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Smart Blood Management and Tracking System

T. Senthil Kumar, S. Prabakaran, Ashim Sharma, Devvrat Vaidya

Abstract: ***The blood bank management system is devised to store, process, analyse and retrieve information concerned with management and supply of blood bags. There are many discrepancies in the current blood management and tracking system such as stealing, hoarding and selling of blood packets at exorbitant rates at need of the hour which lead to unnecessary delay in treatments of the patients which in turn, sometimes leads to death of patients. This work deals with tracking and management of blood donated by an individual at blood banks and hospitals until it is used to cure a patient or disposed of after expiration. The donation, storage and usage of blood will be monitored and tracked so as to make sure that there is no inconsistency. Moreover, the blood packet would be inscribed by a QR code with information of the donor. With help of blockchain, we aim to achieve less redundancy in quest of availability of blood in blood banks. The stored blockchain database would be managed and could be only accessed by authorised user. The database would be accessible to all the hospitals which come under the umbrella of this arrangement. This technological advanced system aims to increase the efficiency, security and robustness of managing blood bags in current blood management and tracking System***

Index Terms**: *SBMTS, smart blood management and tracking system***

I. INTRODUCTION

Amidst, advancement of technology in 21st century, various technologies are being incorporated into our daily routines. With life changing inventions and upgradations in technology, we have become undeniably dependent on machines for our progress. From mobile phones to cars, we are surrounded by machines which tend to make our lives easier. A new approach to redefine the modern healthcare has become precedence for the future need of the mankind. With the application of technology, healthcare has become accessible, efficient and responsive to a great mark.

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***** Correspondence Author
T. Senthil Kumar*, Assistant professor at SRM Institute of Science and Technology. (Tamil Nadu) India.
Dr. S. Prabakaranis a professor at SRM Institute of Science and Technology was awarded his Ph.D in 2008. (Tamil Nadu) India.
Ashim Sharma, UG Student Studying Computer Science Engineering At SRM Institute Of Science And Technology Is Areas Of Interest Are Blockchain And Java Development, (Tamil Nadu) India.
Devvrat Vaidya, UG Student Studying Computer Science Engineering At SRM Institute Of Science And Technology Is Areas Of Interest Are Python, Data Science And Java Development, (Tamil Nadu) India.

It has allowed physicians and doctors to diagnose better and treat their patients. With continuous development of technology in healthcare, mankind has been able to save numerous and increase the life expectancy.

Nowadays, blood donation campaigns have a huge impact in our society. With more people coming forward to help the need, it is the job of the visionaries to make sure that healthy blood packets are available to concerned patients. Availability of blood packets in hospitals and blood banks has become an issue of major concern to authorities. Since, there is no adequate method to track and manage blood packets donated by person, a lot of discrepancies have occurred in the management of blood packets such as hoarding, selling of blood packets at higher rates, unavailability of blood at required time etc.

We present an approach which would reduce the discrepancies in blood management and tracking system. The idea involves streamlining the blood donation, monitoring and usage process. With help of blockchain, a decentralised database of blood packed ID (use of QR code) encrypted blood packets would be built to store the information such donor information, blood type, blood bank name, blood packet location etc. The database would be accessed by only authorised person of the hospitals and the blood donation centres. The blood packet database would be available to all the concerned authorities such as hospitals, blood donation centres and ministry of health so as to keep track. As the blood packet is transported to different location of storage, its current location would be updated in the database until it arrives to its final destination. Both the source and destination location would be notified of the arrival of blood packets at destination and departure of blood packets from source respectively. Once a request is made for a blood packet, the concerned authority would check the blockchain database and accordingly, act on the request. Whenever the packet is used, it would be updated in the blockchain database. As soon as the blood packet is used, the donor would be notified about the use of his/her blood. Since, there is verification at each and every step, it will reduce the black marketing of blood packets.

II. EXISTING SYSTEM

Today, there is only a paper-bound blood management and tracking system in place which isn't secure much. Whenever a person comes to donate blood at blood donation centres and camps, their details are registered on a physical datasheet. After donation, blood packets are not inscribed by the details of the donor, but are only kept according to the category of blood group. Then, the blood packets are transferred to blood storage centres which act as depot until the blood is distributed to the hospitals or blood banks. After reaching the final location, blood packets are tested so as to find whether it is pure or not. If not, blood packets are disposed of.

