Scientific Voyage
Vol. 1, No. 3,
Page 37-46 (2020)

SCIENTIFIC VOYAGE
ISSN: 2395-5546

GCECT
Publication
Jul.-Sep.

Cloud-based automated blood management system

Sougata Sil[1] and Somaditya Roy[2]

[1] *Department of Computer Science & Engineering, Techno Engineering College Banipur, Banipur College Road, Habra 743233, West Bengal;* E-mail: *sougatasil2001@gmail.com*

[2] *Department of Information Technology, Techno Engineering College Banipur, Banipur College Road, Habra 743233, West Bengal;* E-mail: *rsomaditya@gmail.com*

Abstract: From decades, donating, managing, and receiving blood throws a great challenge for the whole human civilization. If there is an excellent blood management system, death due to unavailability of blood along with blood wastage could be reduced. This paper presents a website for online blood management facility. The proposed system consists of three subsystems for real-time blood request response using JavaScript data shuffling and an optimized search for the same; blood bank stock balancing and scientific management and scheduling of blood donation camps by clustering data and performing nested SQL queries for data analysis. This would be an advancement of the classical blood management model to an automated system using web technologies (HTML,CSS, SQL, JavaScript, php). The prototype is carried out using sample data. The system evaluation and analysis are provided .

Keyword: Blood management system; interactive website; real-time communication; stock-balancing; search optimization; clustering; notifying; suggesting; prevention of blood wastage; data analysis

1. Introduction

In recent years, with the rapid development of medicine, health improved a lot. At the same time, health professionals failed to solve many problems [1], that pose a serious threat to the human civilization, therefore the field of health and technology is now a popular research topic, to deal with such problems technically in an automated way of blood management with user convenience in mind compared with the manually operated existing system [2].

In this website, users can be of four types – Donors, Blood Banks, Blood donation camp organizers and recipients. Users can register or login as a guest to avail our services.

Our services to:

Recipients: Searching for blood, Searching and requesting blood as registered users or unregistered guest users.

Donors: Notifying for blood need requests according to location analysis and making specified blood group holding donors aware of blood donation camps.

Blood Banks: Notifying for blood need requests according location analysis and suggesting for balancing stocks according to location cluster need.

Blood donation camp organizers: Notifying for organizing blood donation camps when at certain location cluster there exists a huge range of difference between stock and requirement and informing specified donors about specified blood group blood donation camps.

This paper focuses on implementing these solutions technically to solve the mentioned problems integrating in a website [3]. In addition to all the steps, we have followed a design thinking approach to enhance the proposed solution [4]. We expect to achieve good results in the worse environments, to provide the recipient with blood with ~100% positive results and as fast as it could be.

To conduct the experiment with the prototype of the website, we are using manually made sample user database [4].

The sample database consists of tables for Individual donors(t2) , Blood banks(t1), blood search query log(ureq), user location reference (location_grid), location clusters (l1, l2, l3, l4…). (t1) & (t2) consists of unique user id, name, blood group and available blood groups respectively. (ureq) consists of user input data during generating a search query for required blood.(location_grid) consists of location clusters with each assigned a set of latitudes and longitudes so as to group users according to their location and include them in a specific location cluster. (l1, l2, l3, l4…), are the location clusters, each with the fields of need and requirement for every blood group.

