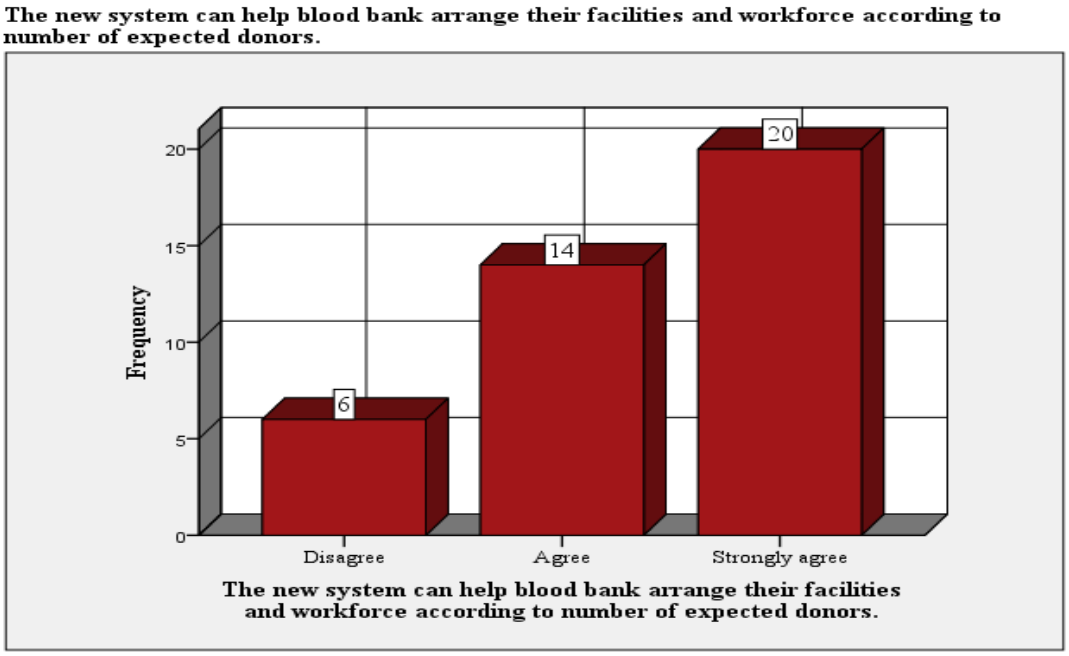


Figure 6. 1 The Result of Question 1.

Table 6. 2 The Respondents of Question Tow.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	7.5	7.5	7.5
	Disagree	1	2.5	2.5	10.0
	Agree	20	50.0	50.0	60.0
	Strongly agree	16	40.0	40.0	100.0
	Total	40	100.0	100.0	

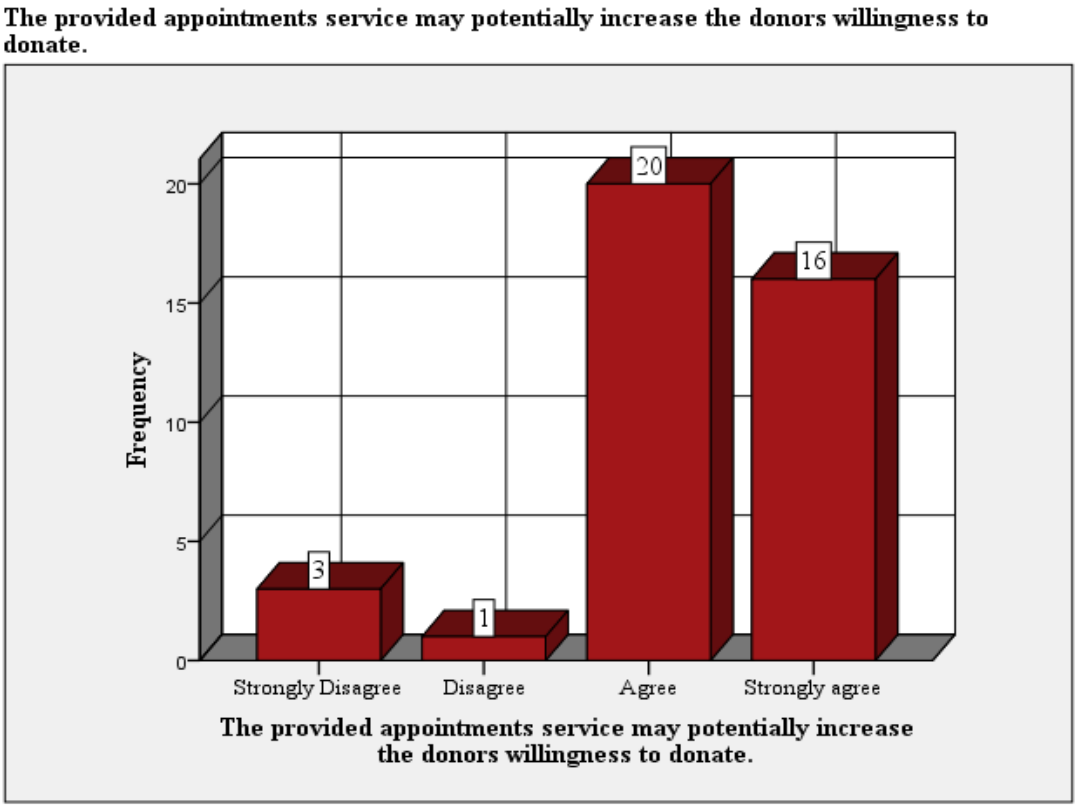


Figure 6. 2 The Result of Question 2.

Table 6. 3 The Respondents of Question Three

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	2.5	2.5	2.5
	Disagree	1	2.5	2.5	5.0
	Uncertain	4	10.0	10.0	15.0
	Agree	24	60.0	60.0	75.0
	Strongly agree	10	25.0	25.0	100.0
	Total	40	100.0	100.0	

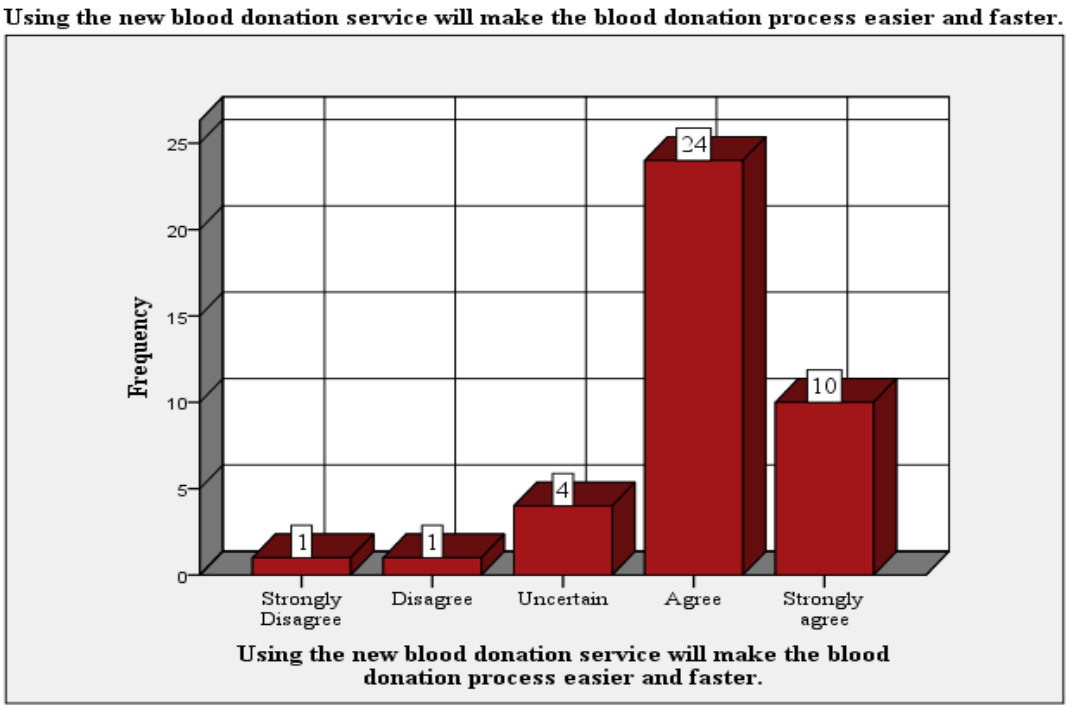


Figure 6. 3 The Result of Question 3.

Table 6. 4 The Respondents of Question Four.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	2.5	2.5	2.5
	Disagree	3	7.5	7.5	10.0
	Uncertain	2	5.0	5.0	15.0
	Agree	12	30.0	30.0	45.0
	Strongly agree	22	55.0	55.0	100.0
	Total	40	100.0	100.0	

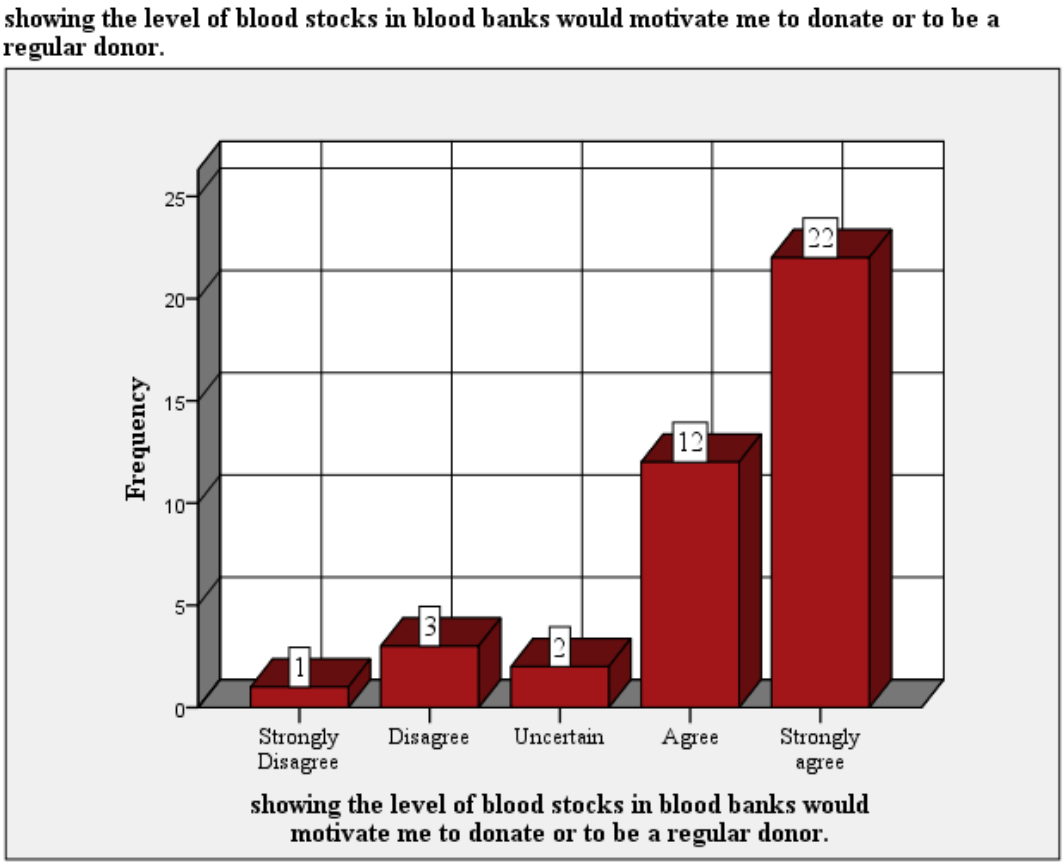


Figure 6. 4 The Result of Question 4.

