

A Web Based Blood Donation System

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Abstract

Currently the National Blood Bank of Ethiopia (NBB) has adopted semi-automated system which made blood donation difficult for manipulation and management of the service. Moreover, most blood banks work in isolation and are not integrated with other blood donation centers and health organizations which affect blood donation and blood transfusion services quality. Hence the aim of this paper is to design a web based blood donation management system which would improve the efficiency of blood collection and utilization. In doing so, three different web based technologies, namely server-side HTML web application, JS generation widgets (AJAX), and service-oriented single-page web apps (Web 2.0, HTML5 apps) were evaluated based on three points of view: software owner, software developer and end user. Hence for this research service-oriented single-page web apps (Web 2.0, HTML5 apps) is used. The reason is that it provides a communication that could involve either simple data passing or it could involve two or more services coordinating for some activity.

Keywords: Blood Donation System; Blood Donation Management; Blood Donation Service

1. Introduction

Life is a precious element from all the belongings we have [1] and it has been medically proven that no human being can survive without blood; it supplies all nutrients and oxygen in the human body [2]. Unlike Ethiopia, blood banks found in different hospitals take care of the entire donation process, including recruiting donors, collecting and screening of the donated blood and preparation and storage of blood [3]. Globally, over 81 million people donate blood annually, but only 45% of these are donated in developing countries, where 81% of the world's population live [4]. According to National Blood Bank, the annual national blood demand in Ethiopia is about 60,000-80,000 units. However, the collection at a national level is only 43% (of which 8.84% is collected from voluntary non-remunerated blood donors, 16.53% from mobile sessions and 76.64% from family replacement donors). Two key problems are the gaps between the supply and demand of a safe blood supply, and the serious safety concerns associated with inadequately screened blood.

A major constraint to solving these problems is the lack of strong infrastructure and systems to

support the management of blood [5]. In addition, most blood banks work in isolation and are not integrated with concrete information system [3]. There is problem in keeping track of the actual amount of each and every blood type in the blood bank, which blood group is going to finish, etc. There is also no alert mechanism when the blood quantity is below its par level or when the blood in the bank has expired. Further, there is no automated way of reminding donors when the next donation time is expected [6].

Hence the question that this research would address is what kind of system helps to manage and effectively facilitate the blood donation service?

According to [8], qualitative methodology is tailored in system development research process. Since it consists of five stages, which are construct a conceptual framework, develop system architecture, analyze and design the system, build the (prototype) system, and observe and evaluate the system. Relevant data had been collected through primary and secondary data. The primary data collection methods deployed were interview and questionnaires, which are used to get original data directly from the respective donors and officials of the organizations.

The interview was conducted with the director of the center, lab technician and IT personnel. As a secondary data, review of the procedures and processes of blood donation and document used by the national blood bank have been used. This methodology enables us to explore the existing system of blood donation management system.

2. Related Work

A blood donation system based on mobile cloud computing is proposed in [3]. It is comprised of two main components: Cloud Computing (CC) component and Mobile Computing (MC) component. The main aim of this work was to design a framework for blood donation system using cloud computing and mobile computing technologies. Stakeholders use the blood donation system as an application installed on their smart phones to help them complete the blood donation process. The application helps the people receive notifications on urgent blood donation calls, know their eligibility to donate blood, search for the nearest blood center, and reserve a convenient appointment using temporal and/or spatial information.

The blood donation system proposed in [7] is designed to process as follows: two types of users are allowed in this system, the donor type and the patient type. For donor account, as input, the donor needs to enter the information needed for the patient to inquire necessary blood. Then the matcher decides to accept the donation or not using rule based knowledge. There are three main roles and three main processes. The three main roles are donor, patient and matcher. The three main processes are record the memberships of donors and patients, acquire the donor's purification blood and matching the patient with related donors. It needs main database for requirements like specific rules for donors. Main rules are divided into two classes in which patients can search on this page for their needs when they need blood.

Generally, the above related works provided an understanding of the different types of blood

donation management systems. This also provided input regarding the provision of knowledge base in the integration of different stakeholders, web portal management, account management of stakeholders via the application and the extraction of knowledge using different data mining concepts and methodologies.