2. Proposed System

2.1 Use Case Diagram

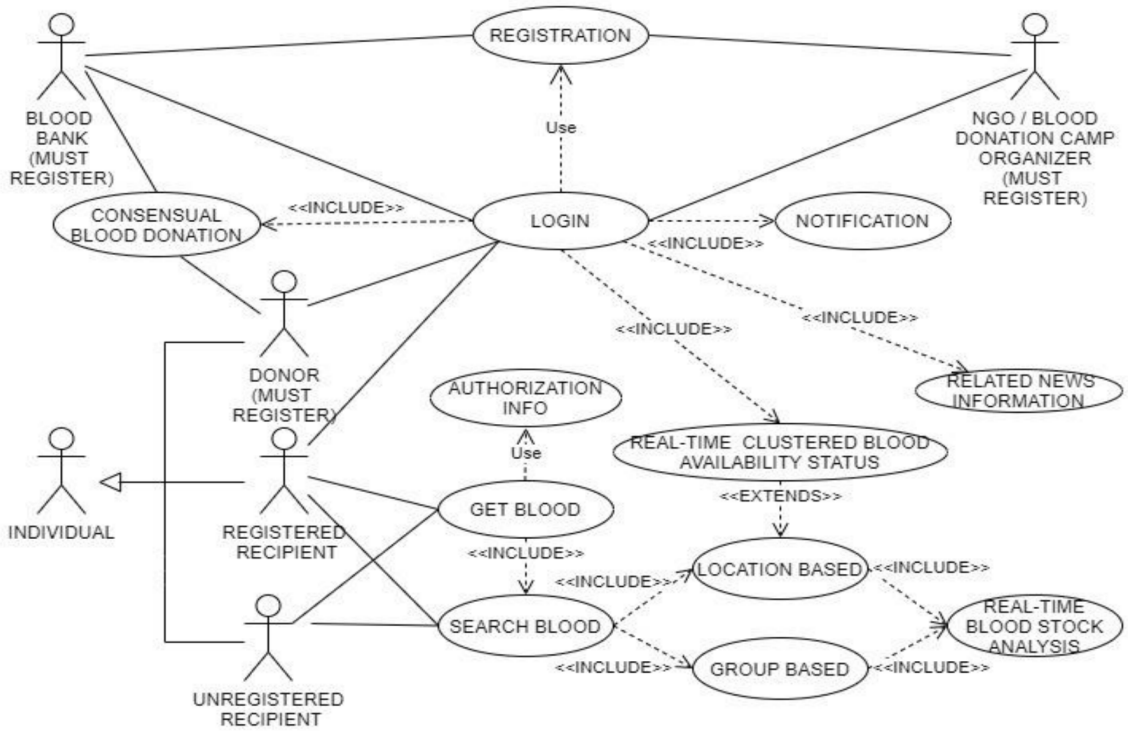

Fig.2.1: System Use Case Diagram

2.2 System Structure I

System structure I describes the user registration/login system according to the type of user. On visiting the home page of the website, the user will be offered with an option of (registration or login) 1. He/she may register into the system or can avail the services as guest [5,6]. To be a donor the user (individual/blood bank) must register into the system, to access their data during a search request.

The user will be redirected to a page consisting of the three types of users on clicking (1), from which the user can register or login to his/her profile [7].

Fig.2.2: Registration/Login

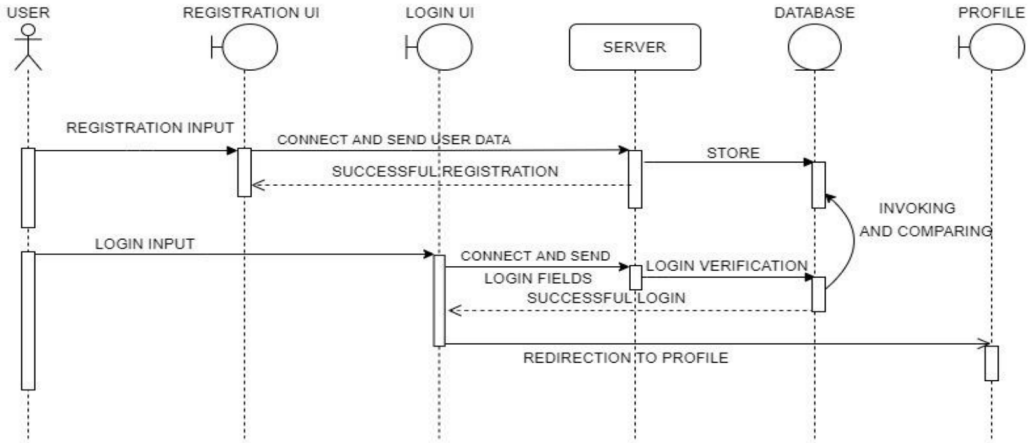

Fig.2.3: Registration/Login Sequence Diagram

This figure illustrates the part of the prototype dealing with the registration and login. The structure of the illustration is made & connected using HTML and the form is validated using JavaScript. The submit button sends the data from the form to the respective tables in the database according to the type of user; using the 'POST' method, ensuring security of the personal data. Login button redirects an existing user to a login page so as to give the user access to his profile after verifying the user name and password from the user entered data during the registration, this is also done using the 'POST' method.