Table 6. 5 The Respondents of Question Five

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	5.0	5.0	5.0
	Uncertain	4	10.0	10.0	15.0
	Agree	24	60.0	60.0	75.0
	Strongly agree	10	25.0	25.0	100.0
	Total	40	100.0	100.0	

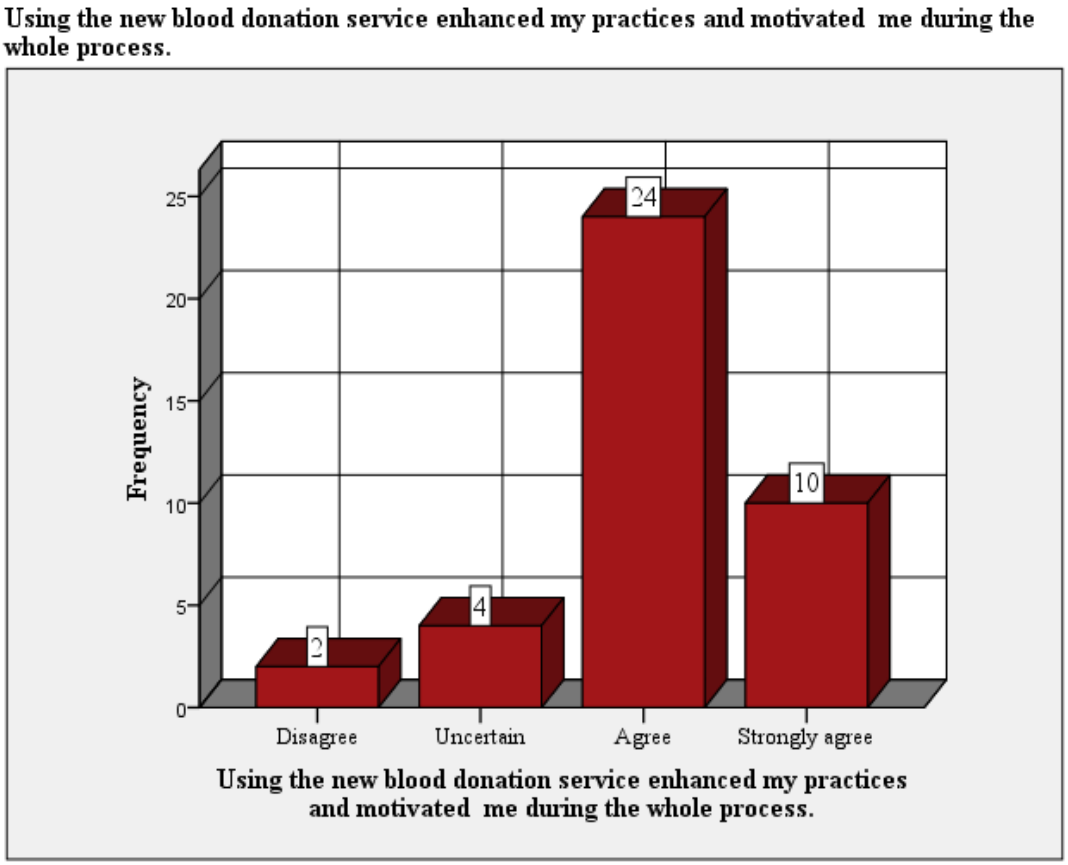


Figure 6. 5 The Result of Question 5.

Table 6. 6 The Respondents of Question Six.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	2.5	2.5	2.5
	Disagree	3	7.5	7.5	10.0
	Uncertain	2	5.0	5.0	15.0
	Agree	25	62.5	62.5	77.5
	Strongly agree	9	22.5	22.5	100.0
	Total	40	100.0	100.0	

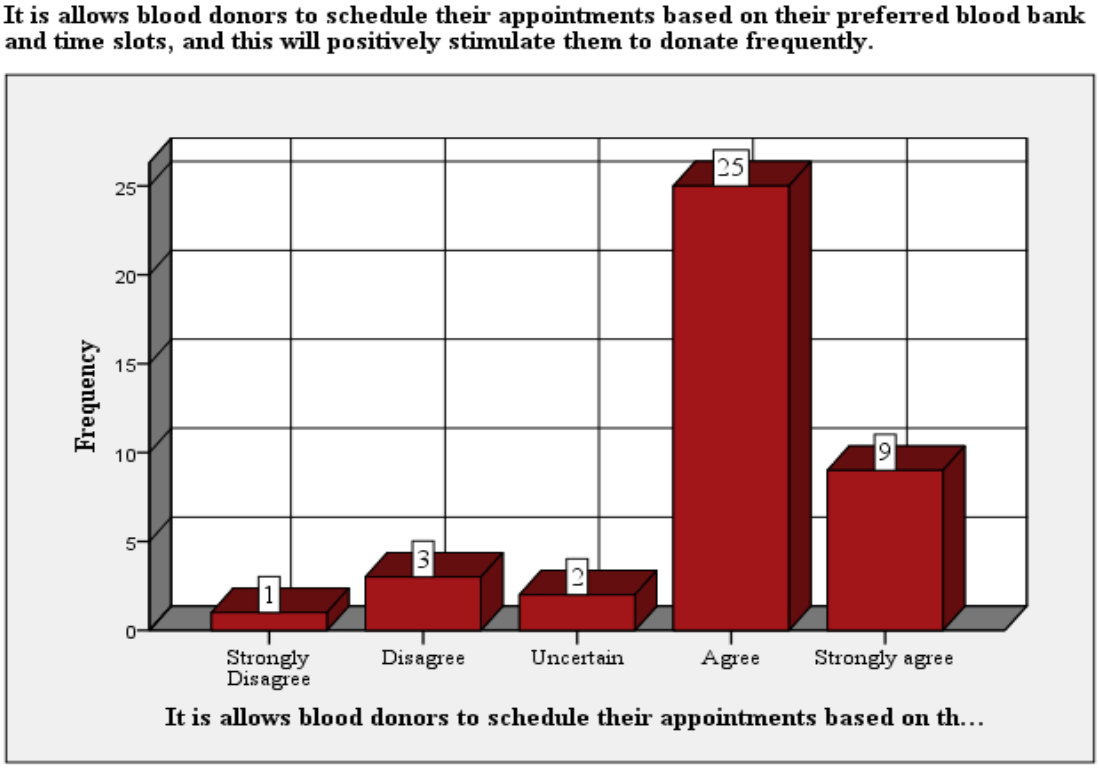


Figure 6. 6 The Result of Question 6.

Table 6. 7 The Respondents of Question Seven.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Uncertain	2	5.0	5.0	5.0
	Agree	22	55.0	55.0	60.0
	Strongly agree	16	40.0	40.0	100.0
	Total	40	100.0	100.0	

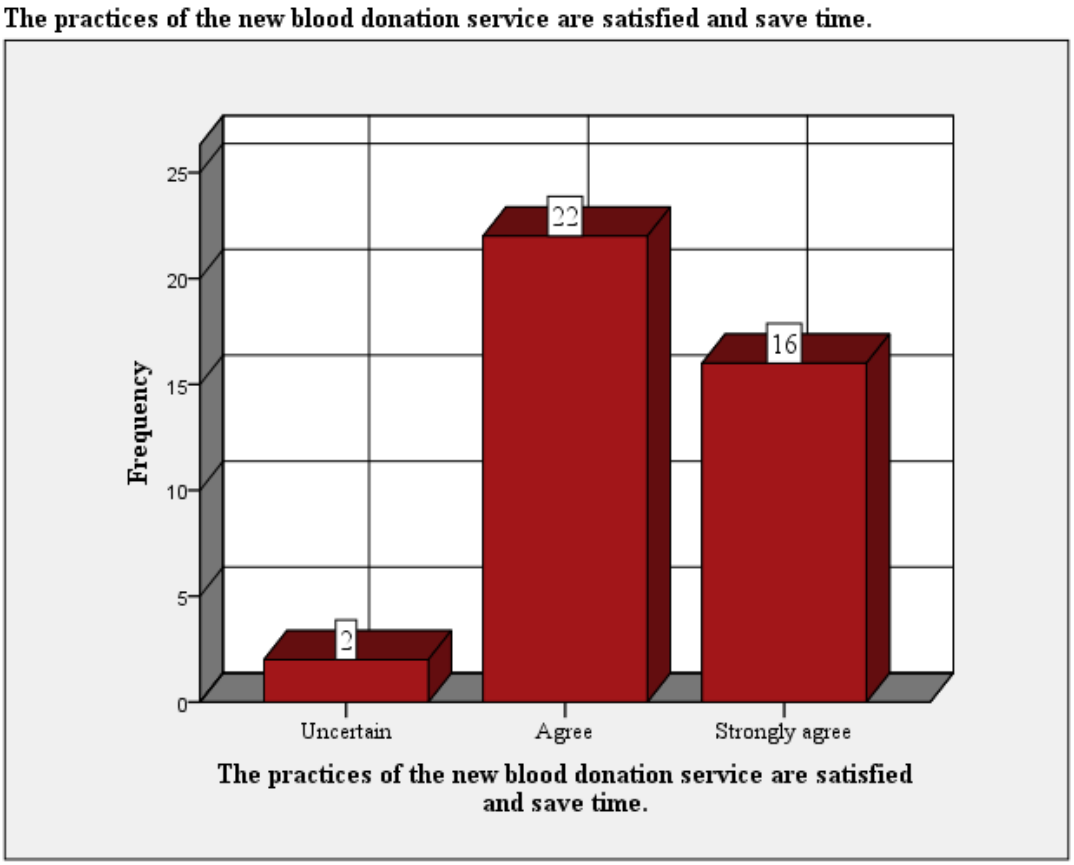


Figure 6. 7 The Result of Question 7.