A location-based framework for mobile blood donation and consumption assessment using big data analytics [9] came up with the idea that blood banks usually suffer frequent shortage of certain blood groups at some locations. Hence, social networks have recently served as a quick channel for advertisements, looking for healthy individuals to donate blood for patients who urgently require blood transfusion at emergencies.

Other blood donation centers may have excess of the same required blood group, which it would eventually be wasted for expiry reasons. This is due to the fact that many blood banks work in isolation, having no integration with other health organizations that would dramatically affect the quality of BDT services.

The paper proposed a framework that uses large-scale time series regression analysis techniques to analyse blood demands and donations matching data. The proposed system also could use different data mining concepts to extract knowledge from the system as future work.

A knowledge based system for blood transfusion [10] was designed for the national blood bank of Ethiopia. The aim of the system was to acquire knowledge necessary in blood transfusion and designing knowledge based system that can provide advice to experts involved in blood transfusion. The system cross matches the compatibility of the patient's blood and the blood going to transfuse. The researcher used a rule based knowledge representation method to represent the relationship between facts and rules. The result shows that the system registers 83.3% complete knowledge of blood transfusion task. This system can be integrated as one

module in the whole blood bank information management system

This research come up with rule based knowledge representation to cross match patients' blood with donor's blood. Hence, it could be used as an input in extracting knowledge using different data mining concepts. After the implementation of the results, the research idea could be adopted to extract different kinds of knowledge.

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3. Requirement Analysis

Requirement analysis has been completed to assess the existing system in NBB and relevant data has been collected through primary and secondary data.

The primary data collection methods deployed were interview and questionnaires, which used to get original data directly from the respective donors and officials of the organization. The interview question was conducted with the director of the center, lab technician and IT personnel. It raises different issues that range from donor recruitment to blood distribution for hospitals and health centers. There were two types of questionnaires: for employees of the organization and for the blood donors. Half of quarterly regular donors fill the questionnaires provided for donors. Hence, out of 60 questionnaires 50 were correctly filled, and the result of this study was concluded based on those successfully returned.

As a secondary data, review of the procedures and processes of blood donation and document used by the national blood bank have been used. Since the data that have been collected through these methods are recent, they have been used in accordance with

the primary data. This methodology would enable us to explore the existing system of blood donation management system.

According to the result of the interview with the professionals, the organization collects blood from different individuals and groups. This collection by the organization is planned based on the need by the health centers and other health organizations that need blood but this collection is not planned for each blood type.

It is possible to say that the current collection process that the bank follows is successful; it is possible to achieve more than 80% yearly but the bank has never achieved 100% collection.

In order to acquire blood from the national blood bank, the health centers sign memorandum of understanding (MoU). Once the bank and the centers agree on terms, it will be possible to request blood from the center with a stamped letter and assigned professional.

It is possible to know the amount remain in the stock of the blood bank but this record is found in hard copy kept in a file and health centers and organizations that need blood could call and check the amount of blood remaining in the bank which is error prone and tedious task. The national blood bank reports to the Ministry of Health (MoH). The reports are done monthly, quarterly, half-yearly, and yearly.

NBB currently has a relatively small network, which connects the data center with different departments with a maximum of 15 users.

For the national blood bank, it is possible to trace when a donor donates blood in the bag it will be given pack number, and after health centers receive the amount of blood they must return the feedback to the bank on how they used the blood taken from the bank.

Currently, the center uses a database application which is developed using SQL database management system. The center uses the database for the recording of donors' profile, blood distribution to health facilities, screening information and discarded

bloods information. In addition, the center generates reports using the information recorded in the database. In addition, the database does not have a front end, which could have made it easy to learn and operate. Thus the existing system is not user friendly.

In order to facilitate the blood donation and processing service, NBB uses various kinds of documents and forms. Those documents and forms currently used in the bank include memorandum of understanding (MoU), donor registration, blood distribution, blood discard and reporting formats. The documents used at the center helped us to know exactly what this documents are for about, what specific information included and what is left out (for example, the problem of not having a separate donor registration form and blood registry form, in addition the reporting format lacks blood specific (O, A, B, AB) output).

4. The Proposed Solution

The final output of this work is a web based blood donation system that is tailored to NBB and would serve as a medium to exchange information easily for the donors, health centers, NBB and the MoH. A prototype was also developed as shown in Figure 2.