After the login, user is redirected to their own profiles where they can access various activity tabs according to their need. The activities include going to the home page for accessing the blood searching and blood request services through the GO TO HOME tab; NOTIFICATION tab for accessing notifications; STATISTICS tab for viewing the stock vs need statistics for each blood group of each location cluster according to the user searched location cluster. This STATISTICS tab is same for all user profiles [5-7].

In this experiment, the registration system will not be focused, as we will be using sample data as described earlier, instead we will login with the username and password to enter into our profiles as individuals, blood banks and blood donation camp organizers. We will also avail the services being a guest user to the website prototype [4].

2.3 System Structure II

System structure II describes the control flow and algorithms involved in the process of Blood searching and Blood request.

2.31 Searching Blood

The blood searching unit is the section of the homepage, where the user can login as guest or as registered user and can avail the specified service, the service can be defined as searching for blood with required parameters among various blood banks and individual donors connected with our system. Through this blood searching unit, the user can only search for blood without disclosing his/her identity that is being anonymous. The search unit deals with both registered and unregistered users therefore there need some privacy protocols to be maintained, so as no donor information is disclosed. Keeping these factors (2) in mind, this search unit only displays the number of matched donor individuals according to the input parameters entered by the user.

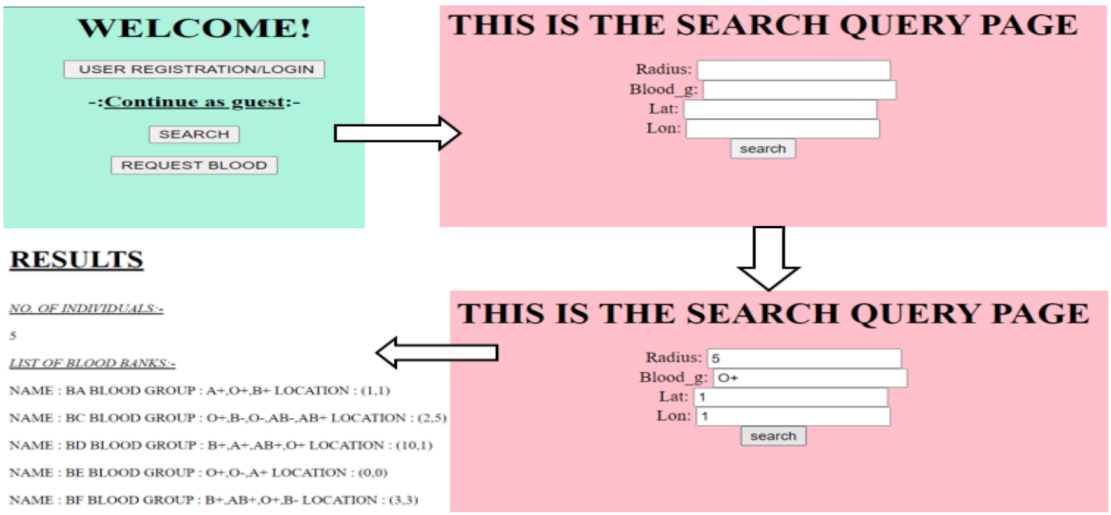

Fig.2.31(A): Search query flow

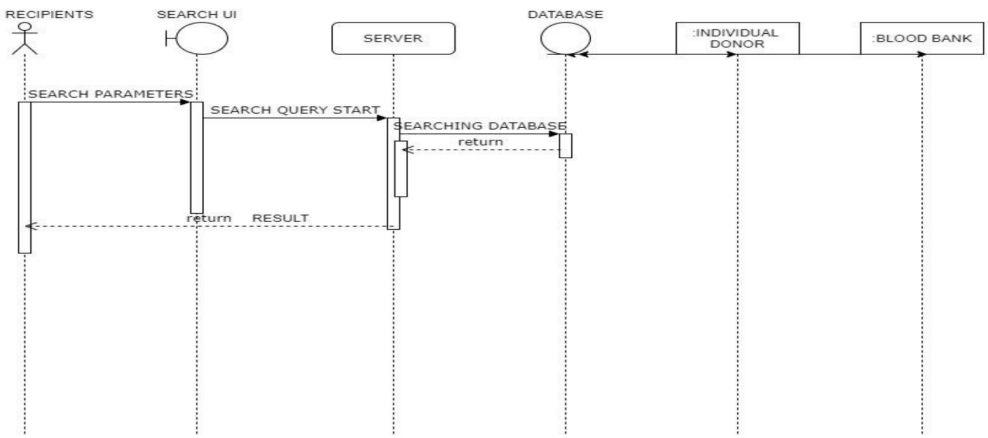

Fig.2.31(B): Blood Search Sequence Diagram

The mentioned figure illustrates the process of Blood Search from the home page to the results of the search query generated by the user with the mentioned parameters.