Table 6. 8 The Respondents of Question Eight.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	2.5	2.5	2.5
	Disagree	3	7.5	7.5	10.0
	Uncertain	2	5.0	5.0	15.0
	Agree	18	45.0	45.0	60.0
	Strongly agree	16	40.0	40.0	100.0
	Total	40	100.0	100.0	

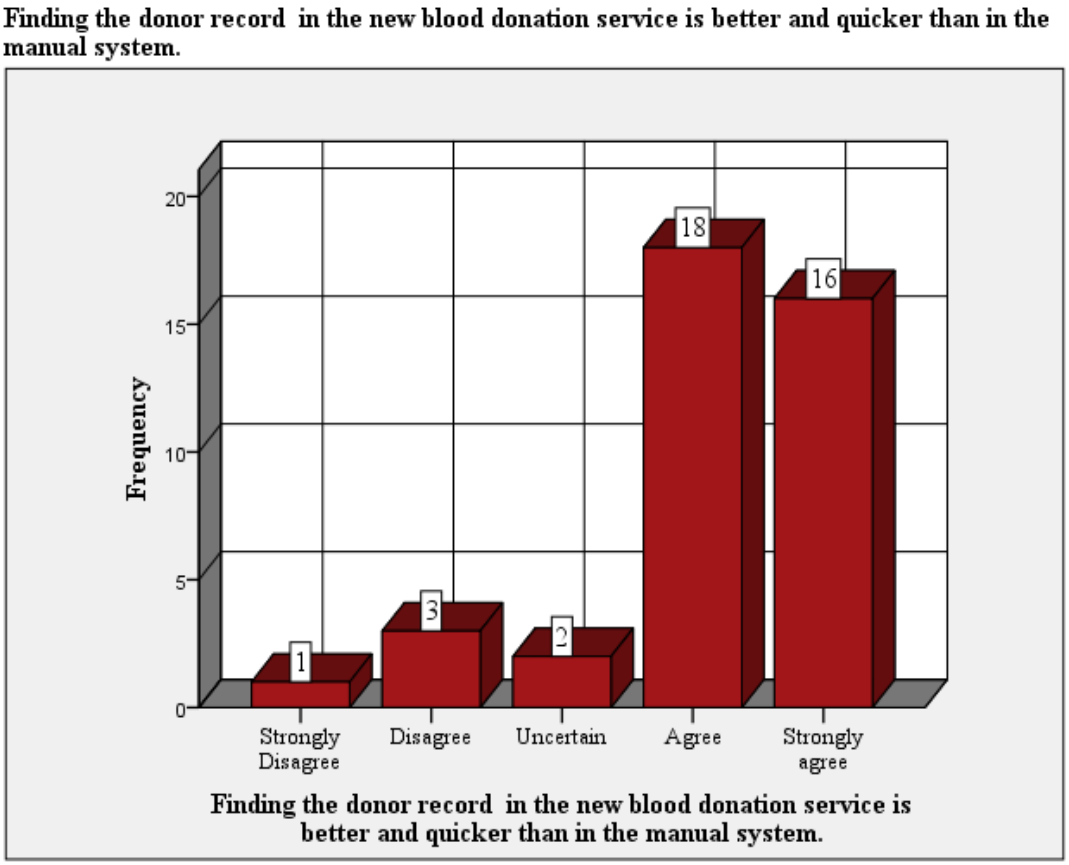


Figure 6. 8 The Result of Question 8.

Table 6. 9 The Respondents of Question Nine.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	10.0	10.0	10.0
	Disagree	4	10.0	10.0	20.0
	Uncertain	2	5.0	5.0	25.0
	Agree	22	55.0	55.0	80.0
	Strongly agree	8	20.0	20.0	100.0
	Total	40	100.0	100.0	

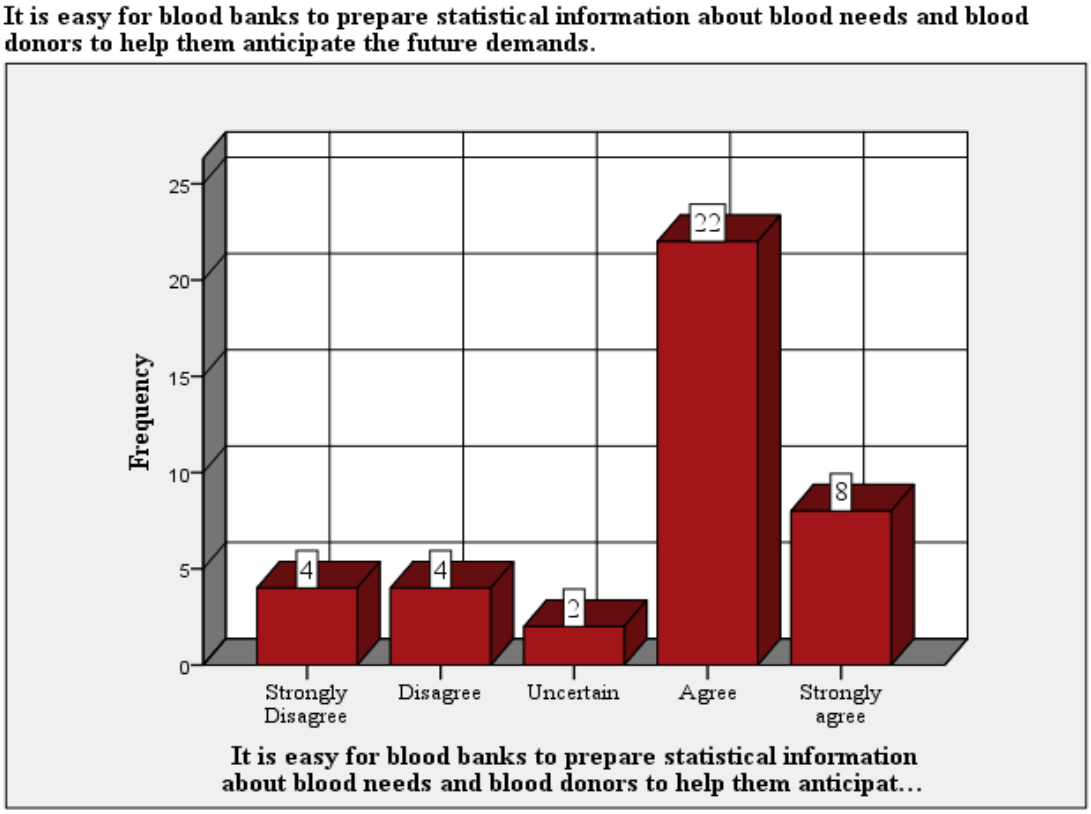


Figure 6. 9 The Result of Question 9.

Table 6. 10 The Respondents of Question Ten.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	2.5	2.5	2.5
	Disagree	1	2.5	2.5	5.0
	Uncertain	2	5.0	5.0	10.0
	Agree	14	35.0	35.0	45.0
	Strongly agree	22	55.0	55.0	100.0
	Total	40	100.0	100.0	

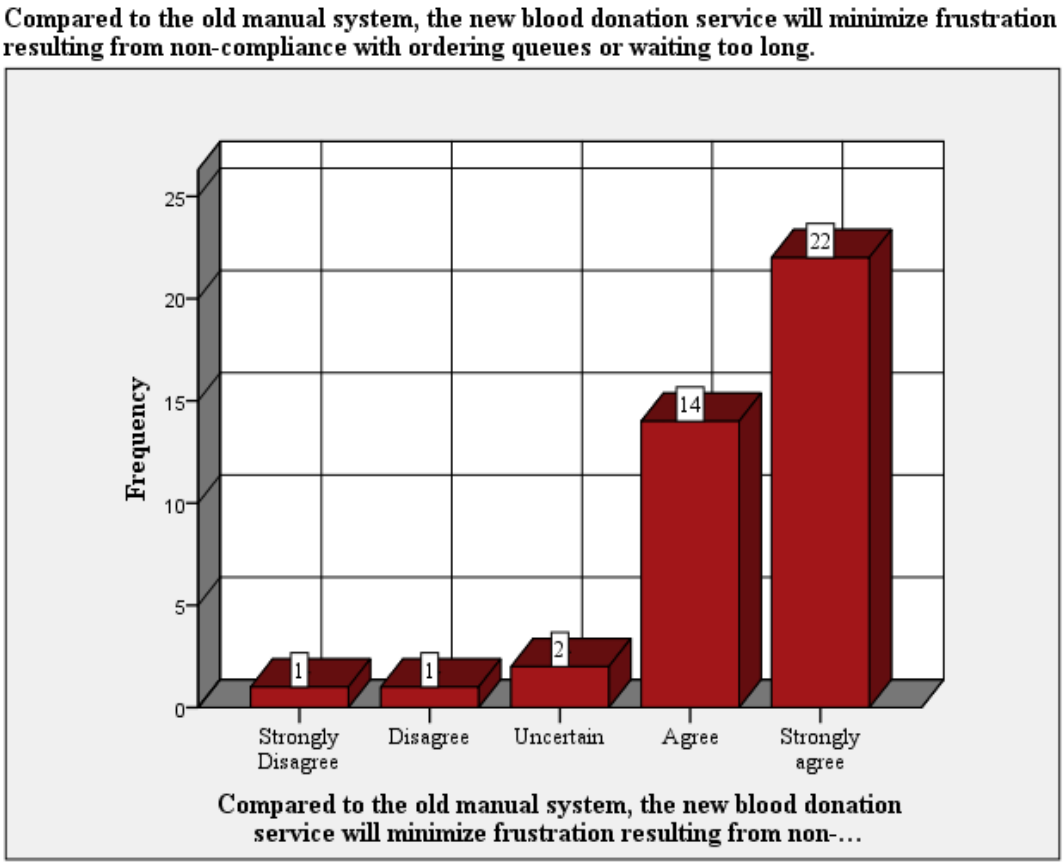


Figure 6. 10 The Result of Question 10.

Table 6. 11 The Respondents of Question Eleven.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	2	5.0	5.0	5.0
	Disagree	4	10.0	10.0	15.0
	Uncertain	2	5.0	5.0	20.0
	Agree	17	42.5	42.5	62.5
	Strongly agree	15	37.5	37.5	100.0
	Total	40	100.0	100.0	

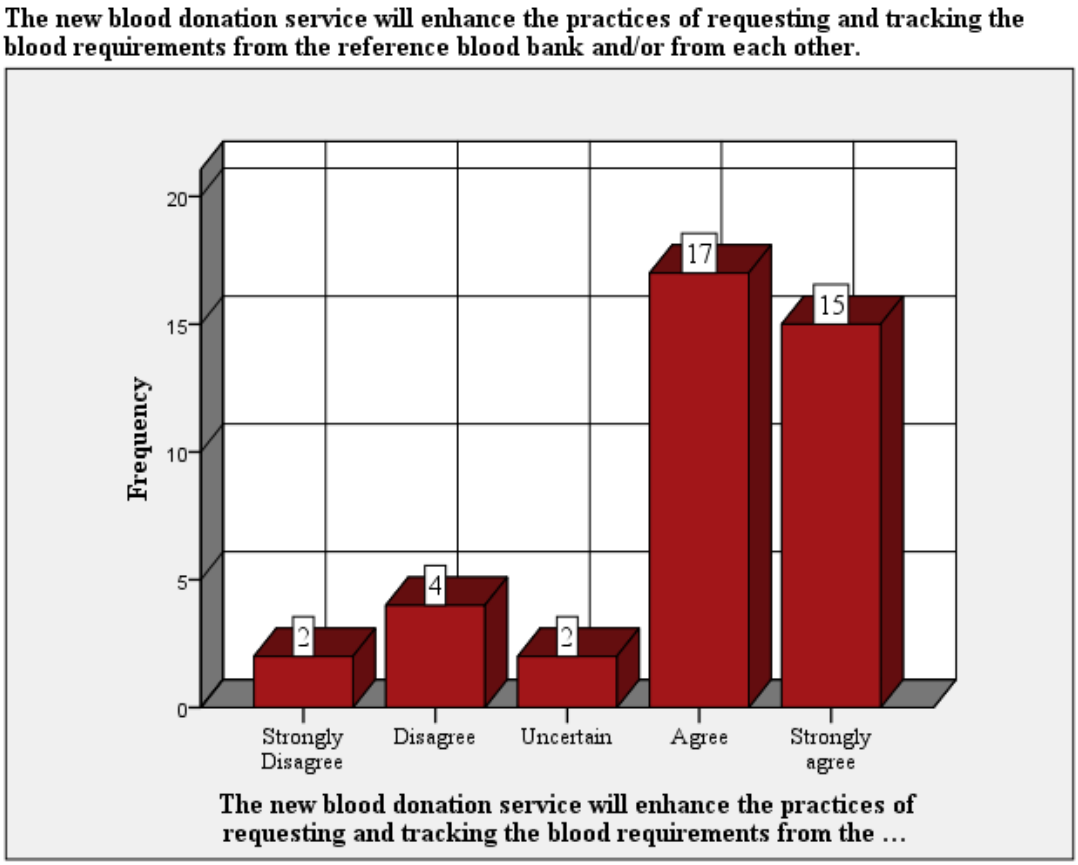


Figure 6. 11 The Result of Question 11.

