|| Volume 6 || Issue 3 || March 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
AND ENGINEERING TRENDS

BLOOD BANK AND BLOOD WASTAGE MANAGEMENT USING INTERNET OF THINGS AND STREAM ANALYTICS

Firoj Shaikh[1], Asst. Prof. V. S. Karwande[2]

M.E Student, Department of Computer Science and Engineering, EESGOI, Aurangabad[1]

Head of the Department, Department of Computer Science and Engineering, EESGOI, Aurangabad[2]

Abstract: - Every year, 65 million trauma-related surgeries are conducted in India. Every day, it sees over 1,300 car accidents, 10 million pregnancy complications, 230 million major operations, and 331 million cancer-related procedures that necessitate blood transfusions. Every year, approximately 6.7 lakh units of blood and its components are wasted in India before reaching the poor. In 2016, more than 6.58 lakh units of blood and its components were discarded across the world. Blood components and goods such as plasma, which has a one-year shelf life compared to whole blood units and red blood cells, which must be used within 35-45 days, accounted for 50-55 percent of the lost units. In this paper, we present an architecture prototype of a Blood and Wastage Management System based on the Internet of Things and stream analytics, through which any donor/requester, hospital, or blood bank can search for their preferred blood group and donate to the nearest blood bank or hospital within City/State/Country using its current position in real time. Donors can register themselves, and hospitals and blood banks can register via a module in the BBABWM (Blood Bank and Blood Wastage Management) app, which also allows for inventory management. Real-time blood stock inventory data can be accessed using a cloud-based web application and made available to hospitals and blood banks around the world. The inventory details for the blood units, as well as the GPS location, are stored in this data structure. Donors/requesters may enter the details of their blood unit as well as their current GPS position to locate the closest blood donor or hospital. The most common causes of wastage are decay during storage and the expiration of blood units due to outdating. The proposed system would assist in improving blood unit transportation to all vulnerable areas, reducing blood wastage, and locating desired donors in real time.

Keywords: Blood, Blood component, Blood products Internet of Things, Stream Analytics, GPS, blood wastage, Transportation, Expiration, Transfusion.

I.INTRODUCTION

Each year, approximately 6.7 lakh units of blood and its components are wasted in India before reaching the poor on time. Between 2012 and 2016, over 2.8 million units of blood, its components, and blood products were discarded by blood banks across India, according to the National Aids Control Organization. About 6.58 lakh units of blood and its components were discarded in the United States alone in 2016. Blood components and goods such as plasma, which has a one-year shelf life compared to whole blood units and red blood cells, which must be used within 35-45 days, accounted for around half of the lost units. Many units of blood expire before they can be used due to the limited shelf life of blood and the difficulty of maintaining proper storage conditions. Between 2011 and 2015, 130,000 litres of blood expired at blood banks in Mumbai, India, according to an Asian Age survey. Though some blood loss is unavoidable, IoT solutions will help minimise the amount of blood that is lost.

Many factors lead to blood and blood product wastage in India, including broken bags, burst packs, infected packs, under donations, clotted donations, broken seals, delays performing tests due to personnel shortages or resource constraints, fridge failure, lack of proper storage, problems with the manufacturing and testing of blood components, expired units, over-ordering, insufficient transportation, and returned after use. In the 2016-17 fiscal year, 16 states and UTs had a supply deficit, while 18 states had a surplus. However, in the aforementioned states, cases of blood unit wastage are normal. Since blood has a 30-45-day shelf life, any surplus blood must be distributed as soon as possible to all areas in need. States like Arunachal Pradesh, Chhattisgarh, Uttar Pradesh, and Meghalaya, on the other hand, fail to fulfil more than 40% of their blood requirements. To avoid blood wastage, care must be taken during transportation, manufacturing, and testing of blood components, as well as storage.

The majority of blood bank processes, such as the temperature of the refrigerator and inventory, are currently controlled manually. Blood banks can keep track of storage quantity, blood types, temperature, and other measurements by using wireless IoT sensors linked to an automated management network, which can then be released online for hospitals and other healthcare providers. Temperature fluctuations may be observed until they endanger the supply if the storage temperature is continuously monitored in real time. The device will send a warning to operators if the temperature falls below or rises above a certain pre-set limit, allowing them to fix the problem and prevent the units from expiring. Area blood banks may also be linked via IoT so that requests are automatically forwarded to the nearest bank in the event of a shortage.