This process includes three steps of redirection with the 'POST' method, firstly on clicking the *Search* button in the HTML structured home page, it redirects user to a search query page. This page allows the user to search blood (individual donors & blood banks) keeping three parameters as the filter of the result. The parameters include radius in which the search should be applied as *radius,* the required blood group for which the user wants to search for as *Blood_g* and the current location of the user. In this experiment with the prototype, the location is manually taken from the user in the form of latitude and longitude; in the real scenario, the website will be accessing the current GPS location of the system used by the user. In this way the parameters will be addressed. On clicking the search button, the backend search query that is the SQL embedded php code filters and fetches the table data from the tables of the database inside the phpmyadmin panel to the display

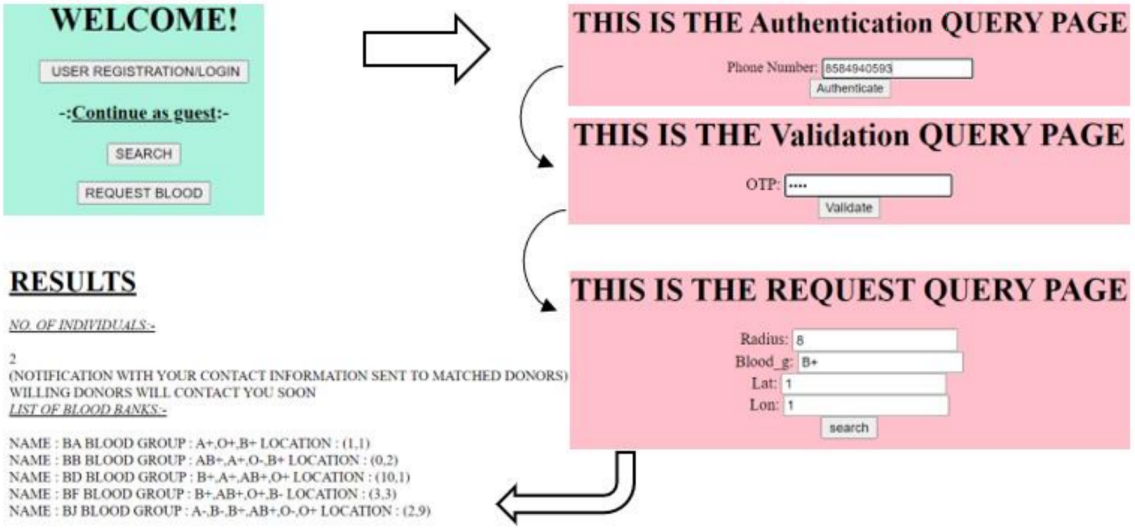

Fig.2.32(A): Request query flow

section. After clicking on this search button, the user is redirected to search results page, where the fetched-out information is displayed in an user readable format [5,8]. From the previous discussion (2), due to these security issues, in the result section, only the blood bank information and the number of matched individual donors is being displayed hiding the information about these individual donors.

2.32 Requesting blood

The blood requesting unit is the section of the homepage, where the user can login as guest or as registered user and can avail the specified service, the service can be defined as requesting (that is searching for matched individual donors and blood banks and then sending a notification request to the matched individual donors for contacting the user generating the request) for blood with required parameters among various blood banks and individual donors connected with our system. Through this blood requesting unit, the user can both search and request for blood keeping his/her personal information into our database as an entry log data. The request unit deals with both registered and unregistered users therefore there need some security measures to be maintained, so as no donor information is disclosed unauthentically to any user. Keeping this factor in mind, the request unit is optimized to authenticate and validate the user using an OTP service [9] as soon as the user enters the Request Blood section, before giving him access to the request query page.

The mentioned figure illustrates the process of Requesting Blood from the home page to the results of the search and request query generated by the user with the mentioned parameters.