Table 6. 12 The Respondents of Question Twelve.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	7	17.5	17.5	17.5
	Disagree	1	2.5	2.5	20.0
	Agree	19	47.5	47.5	67.5
	Strongly agree	13	32.5	32.5	100.0
	Total	40	100.0	100.0	

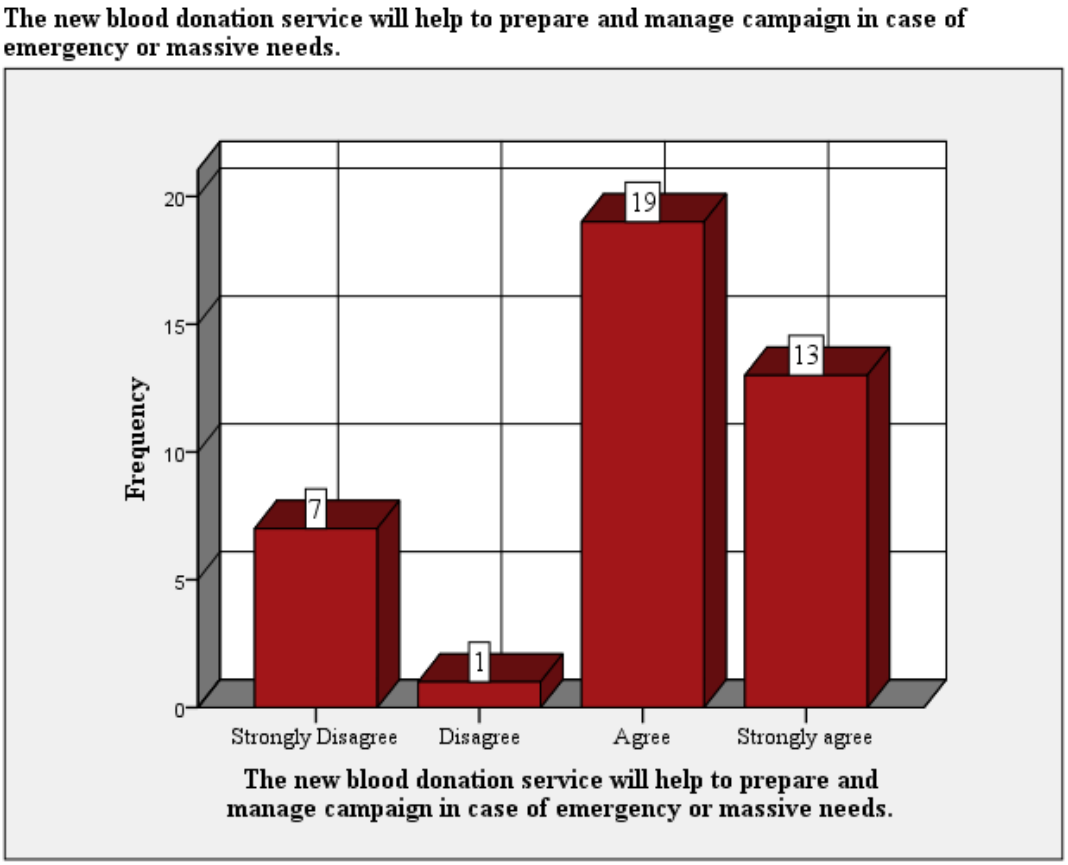


Figure 6. 12 The Result of Question 12.

Table 6. 13 The Respondents of Question Thirteen.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Uncertain	4	10.0	10.0	10.0
	Agree	6	15.0	15.0	25.0
	Strongly agree	30	75.0	75.0	100.0
	Total	40	100.0	100.0	

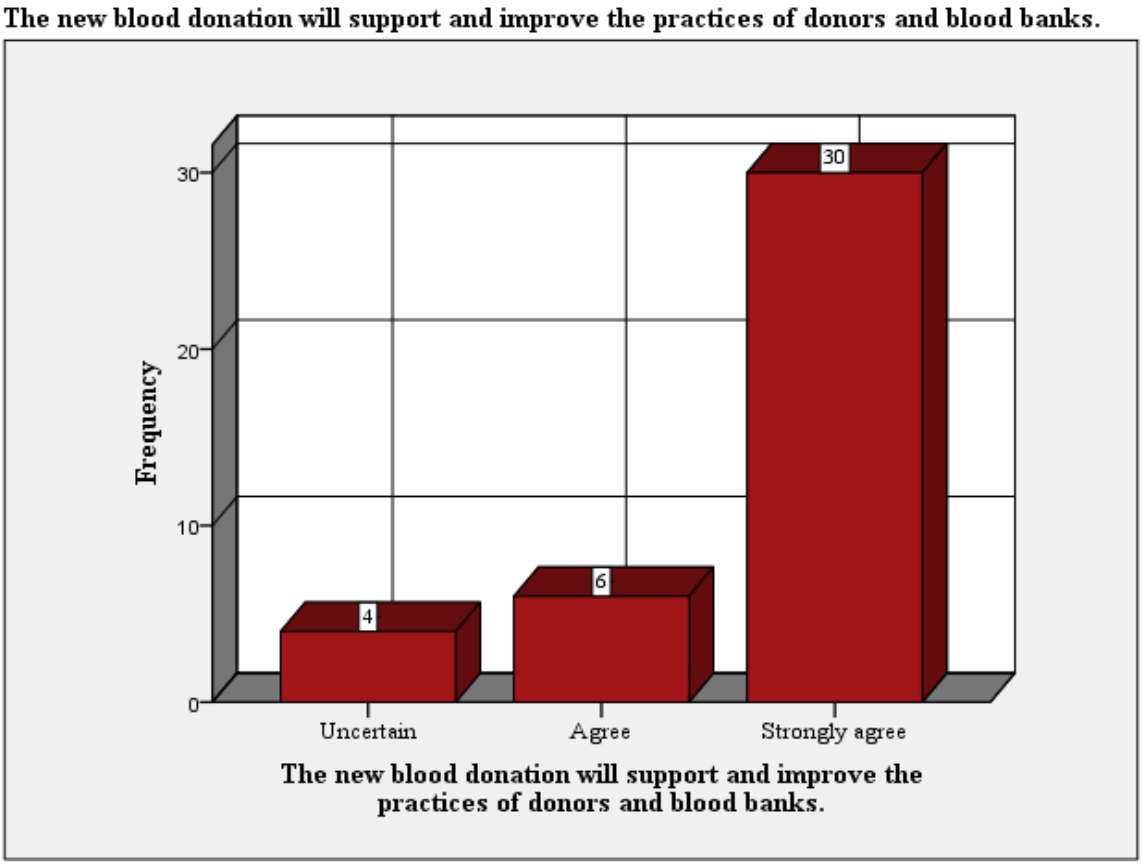


Figure 6. 13 The Result of Question 13.

Table 6. 14 The Respondents of Question Fourteen.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Uncertain	2	5.0	5.0	5.0
	Agree	27	67.5	67.5	72.5
	Strongly agree	11	27.5	27.5	100.0
	Total	40	100.0	100.0	

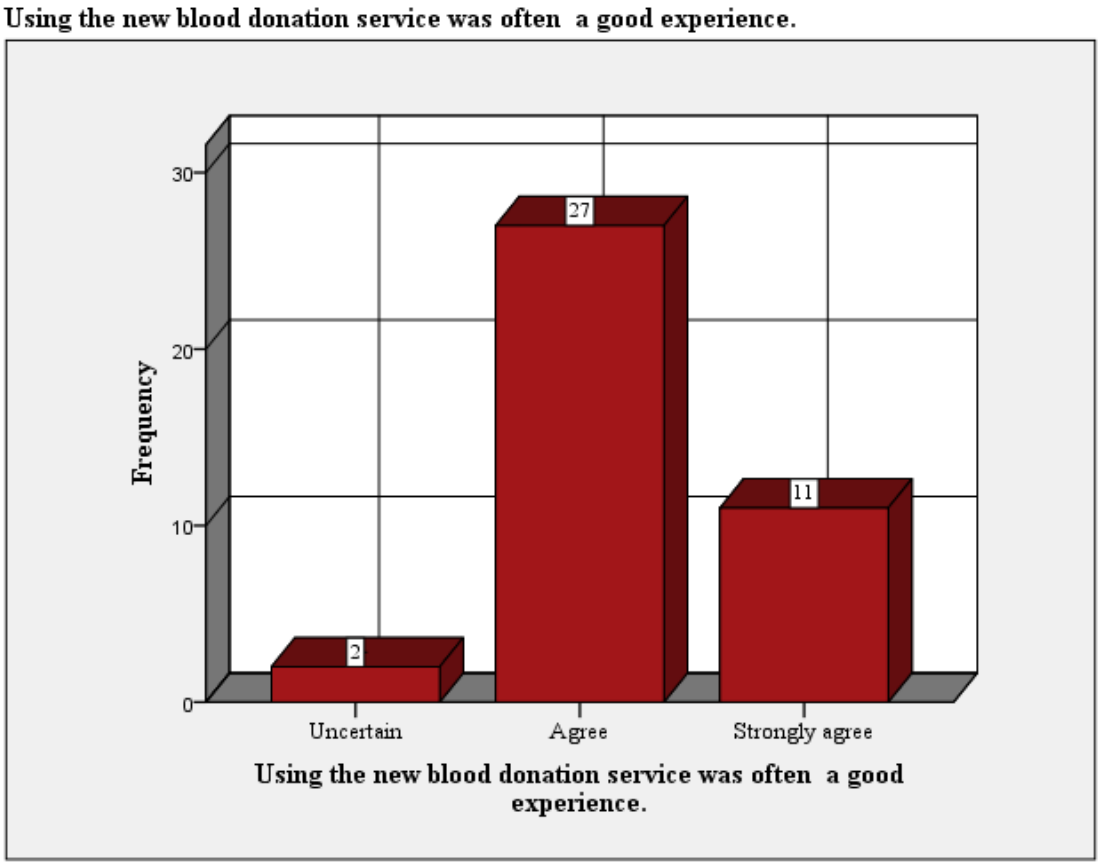


Figure 6. 14 The Result of Question 14.