II. LITERATURE REVIEW

Throughout this research work we are constantly analyzing and reviewing the research efforts of other researchers in order to identify and address questions, common queries in the blood bank management, transportation, storage and wastage systems. Ahmed AL-Kalbani (2017) [5] in research stated that in some hospital use excel sheet in computer to maintain the details and they contact people by call or SMS in case of emergency.

Most health institutions, blood centers and Hospitals use MS Excel/Paper registry as a database of blood donors, in emergencies it is difficult to communicate with donors. When a donor Register for the first time, they are requested to provide personal details (e.g., name, address, age, job, gender, blood group, GPS location) along with medical (e.g., diagnosis, lab results, treatments) data which are collected through applications. Ashlesha C. Adsul (2018) [1] has implemented automated blood management system which fetch information from database and will send SMS to the donor directly on his number which is stored at the time of registration. Hridoy Deb Das (2020) [3] work on blood donors in which requesters can search donors from their current or destination location within 5km, as a result, finding donors and arriving at the destination in the shortest time using GPS location. Fauwzziyyah (2019) [2] In the Prospect and Significance of Lifeline defined blood bank service that ensures patients get quick access to blood donors of any type, it can thrive in remotest of areas and easy to use for online and offline queries for both young and old because of Unstructured Supplementary Service Data Short Message Service (SMS) and free toll line.

The location-based application, operational on android platform, will help clients easily find donors of matching blood groups in their location and can be accessed via their mobile phone, (2014) [10], made a blood donation application with an author named Android Blood Donor Life Saving Application in Cloud Computing. One client can contact quickly with donor of matching blood group. Their application provides list of donors in your city or area. Ritika and Pau (2014) [7] examined different classification algorithms to find out a fair classification technique for the prediction of donations. Jenipha and Backiyalakshmi Ekici and Ozener (2014) [8] defined a variant of the Vehicle Routing Problem, i.e., the Maximum Blood Collection Problem (MBCP), in which blood collected in a set of blood donation sites is delivered with a fleet of collection vehicles to a single processing center. Mehmet Karakoc and Melih (2017) [4] work on Priority Based Vehicle Routing for Agile Blood Transportation between Donor/Client Sites using Artificial Intelligence based Vehicle Routing Problem (VRP) for Blood Transporters (BTs) and propose an efficient vehicle routing scheme for blood transportation between hospitals or Donor/Client Sites (DCSs) within a region. It is formulated to consider the urgency of the requests and responses to minimize the number of BTs while maintaining minimum traveling lengths considering priority. Karakoc et al. (2015) [9] used VRP approach with GA to blood transportation between medical facilities. However, in their approach they did not consider the urgency requirements of the blood.

III. RESEARCH METHODOLOGY

This Research is model driven system workflow of a nation's blood and wastage management system and implementation technique help to resolve blood wastage during transfusion, storage, and transportation within country. This technique has not been the focus of researchers from the reviewed papers. The implemented system is robust, durable, effective, fast, and secure blood delivery.

PHASES OF BLOOD MANAGEMENT

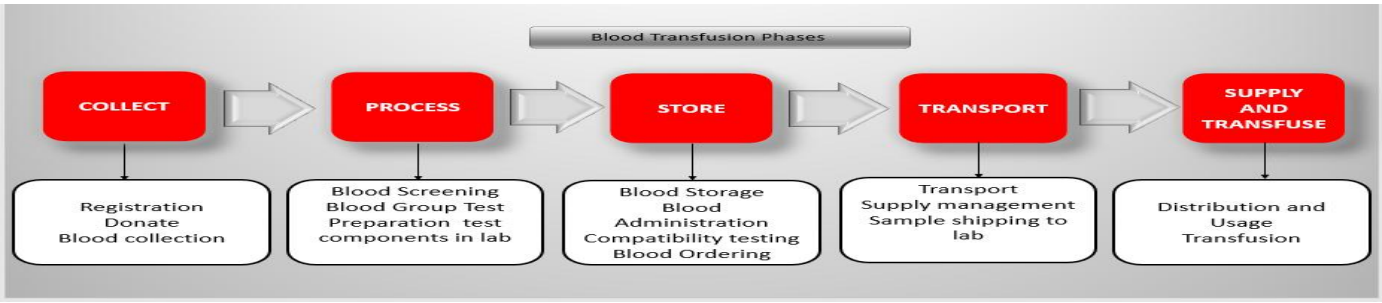

Figure 3.1: Phases in Blood Management System.