This process includes four steps of redirection with the 'POST' method, firstly on clicking the Request blood button in the HTML structured home page, it redirects user to a user authentication page using phone number as the authentication source to start an OTP (One Time Password) service. After submitting the phone number, the system keeps record of it as log data and then an OTP is sent using php code to the entered phone number and the user is then redirected to the phone number validation page. This page allows the user to enter the sent OTP and validate the user so as give access to the next page that is the request query page (if the OTP matches with the sent OTP of that specific php session; access is given, otherwise denied). This page allows the user to search & request blood (individual donors & blood banks) keeping three parameters as the filter of the result. The parameters include radius in which the search should be applied as radius, the required blood group for which the user wants to search for as Blood_g and the current location of the user. In this experiment with the prototype, the location is manually taken from the user in the form of latitude and longitude; in the real scenario, the website will be accessing the current GPS location of the system used by the user. In this way the parameters will be addressed. On clicking the search button, the backend search query that is the SQL embedded php code filters and fetches the table data from the tables of the database inside the phpmyadmin panel to the display section. Besides that, a notification is sent to the matched individual donors. The notification consists of two options to AGREE and DISMISS. If the notification is agreed, the contact information of the recipient will

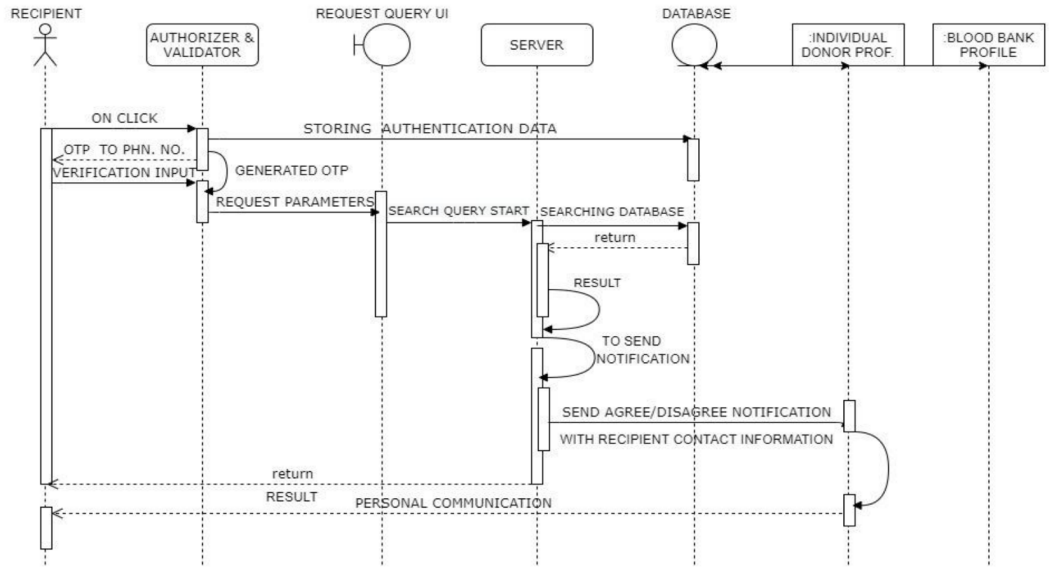

Fig.2.32(B); Blood Request Sequence

be made transparent to that donor then he/she can contact the recipient and move for further steps for successful donation. If the notification is disagreed, the request ends up for that user and continues for the rest. Besides, the user is redirected to search results page, where the fetched-out information (matched blood bank information, number of matched individual donors, notification sent status and number of agreed and disagreed) is displayed in an user readable format. From the previous discussion (2), due to these security issues, in the result section, only the blood bank information and the number of matched individual donors is being displayed hiding the information about these individual donors [8-11].

2.4 System Structure III

System structure III deals with the process of generating notification for balancing blood bank stocks and scientific organization of blood donation camps by the blood donation camp organizers to reduce blood wastage.

(Whole blood lasts for only 42 days, after that the expired blood is thrown away . According to a study annually 6.67% of donated blood is discarded due to its unutilization in proper time. This leads to a loss of (1.3-1.4) million rupees for the blood banks annually.)[12]

This system structure will be further divided into two segments as mentioned previously Blood Bank Profile and Organization profile. The two entities could access their respective profiles by logging in to their profiles through the login/registration button at the home page as described in the *SYSTEM STRUCTURE-I*. Both the entities will be redirected to a similar structured profile pages with three tabs: *GO TO HOME, STATISTICS, NOTIFICATION*; but with different contents of the notification tab. The *GO TO HOME, STATISTICS, NOTIFICATION* tab will redirect the user to the home page, location-based (stock vs requirement) statistics and the specific notification page respectively. The same *GO TO HOME&STATISTICS* tab will be available in the profile of every user category [13].