Table 6. 15 The Respondents of Question Fifteen.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	2	5.0	5.0	5.0
	Uncertain	4	10.0	10.0	15.0
	Agree	24	60.0	60.0	75.0
	Strongly agree	10	25.0	25.0	100.0
	Total	40	100.0	100.0	

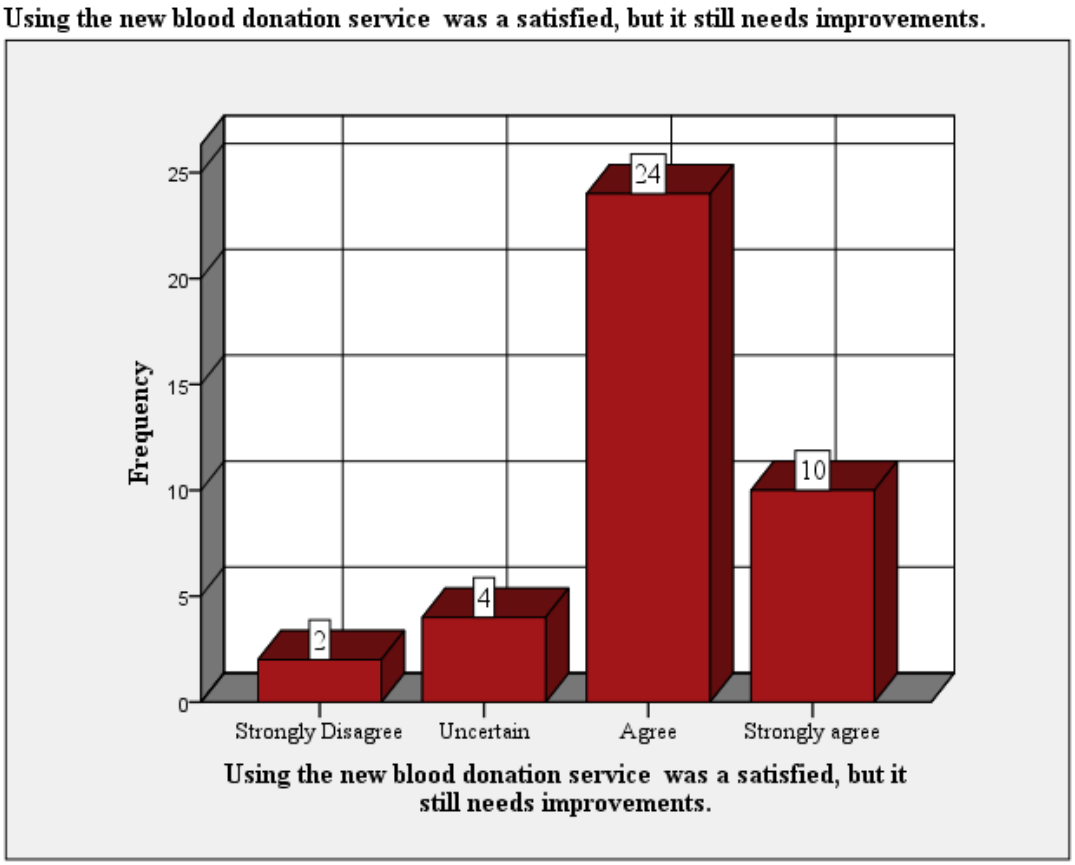


Figure 6. 15 The Result of Question 15.

6.5 Discussion

A deep understanding of blood donation practices is essential to maintain adequate and safe bloodstocks that can be used to meet the high demands for blood. Furthermore, satisfying these demands may be primarily based on voluntary blood donations.

In this study, the researcher aimed to explore the current practices of blood donation in Khartoum, Sudan, in order to obtain a clear picture about the current situation and suggest ideas to help and improve donation practices in that region through invest the advent of ICT development and service design methodology. The results of this study and discussion can be tacked under the headings below based on the research questions, objectives, and potential benefits.

6.5.1 Current practices of blood donation in Khartoum, Sudan

In this study based on the results and finding illustrated in chapter 4**,** we found that family replacement donations were used far more than voluntary donations when trying to meet high demands for blood. According to STAC, 60% of blood donations in Khartoum- Sudan are from family replacement donors. Thus, stronger efforts are needed to increase the percentage of voluntary donations to 100%. These findings were very similar to studies conducted in Egypt (Abdel Messih *et al.*, 2014) and India (Awasthi *et al.*, 2010), where family replacement donations make up 87% and 85.2% of the blood supply, respectively. Furthermore, these findings are also consistent with sub-Saharan African countries (Allain, Owusu-Ofori and Bates, 2004), where family replacement donations make up 80% of the blood supply. However, our findings were dissimilar to studies conducted in Thailand (Awasthi *et al.*, 2010) and Kenya (Kimani *et al.*, 2011), where family replacement donations make up only 29% and 36% of the blood supply, respectively.

In this study, we noted that the most powerful incentives to make people become blood donors are altruism and helping save the lives of others. This finding was consistent with other blood donation studies (Oswalt, 1977; Abderrahman and Saleh, 2014; Márquez-Melgarejo *et al.*, 2015; Waheed, 2015; Papagiannis *et al.*, 2016; Abera *et al.*, 2017; Gao and Wang, 2017). Moreover, these values seem to be found throughout the Sudanese community, particularly within the educated sector, which is almost always engaged in voluntary activities.

Additionally, this study indicated that family, friends, and social media networks are the main sources of information regarding blood donation in Khartoum- Sudan. This finding was similar to the finding revealed by a study conducted in Pakistan, which showed that 65% of respondents indicated that they primarily received information about blood donation from their friends and family (Waheed, 2015). However, this finding did not match the findings by studies conducted in Uganda (Natukunda *et al.*, 2015) and Nigeria (Salaudeen *et al.*, 2011), where mass media was considered the main source of information regarding blood donation. This finding was also dissimilar to the finding of an Ethiopian study that designated pamphlets as the main source of donation information (Mirutse, 2014).

Due to family and friends representing the main source of information regarding blood donation in Khartoum, this study found that misconceptions regarding the donation process pervade the population, especially among rural areas and within the illiterate population. These misconceptions ranged from a lack of knowledge about donating to misinformation about donating that decreases the willingness of people to contribute. These findings were supported by studies conducted in Saudi Arabia (Abolfotouh *et al.*, 2014), where a higher rate of infections being transmitted is cited as a common misconception, and Nigeria (Olaiya *et al.*, 2004), where donors fears contracting HIV and/or hepatitis as a result of blood donation.

Furthermore, the present study found that some Sudanese tribes consider blood donation difficult and will only take part to help their direct family members.

Although some studies revealed that many women believe the misconception that blood donation will lead to menstruation problems and a loss of fertility (Abolfotouh *et al.*, 2014), in this study, we observed a large number of women donating blood at the campaign event held on 19-8-2017.

In terms of stimulating and promote first-time donors and regular, we found the current incentives such as CBC analysis and meals or drinks used by the blood bank to be inadequate, in addition, as one way for stimulating donors, blood campaigns event connect with entertainment programs featuring famous singers, poets, musicians, and other celebrities. The interviewed donors believed many ways can be used to motivate them to donate more, such as giving out award letters, allowing donors to take one day off work, giving out t-shirts, listing donors on a social media honor board, providing free Internet access, tickets for hospitals entrance and honoring frequent donors in some way.

The idea of providing incentives to donors is supported by studies conducted in Saudi Arabia, where (the mostly young) donors preferred to receive token gifts as incentives for donation (Abdel Gader *et al.*, 2011), Nigeria, where donors preferred to receive certificates (Olaiya *et al.*, 2004), Iran (Kasraian and Maghsudlu, 2012), where male donors prefer receiving free blood tests, and the USA, where more than half of donors prefer free health checks (Glynn *et al.*, 2003). Although incentives can positively boost the attitude of donors, the extent to which incentives can attract and

facilitate repeat donation is unclear. In addition, incentives may negatively affect donor motivation when they are removed and could jeopardize overall blood safety by attracting higher-risk donors who conceal information to obtain said incentives (Healy, 2006; Stutzer and Goette, 2010).

In terms of blood donation barriers, the most common was fear of needles, medical issues, lifestyle barriers, and misconception about the donation process. These findings were supported by most other blood donation studies (Oswalt, 1977; Abderrahman and Saleh, 2014; Márquez-Melgarejo *et al.*, 2015; Waheed, 2015; Burzynski, Nam and Le Voir, 2016; Papagiannis *et al.*, 2016; Abera *et al.*, 2017; Gao and Wang, 2017).

The satisfaction of blood donors is an important factor that strongly impacts whether or not donors will become regular. The satisfaction of existing donors can also attract more first-time donors. In this study, we found that, although the relationship between donors and blood service organizations are good, the number of donors that come to donate at a single time has a direct negative effect on overall donor satisfaction, due to increased wait times and disorganization.

Furthermore, we found that paper notebooks are being used to manually record donor information and queue orders. Such methods are inadequate, as they lead to many problems that decrease satisfaction, such as increasing wait times, exacerbating errors in the queue order, and making it difficult to keep track of donors that have come in and which should be contacted for future donations. Therefore, to increase the blood donation rate, blood bank must seek to minimize wait times, connect with donors' places of work to ensure they can take time off for their requested timeslots, and send mobile blood collection units to areas with higher concentrations of donors. These methods will leave donors more satisfied and willing to become regulars.

These findings are supported by similar studies conducted in India, where blood donation practices are seen as an important factor for determining future donations (Kumari and Raina, 2015). Studies conducted in Saudi Arabia indicated that a lack of time to visit donation centers was as the primary reason that many individuals chose not to donate, as men in that country are obligated to fully satisfy their family's needs

(Abdel Gader *et al.*, 2011), while, in the United Kingdom, loss of leisure time was cited as the primary reason for not donating (Piliavin, 1990).

In conclusion, we may say that in spite of the increasing number of donations, blood banks in Khartoum, Sudan still rely more on family replacement donors than voluntary donors. The current practices of blood donation in the region suffer from many limitations that represent a challenge for blood banks, which must meet high demands for blood. In addition, blood donors are unlikely to donate repeatedly due to a lack of motivation.

6.5.2 Improve the Current practices of blood donation in Khartoum, Sudan

Improving the current practices related to blood donation barriers, incentives, and misconceptions required years and a huge work and efforts to eliminate or reduce them not only from governments or blood transfusion agency but from individual, universities, voluntary organization and all stakeholders.

In addition, the current methods used for both recording information and queuing donors are main reasons for them to be unsatisfied regarding blood donation process due to time waste or non-compliance with ordering queue especially for those connected with other work. Therefore, raising donors satisfaction is the main means to mitigates or improve these practices.

To improve and support the limitations of current practices and motivate donors, a prototype for blood donation service supported by ICT is developed and implemented, and the researcher measured the satisfaction upon this prototype in support and improving the current practices, motivate donors and subsequently meet the potential benefits and the objectives of the study.

As one of the current practices of blood donation, in Khartoum- Sudan, blood banks often do not know how many donors expected to attend, which makes it difficult to provide sufficient staff members and may lead to increased wait times as well as an effect on the service quality. In relates to improves and mitigates this practice, the prototype results showed a large percentage of the respondents 85% thinks, the new system can help blood bank arrange their facilities and workforce according to number of expected donors, but other respondents which they are represented 15% disagreed

and thinks infrastructure of blood banks and well-prepared environments itself is one element must be considered and represent a challenge.

In addition, a similar study (Ghandforoush and Sen, 2010; Mobasher, Ekici and Özener, 2015), found that to guarantees a better service to donors and satisfy them, most blood collection organizations utilize an appointment-based schedule in order to reduce wait times, increase staff efficiency, and improve equipment utilization.

In relation to the practices of a long wait, busy schedule and connect with work these elements have negative effects on donors willingness and motivation to be a blood donor or become a regular donor. As an aid to increase the donor's willingness through appointments service, most respondents, which represented 90% agreed, the provided appointments service may potentially increase the donor's willingness to donate, whereas 10% of the respondents disagreed because they think the willingness back to individuals themselves and not connected with the appointments service.

As a similar result, (Natukunda et al., 2015), found although increasing the number of donations and donors is essential, finding an effective means to manage donor visits is also fundamental and will greatly improve the performance of the overall blood donation system and maintain a reliable supply of blood.