Blood Management system can be divided into four main terms, in Figure 1. Registration Collection, Process, Storage Transportation, supply and Transfusion.

A) REGISTRATION AND COLLECTION

Blood donation starts with donor registration at the blood center, Donors can be new donors, returning donors, who donate on regular basis, and who are entering the system occasionally or for the first time.

The collection of blood from donors may take place at blood donation camps, within the blood transfusion center or hospital blood bank. In India it is also often collected from donors during mobile blood collection sessions.

B) PROCESS, STORAGE AND TRANSPORTATION

Blood: whole blood. In this Manual, the generic term "blood" is used to mean whole blood, red cells, blood components and blood products.

Blood component: A separable part of whole blood obtained using centrifugation, e.g., red cells, platelet concentrates or fresh frozen plasma.

Blood products: Blood components obtained from plasma using pharmaceutical processes.

After collection, the blood is then taken to a laboratory for testing. Blood is then processed into components and for storage and distribution as per the need. Generally, Blood is collected at body temperature, i.e., +37 °C. But to maintain its vital properties, it must be cooled to below +10 °C to be transported and stored at refrigeration temperatures of around +4 °C until use.

Small blood donation camps, blood centers sometimes deal with lack testing resources of the blood products, so must be transported to desired location.

The work of Ashlesha C. Adsul (2018) [1] et al. uses GSM Modem and raspberry pi-based system to find a blood donor with the aid of an android application which was built using MIT App Inventor to avoid delay in communication between donor and patient during emergency situations.

Blood cold chain, which begins the moment the blood is collected and continues until it is transfused. The blood cold chain is a series of interconnected activities involving equipment, personnel and processes that are critical for the safe storage and transportation of blood from collection to transfusion.

Transport Condition	**Temperature range**	**Storage Time**
Transport - preprocessed blood	+20 °C to +24 °C	Less than 6 hours
Storage - Preprocessed or processed blood	+2 °C to +6 °C	Approx. 35 days
Transport - processed blood	+2 °C to +10 °C	Less than 24 hours

Table 3.1: **Temperature range *in Blood Management System.***

C) SUPPLY AND TRANSFUSION

Blood transfusion is needed if patient have anemia, a bleeding disorder, sickle cell disease, such as hemophilia, or cancer. A cancer patient needs at least 100 units of blood approximately. Due to need to always have blood stocks and often unpredictable demands on the inventory, a very limited and inevitable outdating of blood and its components in blood bank is accepted. Collection of 500-1000 units/bags of blood in a blood camp is acceptable and manageable, later it can be distributed to ones in need through blood banks or centralized blood repository.

The blood banks are responsible for the issue of blood to the respective hospital ward considering that the blood will be transfused within 30 minutes. Temperature of refrigerator must be between +2º C and +6º C and be fitted with an appropriate temperature alarm.

THE BLOOD UNIT MUST BE DISCARDED IF:

It has been out of the refrigerator for longer than 30 minutes,

OR — if the seal is broken,

OR — there is any sign that the pack has been opened,

OR — there is any sign of hemolysis.

Mehmet Karakoc, Melih Gunay (2017) [4] Effort to improve distribution led to the integration of the supply chain management concept in the development of a web-based system for requisition within the blood supply chain of regional blood bank.

Ahmed AL-Kalbani's (2018) [5] work on full network for Oman hospital through the mobile application can be used as a joint washer between the hospital and donor. This application can be downloaded by anyone as mobile app and there is website also for whom using computer. System works coordinator between the central blood bank in Muscat (Basher) and donors around country [5] . Hridoy Deb Das (2020) [3] has designed system will help the blood requester to find the donors of requested blood groups in the nearby location. The problem with this system is it searches donor within 5km and is highly dependent on the donor. If no donors found within the 5km it may fail. Lau et al. (2013) [11] for long-term management of blood supply, predicted the future blood demand of thalassemia major patients for the next 10 years.