2.41 Blood Bank Profile

After the successful Blood Bank login, the user will be redirected to the Blood Bank profile page with the mentioned tabs.

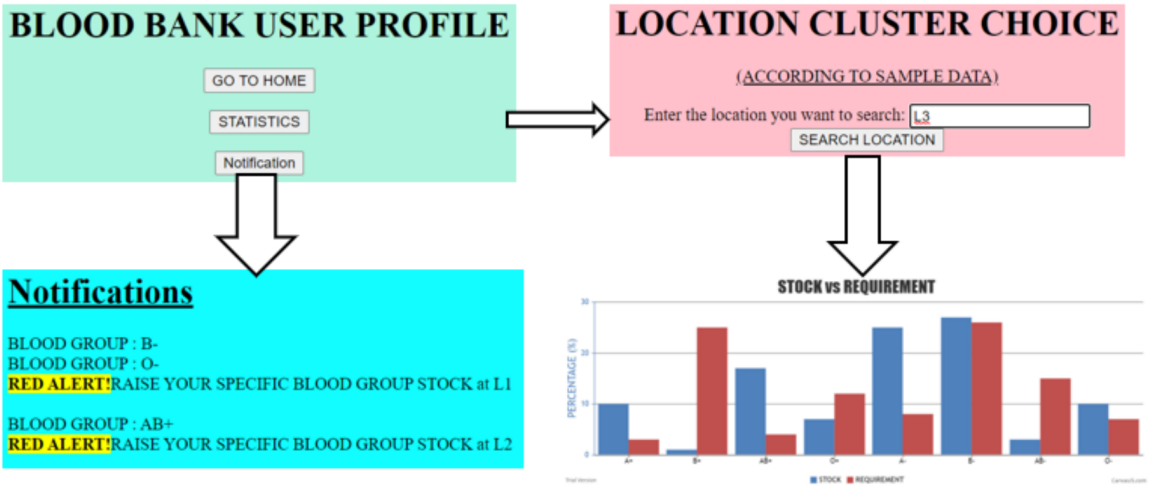

Fig.2.41; Blood Bank profile flow

In the illustrated figure, after clicking on the *STATISTICS* button, the user is redirected to the location cluster page so that the user can view the stock vs requirement statistics of any location the user wants to by simply searching the location cluster in the search location field. The *NOTIFICATION* button redirects the user to the blood bank notification page, where he/she can view the blood bank stock suggestions given by our system according to the location cluster requirement.

A. THE STOCK VS. REQUIREMENT STATISTICS

(In this experiment we are using sample location cluster data as L1, L2, L3…; without entering the real-world location values.)

After clicking on search location button, the JavaScript code embedded with php and SQL, searches for the location table entered in the location field from the database. Then the php code fetches the rows of the tables that is the stock and requirement data for each blood group and initializes it to the JavaScript variables that are used to create and display those data as a visual representation in the form of bar graph.

In the given bar graph, the y-axis denotes the percentage of units of blood and the *x*-axis denotes the eight blood groups (A+, B+, AB+, O+, A, B-, B-, O-).The blue bar denotes blood stock present in that specific location cluster and the red bar denotes the amount of blood needed in that location cluster. The value of the stock column is calculated by accessing the stock databases of the blood banks present in that location cluster. The requirement data is generated by calculating a population-based blood group ratio of that location cluster.

For this process, firstly the registered users are clustered according to their respective location using SQL query, then on every such clustered data, a nested clustering is done based on each of their blood groups. Thus, the ratio is generated which can be assumed as the actual requirement ratio when we have a huge database. Now, in the statistical representation, the bar graph we are using these two data sets to understand the comparison between the Blood Stock and Requirement for a specific location cluster.

B. BLOOD BANK NOTIFICATION

(In this experiment we are using sample location cluster data as L1, L2, L3…; without entering the real-world location values.)