On the other hand, the methods of documenting donation process is considered as the most important and essential for both keep active donors and recruit new donors but the current practices showed the current methods for recording donor information need to be improved, in order to maintain better blood donation historical records and deliver the best services to donors as well as allocating adequate staff members and preparing materials for donors who are expected to arrive can achieve higher efficiency in the donation process. In addition, lack of signboards that could be used to guide first-time visitors was noted. To mitigates or remove these practices through the suggested service, Most of the respondents 85% agreed, using the new blood donation service will make the blood donation process easier and faster, but 10% of the respondents uncertain and thinks to achieve this goal blood banks must first be prepared well by providing adequate materials and staff members in all blood banks not only the reference blood banks because the first impression is difficult to be removed in case of

donors classify the process negatively such as complex or a time consumed in some blood bank.

In addition, According to (Setiawan and Putra, 2015), exploring donor satisfaction regarding the blood donation process is necessary and must be done continuously to identify and improve the weak links in the chain of the overall process and maximize donor satisfaction particularly for first-time donors.

Furthermore, the current practices showed blood banks does not offer any information about the current status of the blood stocks for donors to used bring the attention or stimulate them to donate and to support this, the prototype shows the current blood stocks per blood banks. Based on the results of measured satisfaction, large percentages of respondents which they represented 75 % agreed; showing the level of blood stocks in blood banks would motivate me to donate or to be a regular donor, but other respondents which they represented 20 % disagree due to they believed instead of that blood banks must deliver a better and healthy blood donation service to donors because is valuable and have direct effects on both regular and first time donors. In addition, (Neto, 2011) found to maintain an adequate blood supply, blood banks can encourage blood donors to return to donate more frequently by creating the right environment that makes the process of giving blood a good experience.

In addition, the current practices showed many donors may leave with donation due to connected with business and they wait too long as well as only few blood banks are customized to accept voluntary donation therefore many donors suggest blood banks must customize specific times and some blood banks for those have restriction in time. In supporting this idea through the prototype of new service, large percentages of respondents which they represented 85 % agreed and support the prototype, It allows blood donors to schedule their appointments based on their preferred blood bank and time slots, and this will positively stimulate them to donate frequently, while 10% of the respondents disagreed because they considered the actual motivation relate with good and professional treatment from staff member, using health materials and care with service provided to donors such well-prepared rooms for waiting. This result supported by (Pagliariccio, 2010) and (Nguyen et al., 2008) which they argued a positive satisfaction is strongly linked with the donors intent to return (Pagliariccio, 2010), (Nguyen et al., 2008).

Moreover, the current practices of blood donation used the manual documenting for all process negatively affect practices and motivation as well as donor satisfaction and donation rates. In addition, for individuals involved in the donation process, minimizing wait times and avoiding mistakes in queues are essential to increase the motivation during the donation journey this was challenged by the manual method used in blood banks. In regard to these practices, the prototype not only supports the practices during the donation but extends to donors receive information about any transaction made on their blood until is delivered. Based on the results of measuring the satisfaction of the prototype, large percentages of respondents which they represented 85% agreed, using the new blood donation service enhanced my practices and motivated me during the whole process, but the other respondents which they represented 10%, uncertain and argued this is something intangible and can be measured after several donations.

Customer satisfaction is a very important element in delivering services or products, in this study we found that the current practices of donating blood were an unsatisfied process for most donors due to use the manual process during the whole donation journey that leads to increase the time that donors spent. Our prototype results show that 95% of the respondents believed, the practices of the new blood donation service are satisfied and save time, but 5% of the respondents are uncertain because they think when putting in actual use it will be similar to electronic governments service that always stopping due to internet connection problems. In a similar study, (Pagliariccio, 2010), (Nguyen et al., 2008), considered the satisfaction with the blood donation process represents an important factor in donors recruitment and retention programs because positive satisfaction is strongly linked with the donors intent to return.

In relates to saving donors records, the current practices found all information is registered in document base paper format manually, and donors are asked to fill blood donation form for each donation, and no past information is saved, Therefore, searching for specific donor take a long time, especially to list and inform regular donors that donation date has coming soon. In facilitates these practices through the new blood donation service prototype, large percentages of respondents which they represented 85 % agreed, finding the donor record in the new blood donation service is better and

quicker than in the manual system, but the other respondents which they represented 10%, disagree because they considered most employees of the reception at STAC blood bank will lose their job due to computer literacy and will resist implementing the new system. In similar, WHO advised hospitals and blood banks to establish accurate donor records benefit both the donors and the recipients of their blood as well as contribute to the efficient operation of the blood collection program. They are particularly important in developing a panel of regular, voluntary non-remunerated donors (WHO, 2009).

The current practices showed as the results of using the manual method, blood banks spending more time in preparing reports or statistics about the donors and donation to help for anticipating the current situation and plan for future demands, and it considers another burden and consuming a lot of time. In relate support and improve this practices by using the prototype of the new suggested service, large most of the respondents which represent 75 agreed, It is easy for blood banks to prepare statistical information about blood needs and blood donors to help them anticipate the future demands, whereas 20% of the respondents disagreed due to they believed years of actual use was required to judgment as well as anticipating process need a forecasting model not only data.

The frustration of consumers towards any service or product makes them look for other alternatives, which affects the provider, but here the consumer does not expect any return from the service provider so blood banks may lose frustrated donors forever in sensitive products demands massively. The current practices have many limitations and factors possible to cause the frustrations particularly donors has time restriction such as non-compliance with ordering queues or waiting too long. The new blood donation service provides an appointments service to mitigate these practices, and the results showed a large percentages of respondents which they represented 90 % agreed, compared to the old manual system, the new blood donation service will minimize frustration resulting from non-compliance with ordering queues or waiting too long, but some respondents which they represented 5%, disagree because they considered these are not big problems if blood banks provided suitable and comfortable place with free internet, while the remain respondents which they represented 5%, uncertain due to blood banks are not designed to serve this purpose.

The blood transfusion is a lifesaving when is done at a right time, from this point the current practices showed that hospitals and blood banks are consume a lot time to meets the needs in where asking family members of patients to bring donors to donate or broadcast their needs on social media to catch the attention of some volunteers, although this method widely used but is a time consumed and a risk in case of emergency needs such traffics accident because STAC laboratory and other blood banks record blood distribution and delivery on paper forms which provide challenges in terms a lot of time consumed in movement between blood banks to meets demands, and the process of tracking the blood requests are the responsibility of patients family. In mitigating these practices through our prototype most percentages of respondents (80%) thinks, the new blood donation service will enhance the practices of requesting and tracking the blood requirements from the reference blood bank and/or from each other, whereas 15% from the respondents disagreed because they consider the current practices are good and used since long years and any internet problems may delay the process rather than improving.

In the case of massive blood needs, blood banks use the blood campaigns to collect the required blood but the current practices of the attended campaign showed the organizers of the campaign have not any information about the number of expected donors may attend. In addition, some donors are frustrated regarding campaign coordinator due to they are unannounced when location and time changed. Regarding these practices the prototype results found large percentages of the respondents which they represented 80% they agreed, the new blood donation service will help to prepare and manage campaign in case of emergency or massive needs, while 20% of the respondents disagreed because they consider some audiences are unable to use the new service due to not owned smartphone or illiterate. In addition, according to (Sönmezoglu *et al.*, 2005), promotion of regular donors should be implemented to ensure the adequacy of the blood supply at all times rather than mass appeal as way to collect a large quantity of blood in a very short period of time because adverse reaction rates for first-time donors are usually higher than for regular donors and this will effects on their donation in future (Sönmezoglu *et al.*, 2005).

As seen in chapter 4, blood donation practices in all steps depend on paper-based practices that have many limitations directly have a negative effect on the donors and challenged blood banks to meets the high demands, and needs to improve. To support and improve these current practices, the prototype is designed and implemented based on donors and blood banks viewpoints. The result showed that a large percentage of the respondents which they are represented 90% they agreed, the new blood donation will support and improve the practices of donors and blood banks, but 10% of the respondents are uncertain because they consider a long used required as evidence for a judgment and digital divide especially the access type is the main threat will challenge the service.

In addition, the studies found use ICT to support health sector practices are significantly increasing in developing countries such as used in the dissemination of health information and raising awareness (Aranda-Jan, Mohutsiwa-Dibe and Loukanova, 2014). Moreover, the WHO announced that the mobile health sector has the ability to transform the face of health service delivery around the world (World Health Organization, 2011).

Donation experience plays a vital role in the decision to donate or become regular, the current practices showed donors traveling to reach blood banks with costs in time and money therefore if they fail to make a donation for any reasons would be a negative experience to them, also as potential negative experience, most blood banks do not have rooms dedicated to accommodating those have adverse reaction from donation. Furthermore, post donation communication or information represents an important element to stimulate donors and make the service or the experience good but donors not receive any information after the donation about their donated blood, in addition, some voluntary donors believed their blood sold rather than delivered voluntarily. Therefore, to minimize the negative experience blood banks must take in account these elements.

As a means to support positive experience after donation or post-donation, the new suggested service reported any transaction made on donors or their blood during or after donation to motivate them as well as remove the idea of the blood sold. In relates to improve the experience, the results of showed, a large percentage of the respondents which they represented 95% they agreed, using the new blood donation service was often a good experience, but of the other respondents which they represent 5% uncertain

without reasons. In similar the studies found a positive donation experience, especially among first-time donors, are cited as key factors that can positively affect their decision to return and to become a regular donor as well as a negative experience can make donors unlikely to return for frequent or second donations (Newman et al., 2006) and (Vavić et al., 2012).

To conclude, the new blood donation service aimed to improve and support the current practices of blood donation a well as motivate donors to donate frequently, and in meeting these goals, the results showed a large percentages of the respondents which they represented 85% they agreed, using the new blood donation service was a satisfied, but it still needs improvements and the other respondents which they represent 10% uncertain because do not trust in Sudan ICT readiness and internet problems to meets these goals.

6.6 Participants Comments for Prototype Evolution

- Dr. Kamal, as one of the participants, comments, "This system is a very good but make it work offline is important."
- Yasir, is a donor, said, "Although most donors can use ICT those uneducated may lose them as a blood donor therefore, alternative solutions are required."
- Fatima is a nurse, said, "Your app is nice particularly the colors is consistent but try to make it work on the iPhone."
- Omer is a doctor, said, "Is this national number at registration is real."
- Hashim is a lab technician said, "The messages send to donors need to be reconstructed and sent as SMS."

CHAPTER SEVEN CONCLUSION

7.1 Introduction

Blood transfusion is considered a life-saving intervention, regarding this importance every country established blood banks to keeps sufficient blood bags that can be used in case of blood loss related to road traffic accidents, pregnancy complication, malaria, anemia, hemorrhage, surgery, and chemotherapy.

Although safe and sustainable blood supply is an essential component in the health care system worldwide, however, blood is scarce and demand far outweighs the supply due to low donation rates. The lowest donation rates caused for many reasons, for instance, the blood donation process itself and lack of donors motivations represent the majors' elements are tightly linked with these problems.

In this study, the researcher firstly investigated the current practices of blood donation in Khartoum- Sudan to point out the main factors or limitations challenges for blood donation organizations or blood banks to collect enough blood to facilitate in meeting high blood demands as well as motivates donors to continuously donating blood as well as attracting new blood donors, where we found, blood donation process and blood banks in Khartoum- Sudan use paper and manual methods to record the information of both blood donation and donors, and the current practices are considered one of the most important elements that have direct effect on donor decision to repeat donation or become regular.