D) DISCUSSION AND OPEN ISSUES

Communication gap between blood banks, donors, regulators, hospitals, and receivers are leading to wastage of blood in India. Blood wastage could impose a serious impact on the healthcare system of the country. Blood bank is accepting very limited and inevitable outdating of blood and its components because of internal need to always have blood stocks and often non predictable demands on the inventory. Mega blood donation camps should be avoided to minimize blood wastage. A collection of up to 500 units of blood in a camp is acceptable and can be managed. But if more than 2000 units of blood are collected in a mega camp, 10 to 20 percent of the blood collected in such donation camps are wasted as per estimations because of deficiency in storage facilities and Infra problem.

Blood is wasted when it cannot be transfused to patient due to some technical reasons which include faults in storage or expiration. Many factors can lead to wastage of blood and its components in India like burst packs, contaminated packs, clotted donations, delays conducting tests due to staff shortage, broken bag, lack of proper storage, expired units, over-ordering, improper transport, returned after more than 30 minutes, problems with the manufacturing and testing of blood components, lack of proper knowledge and awareness.

IV. SYSTEM ARCHITECTURE

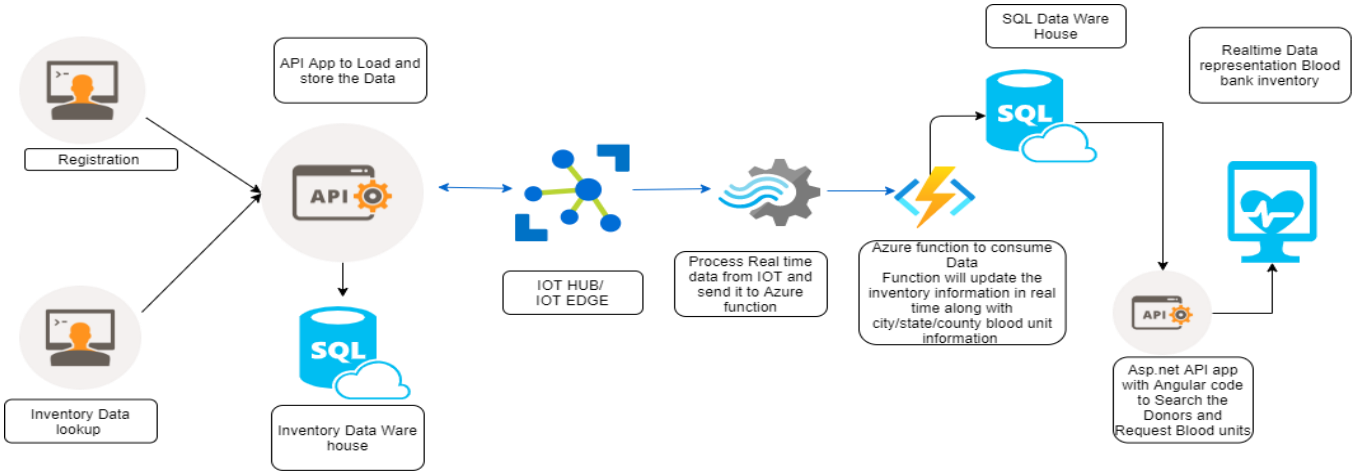

Figure 4.1: System Architecture / Proposed Framework.

Font end / UI is implemented in angular which includes Registration, Inventory and Donate/Request screens. Angular is a TypeScript-based open-source web application framework led by the Angular Team at Google and by a community of individuals and corporations. Angular is a complete rewrite from the same team that built AngularJS. System is integrated with Azure IOT for real time data transmission. Azure stream analytics is used to maintain and update Blood units at different levels in the system such as City/State /Country. Azure Stream analytics will hold the real time information about the blood units. Inventory in the hospitals and blood banks will be updated with Azure function on real time. In case of a shortage area blood banks also can be used to network through IoT connectivity so that requests are forwarded automatically to the nearest bank. Backend is implemented with Swagger UI - Swagger is an Interface Description Language for describing RESTful APIs expressed using JSON.