Figure 1: The Developed Web Application

In addition, the system brings together different types of stakeholders including blood donors, blood banks, health organizations, and MoH staff through the web application. In the proposed architecture, as shown in Figure 2, there are five components as presented below.

1. *Registration Module*: has the following three services.
 - Donor Registration Service: handles donor registration; it enables them to reserve for

donation and view their donation and reservation profile.

- NBB Employee Registration Service: provides registration for the employees of NBB where the authorized organ to register the employees is MoH. The registration enables the employees to manage donor's reservation, hospitals and health centers request, view stock and manage the health centers account.
- Health Centers Registration Service: provides health centers registration that enables them to request blood, view their requests and view request history.

2. *Request Submission Module*: has the following three services.

- Reservation Request Service: enables donors to send reservation request, which will be managed by NBB.
- Campaign Reservation Request Service: enables to broadcast campaign for donors, thus donors can register themselves as campaign donors.
- Blood Request Service: enables health centers to send blood requests, which will be managed by NBB according to the blood stock.

3. *Broadcasting Module*: has the following two services.

- Broadcast Low Par Value Blood Type: broadcasts the blood in stock with a lower par value.
- Campaign Donation Management Service: enables the center to broadcast different campaigns which donors could directly sign up via the web application and donate blood according to the registered campaign.

4. *Request Response Management Module*: has the following two services.

- Donation Management Service (Reserved, Campaign & Unreserved Donation): enables the management of donor's reservation. Thus donors reserved can easily donate blood. It is also responsible for the management of

campaign donation requests. In addition, donors who want to donate blood without reservation or walking donors can also be managed via this module.

- **Stock Management Service:** enables NBB employees to manage stock.

5 **Reporting Module:** has the following service.

- **Reporting Service:** enables to generate reports, including donor's reservation report, donor's donation, health centers request report, etc.