Moreover, the current practices have many problems that challenge blood transfusion agency in meeting high demands of blood needs and motivate donors to become a regular donor or recruit a new one.

In sum, based on these practices, the researcher investigated how to improve these practices as well as implementing a prototype for a suggested new blood donation to be used by blood banks to improve the current practices and motivate donors to donate frequently.

7.2 Important Results

In this study, the researcher aimed to improve and support the current practice of blood donation in Khartoum- Sudan blood banks as well as motivate the donors to donate frequently.

The researcher proposed and implemented a new blood donation service or system that has consists of two components: a web-based application and an android app. Through a web-based component, the hospitals or blood banks can do their various duties in a manner that may potentially increase motivation or reduce frustrations between donors and employees of blood banks whilst the android app component aimed to mitigates or remove the elements that caused donors to be unsatisfied upon the donation process as well as support those practices lead to motivates them such as avoid the problems of long waiting time, select they preferred slots time to donate and tracking the journey of donation as well as levels of blood stocks in the banks.

Based on the results of measuring the satisfaction upon the new blood donation service prototype in supporting and improving the current practices and motives donor, the findings of this study indicate that the new proposed service can potentially be used to support and improve the current practices as well as donors can be motivated.

Also, we proved that the suggested new blood donation service has many potential benefits for both blood banks and donors such as:

- Blood banks can arrange their facilities and workforce according to the number of expected donors.
- The blood donation process be will be made easier and faster.
- It is easy for blood banks to prepare statistical information about blood needs and blood donors to help them anticipate and plan for future demands.
- Blood requirements shared between hospitals, blood banks, and donors to minimize the time.
- Donors' practices are supported during and after donation.
- Doctors and technician laboratory will conduct their duties effectively.

- Using the appointments service donors can schedule their donation as their preferred in terms of time and banks to save time and be satisfied.
- Donors and blood banks stakeholders can explore many statistics about blood and donors.

7.3 Recommendations and Future Work

- Extending the implementation of app component to support ISO and windows operating system.
- Connecting the app component with transportation apps such as Careem, Tirhal and etc., to motivate the donors by providing free or low transport.
- Connecting and validating the information of the registering process and requesting blood with Sudanese national number.
- Enables integration with governments and private sectors organization to awards first time donors or regular donors.
- Sending the messages that summarize the donation journey as SMS by integrating the service with telecommunication company instead of email messages.
- Extending the web-based components to be fully blood banks system and add the barcode service functionality.
- Extends the new service by adding a forecasting model for blood needs to be used in designing strategies by blood banks.

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APPENDIX A

Data collection

This appendix contains Letters for Data Collection from Sudan University of Sciences and Technology, College of Computer Science and Information Technology to the General Manager of Blood Transfusion Service.

SUDAN UNIVERSITY OF
SCIENCE & TECHNOLOGY
College of Computer Science
& Information Technology

جامعة السودان
للعلوم والتكنولوجيا
كلية علوم الحاسوب
وتقانة المعلومات

التاريخ 2017/08/16م

السيد/ مدير عام خدمات نقل الدم

حفظه الله ،،،
السلام عليكم ورحمة الله ،،،

الموضوع: طلب توفير بيانات

بالإشارة للموضوع أعلاه، نفيد سيادتكم بأن الطالب/ الطاهر سعد أحمد سعد طالب دكتوراة بكلية علوم الحاسوب وتقانة المعلومات الدفعة السادسة، قد تناول موضوع التبرع بالدم فى السودان تحت بحث بعنوان (Improving Blood Donation in Sudan Through Service Design) نرجو منكم شاكرين إمداده بما يكفي من معلومات.

،،، ولكم جزيل الشكر والتقدير،،،

د. طلعت محيّ الدين وهبي
عميد الكلية

جامعة السودان للعلوم والتكنولوجيا
16 AUG 2017
كلية علوم الحاسوب وتقانة المعلومات

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كلية علوم الحاسوب و تقانة المعلومات

Republic of the Sudan
Sudan University of Science and Technology
College of Computer Science and Information Technology

التاريخ: 2018/09/12م

النمرة : ج س ع ت / ك ع ح ت م

السيد /مدير عام خدمات نقل الدم

،،،حفظه الله،،،

السلام عليكم ورحمة الله وبركاته

الموضوع: طلب نماذج وإستمارات التبرع بالدم وصرفه وطلبه

نفيدكم علماً بأن الطالب/ **الطاهر سعد أحمد سعد** ، مسجل ضمن برنامج الدكتوراه في علوم الحاسوب بجامعة السودان للعلوم والتكنولوجيا الدفعة السادسة، و أنه يقوم ببحث الدكتوراة في مجال **التبرع بالدم في السودان تحت عنوان (Improving Blood Donation in Sudan Through Service Design)** و نسبة لما لكم من سبق في هذا المجال ولما لكم من خبرة علمية و عملية و إسهامات في مجال تطوير البحث في البلاد ، نرجو من سيادتكم التكرم بإمداده بالنماذج والإستمارات التالية:

1- إستمارة التبرع أو كرات المتبرعين .
2- النماذج والإستمارات التي تستخدم لطلب الدم من معمل إستاك بواسطة المستشفيات.
3- النماذج والاستمارات التي تستخدم لصرف الدم للمستشفيات بعد التبرع في حالة التبرع الاسري والطوعي.

،،، ولكم جزيل الشكر والتقدير،،،

د. صلاح الدين الفكي الرفاعي
عميد الكلية

جامعة السودان للعلوم والتكنولوجيا
13 SEP 2018
كلية علوم الحاسوب وتقانة المعلومات

APPENDIX B

Photos from Blood Campaign

This appendix contains part of photos captured during a blood donation campaign held in August 2017.


قطر
الحياة

APPENDIX C

Form of Blood distribution

This appendix is a form used by blood banks to deliver the requested blood components and adapted by the researcher where a barcode column was added.

فورم إرسالية الدم ومشتقاته

Shipment code No. : 19

Section. : DATA ENTRY

Hospital Name: الخرطوم التعليمي Date 19-06-06 Time 09:36

Patient Name : Mona Ahmed Blood Group & RH Type O+

No	Barcode	Collection Date	Expiratory Date	BG and Rh Type	Type of product and code number	Date of retaining unit	Crosse Matching
46	46 59 2019-05-12	2019-05-13	2019-05-29	O+	RBC		Compatible
50	58 2 2019-05-25	2019-05-26	2019-05-31	O+	RBC		Compatible

Note :

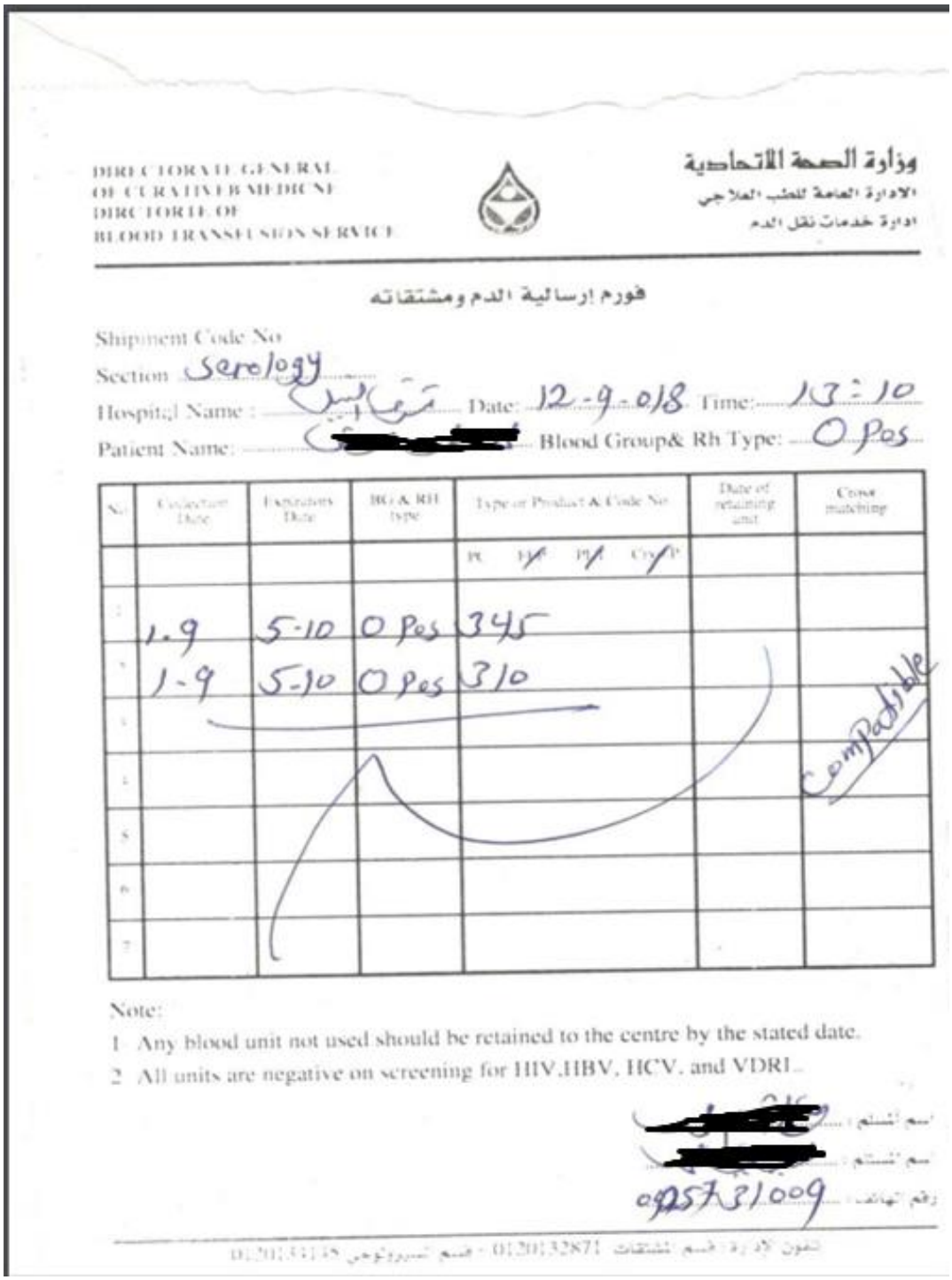
1. Any blood units not used should be retained to the center by the stated date.

2. All units are negative on screening for HIV, HBV, HCV, and VDRI.

اسم المسلم .....

اسم المستلم .....

رقم الهاتف .....



DIRECTORATE GENERAL
OF CURATIVE MEDICINE
DIRECTORATE OF
BLOOD TRANSFUSION SERVICE

وزارة الصحة الاتحادية
الادارة العامة للطب العلاجي
ادارة خدمات نقل الدم

فورم إرسالية الدم ومشتقاته

Shipment Code No:

Section: serology

Hospital Name: [redacted] Date: 12-9-018 Time: 13:10

Patient Name: [redacted] Blood Group& Rh Type: O Pos

No.	Collection Date	Expiration Date	BG & RH type	Type or Product & Code No	Date of returning unit	Cross matching
				PC FFP PP Cryo P		
2	1.9	5-10	O Pos	345		
3	1-9	5-10	O Pos	310		Compatible
4						
5						
6						
7						

Note:

1. Any blood unit not used should be retained to the centre by the stated date.
2. All units are negative on screening for HIV,HBV, HCV, and VDRL.