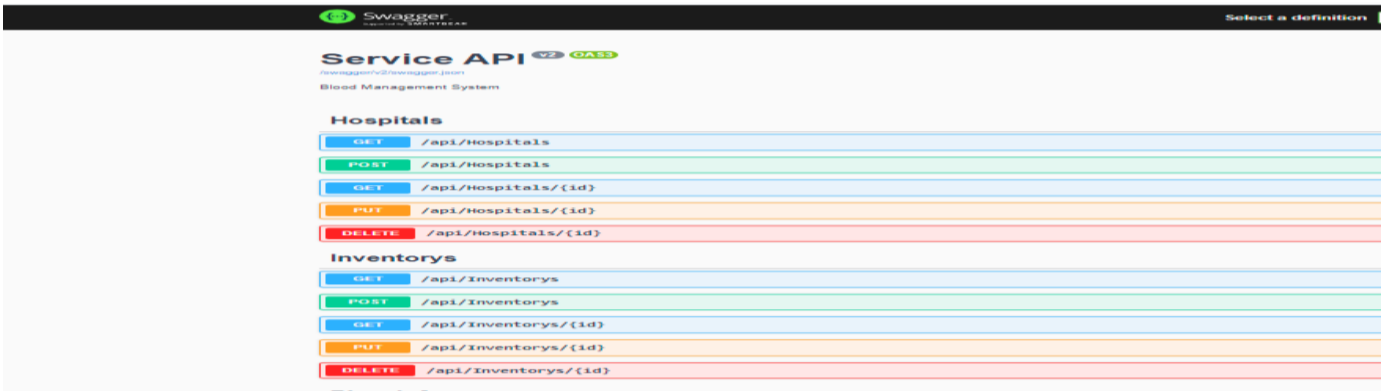

Figure 4.1: Service API for Proposed system

Swagger is used together with a set of open-source software tools to design, build, document, and use RESTful web services. Swagger includes automated documentation, code generation, and test-case generation.