After clicking on the NOTIFICATION button, the html code redirects the user to the blood bank notification page. The notification page backend SQL embedded php algorithm takes the access of the blood bank stock data of the user and the neighbouring blood banks of that location and checks weather the blood stock and requirement difference(from the previous section of statistical calculations) is less than 5%, then NO WARNING; if greater than 5% & less than 20%, then alert message for upraising the blood stock of that specific blood group. Thus blood is balanced at every location cluster to provide the fastest service and positive availability at the nearest blood bank.

2.42 Organization Profile

After the successful Blood Bank login, the user will be redirected to the Blood Bank profile page with the mentioned tabs.

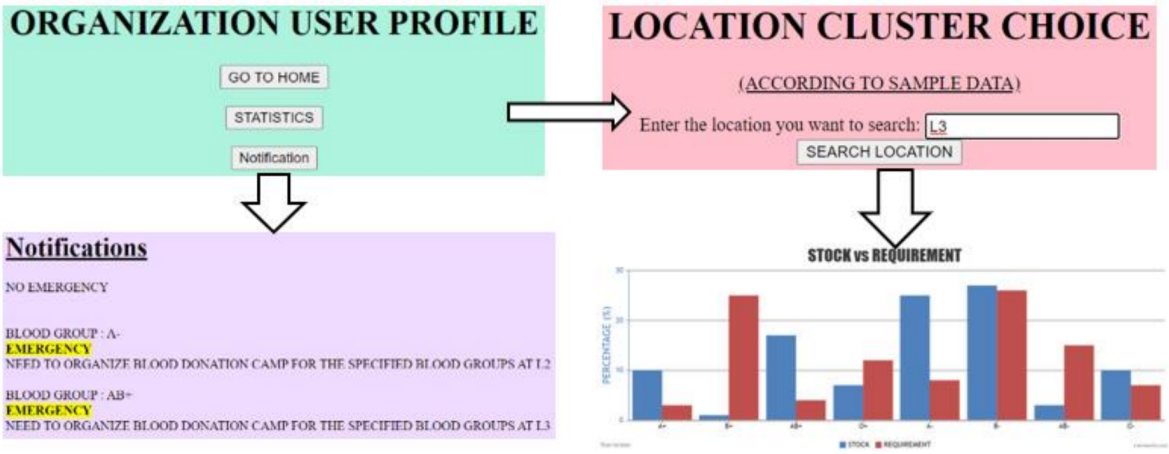

Fig.2.42; Organization profile flow

In the illustrated figure, after clicking on the *STATISTICS* button;*[same as blood bank profile statisticssection, statistics tab is same for every user]*. The *NOTIFICATION* button redirects the user to the Organization notification page, where he/she can view the notification for organizing blood donation camps at specific locations according to the suggestions given by the system.

Organizing blood banks is the final option to balance blood stocks at blood banks according to the location requirement when the blood bank stock management suggestion fails to balance the blood stock.

In this process, as soon as the organization user is redirected to the notification page, the backend SQL embedded php algorithm checks for the difference between Stock and Requirement data sets from the statistical calculations as described earlier. If the difference for one or more blood group is greater than 20%, then an emergency notification is sent to the blood donation camp organization with the location and those specific blood groups which are deficient so as to organize an blood donation camp only for those specific deficit blood groups. At the same all the individual donors within that location cluster, with those specific blood group holdings will be sent an notification regarding the blood donation camp with the location of the event, thus only collecting that deficient blood group to fulfil the need and not to store excess blood, leading to blood wastage.

3. Results and Discussions

After the successful testing of the system for accuracy, using a small set of sample database, now the system will be tested for its capability to work with large databases and the execution of the queries with time complexity approach.