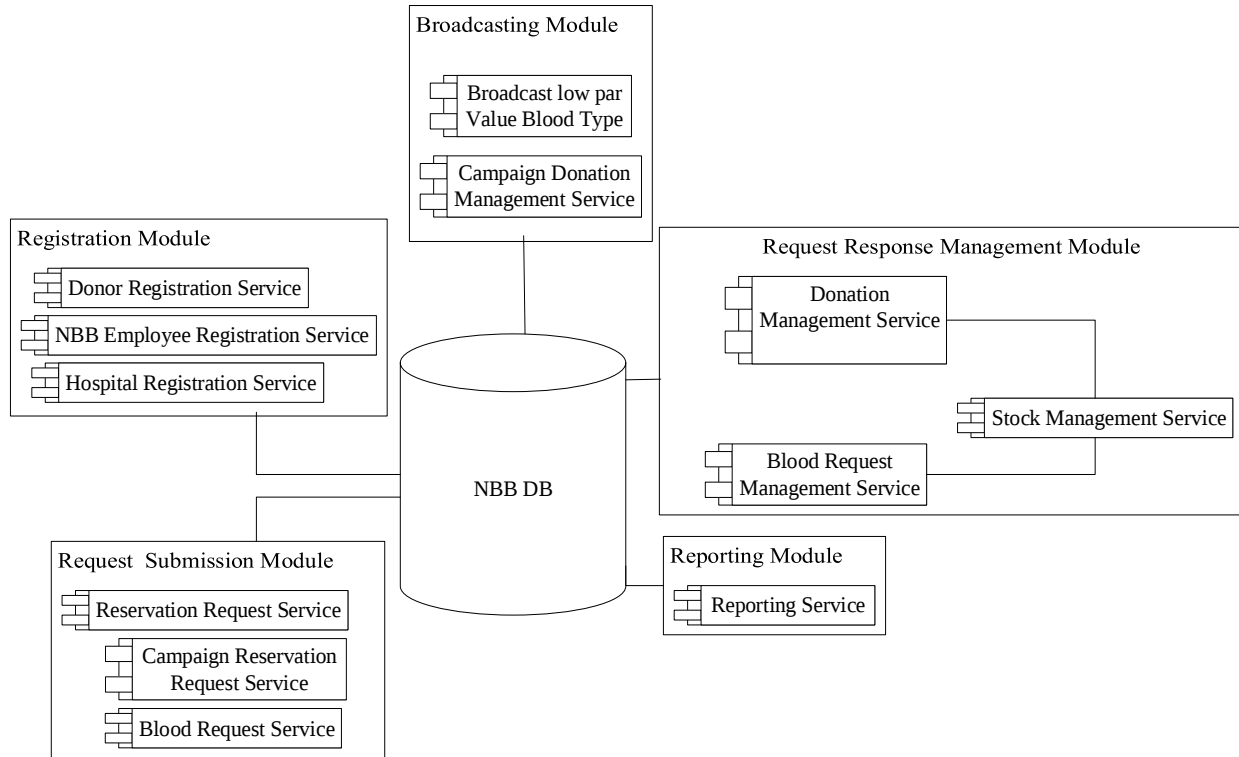


Figure 2: Blood Donation System Architecture

The evaluation of usability is an important aspect of software design and development and a questionnaire was distributed for a total of 19 respondents. According to the result of user interface evaluation most of the respondents, i.e., 84.89%, strongly agreed that the system prototype has an interface that is easy to use, attractive and the security is maintained properly.

5. Discussion

This research is carried out with the aim of proposing a web based blood donation management system and addressing the problem of direct control and management of the overall activities performed in the blood bank centers of MoH. Thus, web based blood donation mechanism was implemented for the stakeholders.

The prototype developed in this paper demonstrated how a service implementation

facilitates the blood donation mechanism. Donors could register themselves for reserving a spot for donation via the web based application, which would also entertain viewing their donation profile. This process would facilitate the blood collection through minimized time and effort. Health centers could be registered by the NBB after agreeing with the terms and contract of the NBB. There after they must sign the MoU based on the terms of the national blood bank regarding the safety of the blood. It is also possible for them to view their blood request profile as well. NBB would manage donors and health centers to facilitate blood donation and processing mechanism efficiently and effectively. Since NBB reports to MoH, the system would be managed by MoH.

NBB currently has 24 branches where blood donation and distribution services are given. But, the

result in this work must be somehow modified with further analysis and minor modification of the existing systems on each branch to provide a comprehensive solution for sharing data sources. In developing the system prototype, requirements were acquired using in-depth interview, questionnaire and documents used at the center. The collected requirements were analyzed and designed using UML.

The research has provided an input regarding the provision knowledge base in the integration of different stakeholders. In comparison with other researches, this research has come up with three main web application architecture types. These are server-side HTML web application, JS generation widgets (AJAX), and service-oriented single-page web apps (Web 2.0, HTML5 apps) which each of them had been reviewed and service oriented single web apps (Web 2.0, HTML5 apps) was adopted. This was because it provides a communication that can involve either simple data passing or it could involve two or more services coordinating for some activity. In addition, Responsiveness/Usability, Performance and Conversion rate of the web application is high which will be demanded by the blood donation management service.

6. Conclusion and Future Work

This research is carried out with the aim of proposing a web based blood donation management system and addressing the problem of direct control and management of the overall activities performed in the blood bank centers for MoH. Thus, web based blood donation mechanism was implemented for the stakeholders. The prototype developed in this paper demonstrated how a service implementation facilitates the blood donation mechanism.

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Figure 3: Donors Reservation

This process will facilitate the blood collection through minimized time and effort. Health centers could be registered by the NBB after agreeing in the terms and contract of the NBB. There after they must sign the MoU based on the terms of the national blood bank regarding the safety of the blood. In addition, it is also possible for them to view their blood request profile as well.



Figure 4: Manage Blood Stock

In order to implement our result, NBB and MoH should support the project in human resource and finance. In addition, the organizations should upgrade the hardware and network infrastructures of the main center and MoH. The regional health bureaus should support their respective blood bank centers with necessary human resource, hardware and network infrastructure for the implementation of this project.

It is recommended that interfacing issues like network infrastructure, security and particularly the data type that might be required by other stakeholders must be taken into consideration up on project initiation and planning.

Finally, the expansion of this system architecture is open for further work in accommodating other requirements like Android application based blood donation and consideration of other security aspects.

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