V. IMPLEMENTATION AND RESULT ANALYSIS

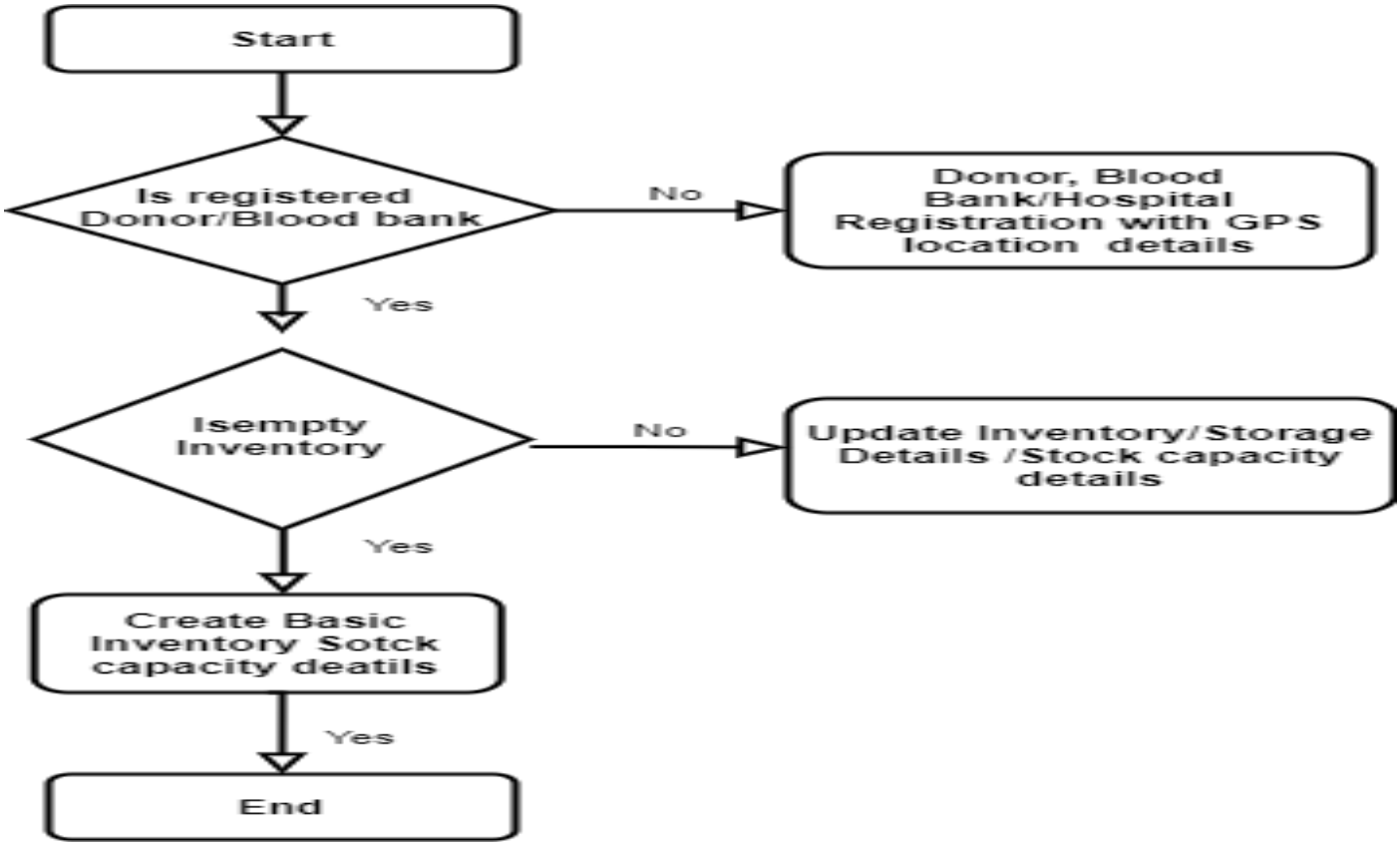

Figure 5.1: Project flow for proposed system

Registration:

Donor Registration: Proposed system uses web module for Donor registration donor details such as Name, Address, Phone, Blood group, GPS location coordinates are captured using above module.

Hospital/Blood Bank Registration: Proposed system uses web module for Blood Bank registration. Blood Bank details such as Name, Address, Phone along with GPS location are captured using above module.

Inventory: System uses web application to maintain the centralized Data Warehouse about hospitals and blood banks inventory that will keep the total capacity and vacancies according to blood group. The blood unit count will be initially managed by the Hospital's or Blood banks periodically. When the Blood unit is transferred or received through App it will lock the count and later it will update the locked count in the database after successful transfer.

Donate/Request Blood: The Solution is implemented in Azure cloud for High availability, reliability, low latency. Blood banks focus on enhancing facility, storage capacity and ensuring a positive donor experience to basically encourage the donors to repeat donations and reduce shortages. However, the threat of shortages is looming constantly, so it is imperative for blood banks to manage their available supply as tightly as possible to avoid unnecessary waste. Donate or Request Blood unit – this is web-based GPS Search module will find the nearest location where blood units can be shifted based on their storage capacity and minimum possible distance.

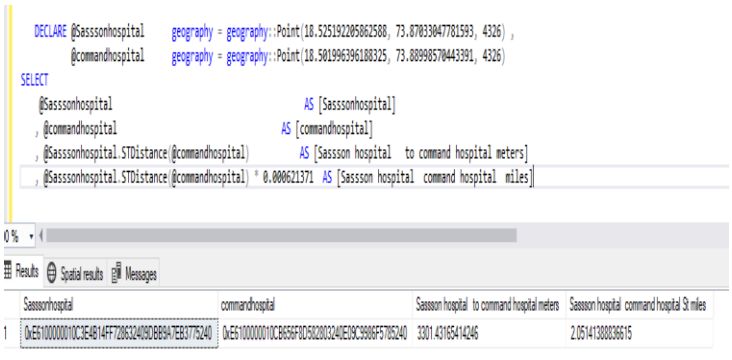

Figure 5.2: MSSQL Geospatial data types: Geography and distance calculation.

Geography data types are more than just data types, they are objects, and therefore have methods. For example, to find the distance between Blood bank Sasson hospital pune and command hospital pune we can run this query:

Geography data types are more than just data types, they are objects, and therefore have methods. For example, to find the distance between Blood bank Sasson hospital pune and command hospital pune we can run this query:

```
DECLARE
@Sasssonhospital geography =
geography::Point(18.525192205862588,
73.87033047781593, 4326) ,
@commandhospital geography =
geography::Point(18.501996396188325,
73.88998570443391, 4326)
SELECT
 @Sasssonhospital AS [Sasssonhospital]
, @commandhospital AS [commandhospital]
, @Sasssonhospital.STDistance(@commandhospital) AS
[Sassson hospital to command hospital meters]
, @Sasssonhospital.STDistance(@commandhospital) *
0.000621371 AS [Sassson hospital command hospital
miles]
```