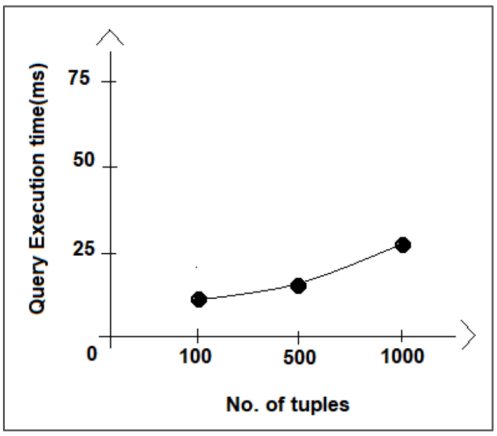

Fig.3.1: PROPOSED SYSTEM

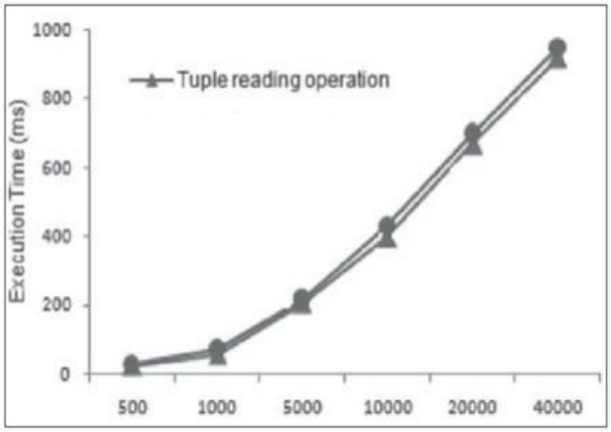

Fig.3.2: EXISTING SYSTEMS

The Figs. 3.1 and 3.2 illustrates a graphical representation of the query execution speed (in milliseconds) to the number of tuples in the database from which it fetches & filters the data and displays it to the user.

The comparison the two figures proves that the proposed has attained the execution speed required to handle huge data traffic. On detailed analysis, it can be observed that the slope of Fig. 3.1, is much efficient than the existing systems [14] when the experiment is done by generating a huge user database by looping randomize function and returning the value into the tuples of the tables in our database. These experiments provide us with a descent feedback and expected results.

4. Conclusion

This paper presents a scientific Blood Management System designed to help people in need of blood and blood banks to search and request and avail blood faster with a positive impact and to prevent wastage of blood and money and time. The system (website) is divided and maintained with many subsystems. All these

subsystems integrate to make a positive change to the current health care system that is the blood management system.

- Automated system of blood management (A website)
- Easy and positive search result for the required blood
- Predicting zonal blood stocks, to make it available before vacancy
- Time to time management of blood donation camps to overcome blood wastage
- Faster, accurate and secured real-time responses

The future aspects of this project are enormous. This will include statistical analysis on health factors, trend of diseases on a blood group, after a huge user base; data marketing for health research and lot more using Machine Learning algorithms. Our future works will also include updating our system from a website to an app to make it more user friendly and attractive and popular for the use of common people [15].

Acknowledgment: SS expresses his sincere gratitude to the rest of the team members for their insightful comments and encouragement, and for the hard questions which inspired me to widen up my thoughts from various perspectives.

References:

1. K. Ghosh, *Ind. J. Hematol. Blood Transfus*., **34** (2018) 501.
2. K. Vikas, M. Sharad, *IJE* **1** (2011) 260.
3. S. Shrinivas, V. Vijay and S. Yennam, *IJARIIT* **3** (2017) 218.
4. R. Garett et al., *J. Commun. Media Technol.* **6** (2016) 1.
5. P. Kumari and R. Nandal, *IJARCS* **8** (2017) 1231.
6. M. Fotachea and C. Strimbei, *Proc. Econ. Finan.* **20** (2015) 243.
7. L. Lemay, R. Colburn and J. Kyrnin, Mastering HTML, CSS & Javascript (Web Publishing, 7th Edition, BPB publications, 2016).
8. A. Sumita, Computer Science with C++, Database, SQL, Boolean Algebra, Networking Basics (11 Edition, Vol. 2, Reprint 2017, Dhanpat Rai & Co.(P) Ltd. Publication).
9. M.H. Eldefrawy, K. Alghathbar and M.K. Khan, 8th International Conference on Information Technology: New Generations, pp. 327-331, July 2011.
10. M. Joel and H. Ray, Murach's PHP and MySQL (3 Edition, Reprint 2017, MMA publication).
11. M.S. Rahman, K.A. Akter, S. Hossain, A. Basak and S.I. Ahmed, IEEE Workshops of International Conference on Advanced Information Networking and Applications, pp. 544–548 (2011).
12. S. Hisham, A. Al-Madani, A. Al-Amri, A. Al-Ghamdi, B. Bashamakh and N. Aljojo, *Life Sci. J.* **11** (2014) 60.
13. D. Pandey, A. Umare and R.S. Mangrulkar, IJRSE **3** (2017).
14. A. Gaikwad et al., *IJTSRD* **2** (2017)1027.
15. S. Roy and S.K. Bandyopadhyay, *Int. J. Res. Info. Tech.* **1** (2013) 248.