اسم المستلم: [redacted]

توقيع المستلم: [redacted]

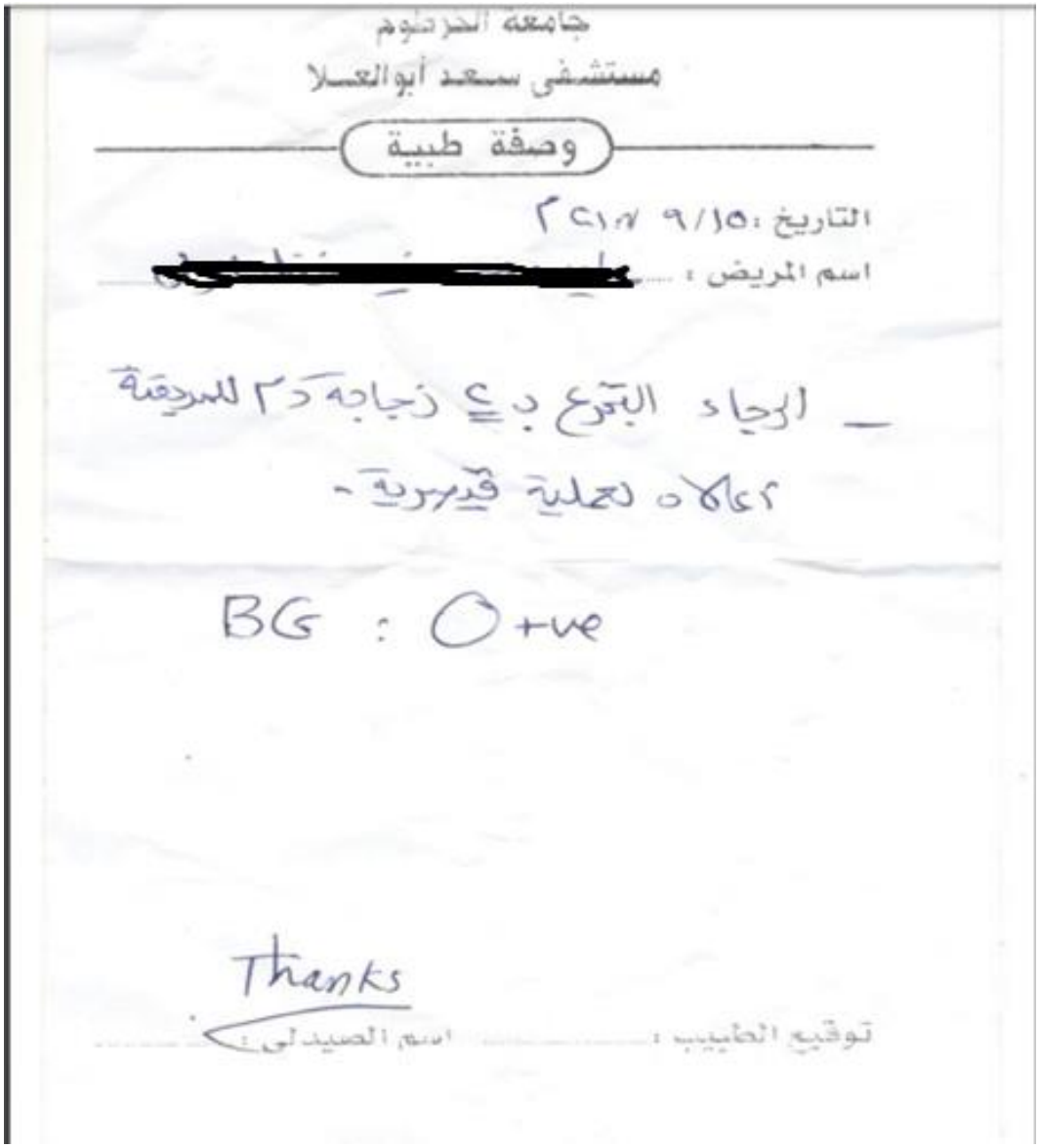
رقم الهاتف: 0925731009

لمزيد من الاستفسار: قسم المشتقات 01201132871 - قسم السيرولوجي 01201132148

APPENDIX D

Blood Request and Donation Statement

This appendix contains some blood needs issued by hospitals and donation statement to prove an individual is donated, and particularly in case of family replacement.


جامعة الخرطوم

مستشفى سعد أبو العلا

وصفة طبية

التاريخ: ٢٠١٧/٩/١٥

اسم المريض: [redacted]

- الرجاء التبرع بـ ٢ زجاجة دم للسرعة

وعلاه لحالة ضرورية -

BG : O +ve

Thanks

توقيع الطبيب: ..... اسم الصيدلي: .....

وزارة الصحة ولاية الخرطوم

مستشفى الخرطوم لعلاج الأورام

RICK

وصفة طبية

التاريخ: ١٩٩٢ م الوحدة:

الإسم: [redacted] العمر:

للاحتفاظ بالدم السرطاني

تحتفظ عدد (١) زجاجة

دم الصائم المذكورة

لعلاجه

[redacted]

إمضاء الطبيب:

مستشـــفي دريـــم التخصصي
Dream SpecializedHospital

مرافق

التاريخ / ...../...../2018م

السادة بنك الدم المركزي

بعد التحية والاحترام

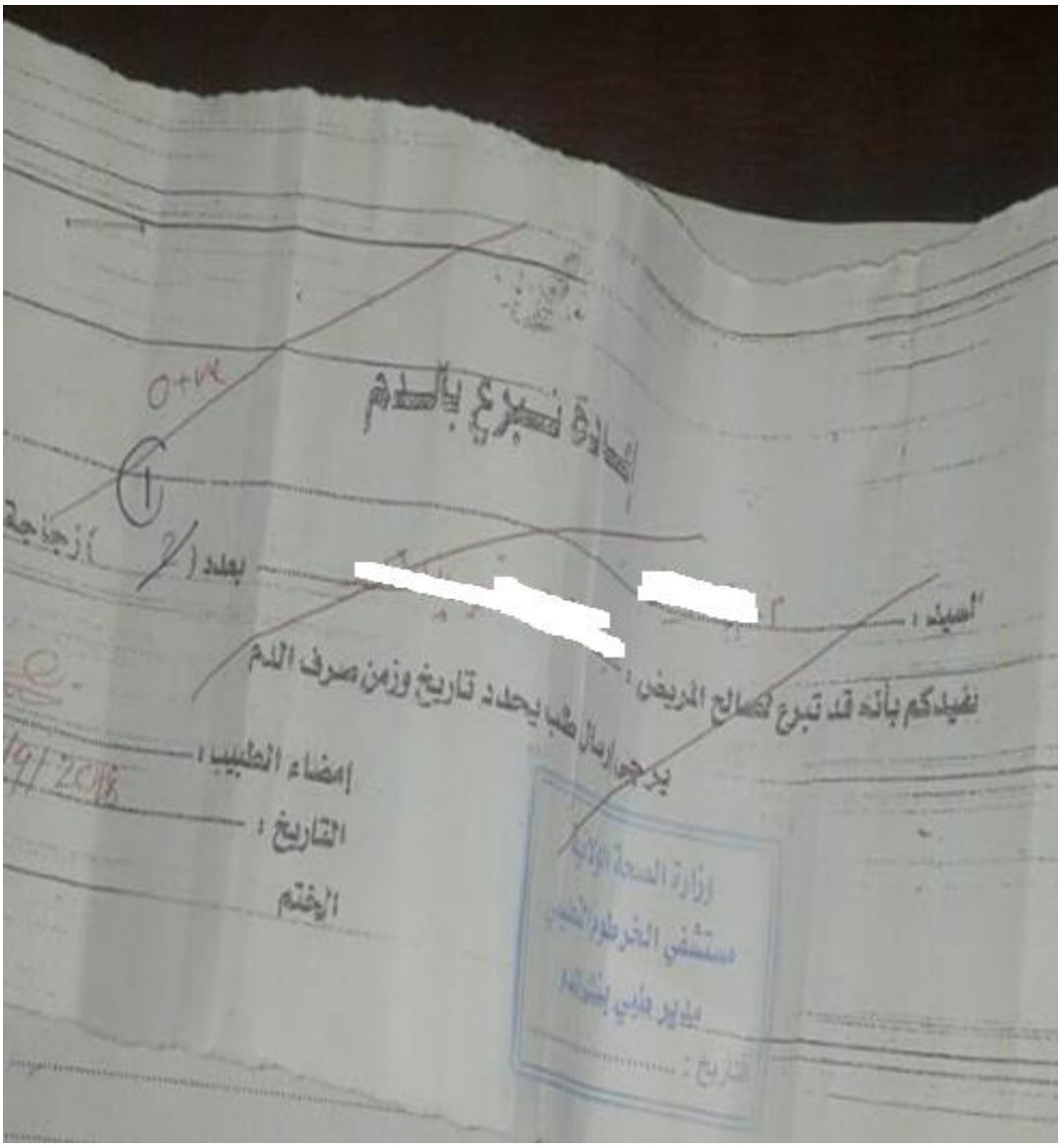
الموضوع / تحضير دم للمريضة / .....

بالاشارة للموضوع اعلاه الرجاء تحضير عدد (.....) زجاجة دم للمزكورة اعلاه حسب الفصيلة والتجانس ، والفصيلة هي (.....).

مع جزيل الشكر لتعاونكم معنا

الميترون

[redacted]


O+ve
الوحدة تبرع بالدم
بعدد (2) زجاجة
السيد :
نفيدكم بأنه قد تبرع لصالح المريض :
يرجى ارسال طلب يحدد تاريخ وزمن صرف الدم
إمضاء الطبيب :
التاريخ :
الختم
وزارة الصحة الوطنية
مستشفى الخروب الجهوي
مدير طبي إستقبال
التاريخ :

APPENDIX E

A Survey Questionnaire

This appendix is a questionnaire used to measure the satisfaction upon the prototype.

Please, select (✓) the most appropriate option of each statement which corresponds most closely to your desired response.

No	Question or relative advantage	Strongly Disagree	Disagree	Uncertain	Agree	Strongly agree
1.	The new system can help blood bank arrange their facilities and workforce according to number of expected donors.					
2.	The provided appointments service may potentially increase the donors willingness to donate.					
3.	Using the new blood donation service will make the blood donation process easier and faster.					
4.	Showing the level of blood stocks in blood banks would motivate me to donate or to be a regular donor.					
5.	It is allows blood donors to schedule their appointments based on their preferred blood bank and time slots, and this will positively stimulate them to donate frequently.					
6.	Using the new blood donation service enhanced my practices and motivated me during the whole process.					
7.	The practices of the new blood donation service are satisfied and save time.					

8.	Finding the donor record in the new blood donation service is better and quicker than in the manual system.					
9.	It is easy for blood banks to prepare statistical information about blood needs and blood donors to help them anticipate the future demands.					
10.	Compared to the old manual system, the new blood donation service will minimize frustration resulting from non-compliance with ordering queues or waiting too long.					
11.	The new blood donation service will enhance the practices of requesting and tracking the blood requirements from the reference blood bank and/or from each other.					
12.	The new blood donation service will help to prepare and manage campaign in case of emergency or massive needs.					
13.	The new blood donation will support and improve the practices of donors and blood banks.					
14.	Using the new blood donation service was often a good experience.					
15.	Using the new blood donation service was a satisfied, but it still needs improvements.					