VI. CONCLUSION

If patients have anemia, sickle cell disease, a bleeding disorder such as hemophilia, or cancer they may need a blood transfusion. A cancer patient generally needs at least 100 units of blood. India heavily relies on blood transfusions due to a higher prevalence of blood borne diseases and complications during pregnancy. A blood Bank can be defined as a storage place where blood is collected, preserved, and used whenever needed or demanded. Everyone is aware that the traditional blood bank management system includes paperwork and lot of manual work. Its fails when there's emergency situations. In some hospital still using excel sheet in computer and they contact people by call or SMS in emergency case.Requesters can search donors from their current or destination location, can find more than one donor parallelly and request for more than one blood group, Using GPS finding donors and arriving at the destination will be easy and in the shortest time. For Donate or Request Blood unit – There is web-based GPS Search module. BBABWM (Blood Bank and Blood Wastage Management) app has privilege for registration and inventory maintenance so that donors can register themselves and hospitals and blood bank are registered through a module in app portal. Real time blood stock inventory data can be collected using web application hosted on cloud and it will be accessible to hospitals and blood banks within the country. These data structure stored contains the Inventory information about the blood units along with GPS location. Donors/requesters can enter details of blood unit and its current GPS location to get the desired information about nearest blood bank or hospital.

VII. FUTURE SCOPE:

Primary reason of wastage is because of deterioration during storage and expiry of blood units due to outdating. Proposed system shall help to improve transportation of blood units to all needy areas, reduce blood wastage and find desired donor within in real time. This work has a centered focus on how to fulfill the need of blood to those in need of blood by providing a communication platform, to serve the blood request within a geographical area in the required timeframe and location trace. In future system will be connected to Actual IOT devices and data is collected in real time without manual intervention.

REFERENCES

[1] Ashlesha C. Adsul , V.K.Bhosale , Dr.R.M.Autee, "AUTOMATED BLOOD BANK SYSTEM USING RASPBERRY PI" 2nd International Conference on Inventive Systems and Control (ICISC) IEEE , in 2018.

[2] Fauwzziyyah O. Umar Lukman E. Ismaila & Ibrahim A. Umar "The Prospect and Significance of Lifeline: An E-blood bank System" 15th International Conference on Electronics Computer and Computation (ICECCO 2019) IEEE, in 2019.

[3] Hridoy Deb Das, Rakib Ahmed, Nurunnahar Smrity , Linta Islam "BDonor: A Geo-localised Blood Donor Management System Using Mobile Crowdsourcing", 9th International Conference on Communication Systems and Network Technologies (CSNT) IEEE 2020.

[4] Mehmet Karakoc, Melih Gunay "Priority Based Vehicle Routing for Agile Blood Transportation between Donor/Client Sites", International Conference on Computer Science and Engineering (UBMK) IEEE, 2017.

[5] Ahmed AL-Kalbani, Syed Imran Ali Kazmi, Jitendra Pandey "IoT Based Smart Network for Blood Bank Ahmed" 7th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO) IEEE, 2017.

[6] Mr. Shreyas Anil Chaudhari , Ms. Shrutika Subhash Walekar, Ms. Khushboo Ashok Ruparel, Ms. Vrushali Milind Pandagale "A Secure Cloud Computing Based Framework

for the Blood bank" International Conference on Smart City and Emerging Technology (ICSCET) IEEE, 2018.

[7] Ritika, Pau, A.: Prediction of blood donors population using data mining classification technique. Int. J. Adv. Res. Comput. Sci. Softw. 4(6), 634–638 ,2014.

[8] Ekici, A., Ozener, O.O.: Routing for blood supply management. In: 20th Conference of the International Federation of Operational Research Societies IFORS ,2014.

[9] Karakoc, M., F. Al-Turjman, and M. Gunay, "Routing Approach for Urgent Blood Transportation between Medical Facilities. 6th Hospital and Health Services Management Congress", 16-19 December, 2015.

[10] T. H. Jenipha and R. Backiyalakshmi, "Android blood donor life saving application in cloud computing," American Journal of Engineering Research (AJER), vol. 3, no. 02, pp. 105–108, 2014.

[11] Lau, E., He, X., Lee, C., Wu, J.: Predicting future blood demand from thalassemia major patients in Hong Kong. PLoS One 8(12), e81846 ,2013.