Else, they are used whenever required by the patient. In this whole process, the donor does not get to know whether their donated blood was used or not. Moreover, since all the blood packets, locations, donors etc. are registered on paper bound databases, these databases can be manipulated easily by anyone who is holding the database. Usually, patients have to pay some amount to get access to blood packets. To earn more profits, some hospitals may start hoarding of blood bags and sell the blood packets at higher price than the usual. Generally, blood packets are available as first come first serve basis but, blood centres or hospital might make it available only to the person who is the highest bidder to earn more profits. Since the database is paper bound, it can be easily changed to incorporate the person who provides more money. In addition to this, if the physical database is lost, there is not alternative to recover the database since it is not digitally stored or backed up.

III. RELATED WORK

Ming Jiang, Bo Xing, Zhonghua Sun, Ping Fu, Hexin Chen, Mianshu Chen, … Yu Wang [1]proposed a RFID based blood information management system that adopts fingerprint sensor to identify donor and RFID is used to increase the convenience of management. Moreover, GPRS is used with along with this system to transmits real time data between bloodmobile and blood centers."

Kaid, D., &Eljazzar, M. M [4] explores the effects of integration of enterprise resource planning systems with blockchain technology.For smooth integration, distributors aim to achieve automated payments through smart contracts with their retailers in a blockchain network. Authors study the us of QR code in supply chain industry."

Ali, R. S., Hafez, T. F., Ali, A. B., & Abd-Alsabour, N [5] develops a web-based application which runs on a centralised database to collect and manage data from all the sources that is blood donation centres and blood banks. It stores all the information related to blood donation, testing and storage of bags, and delivery to patients."

"Hirsch, R. L., &Brodheim[6] primarily deals with advantages and disadvantages of centralised and decentralised blood bank database."

"Belien, J., &Forcé, H.[7] provides an overview on inventory and supply chain management of blood products."

"Esmail, M. Y., & Osman, Y. S. H.[8] has develop a centralised blood bank management system using PHP, mysql and barcode technique for accessing and storing information related to blood banks."

Adarsh N, Arpitha J, Md. Danish Ali, Mahesh Charan N, Pramodini G Mahendrakar [12] has develop a system by using RFID to manage blood bank. The number of transfusion error are decreased by this system as inventory status of blood packet is continuously monitored in real time."

"Anish Hamlin M R, Albert Mayan J [13] has develop a mobile application to assist in donation of blood from a donor in emergency case. In the need of the hour, nearest potential blood donor will be tracked by gps which as the same blood group as required. If potential blood donor accepts the request an OTP will be send to donor for verification. If request is not accepted, the app will automatically search the next potential blood donor."

"Radha, R.Mahalle [14] focuses on connecting all the blood banks to cloud storage so that real time-time information related to blood stock is available at every blood bank."

"Basit Shahzad, Jon Crowcroft [16] proposes a system in which adjustable blockchain would be used in the process of electronic voting from polling, quantifying data to declaration of result. Effective hashing techniques would be used to secure the data."

"Adsul, A. C., Bhosale, V. K., &Autee[18] aims to fulfill the requirement of blood bags using android application and raspberry pi. The participants data will be collected using android application and raspberry Pi via installing it at different locations."

"Mittal, N., &Snotra, K. [19] aims to present a relation between existing framework of blood banks and enhanced framework to improve efficiency. An android application will be created to manage the blood bank system of receiving and retrieving information about donor and recipient."

"Boonyanusith, W., &Jittamai, P. [20] aims to develop a web based system to organise blood donation within the supply chain. The main objective of the work is increase the efficiency of data communications among different stakeholders in the supply chain so as to improve response time to delivery of blood bags to patients."

IV. PROPOSED SYSTEM

The proposed system works uses blockchain to create and secure database. Blockchain technology is a public ledger distributed that records messages sent from one node to another (transaction) over participating networks.[15]

The process of supplying blood packet can be divided into four steps i.e. blood collection, transportation of packets, packet storage and utilization of begs. At the beginning of process that is blood collection stage donors arrive at blood donation centres to donate blood. After donation of blood, the blood collected is screened to check purity of blood and to know blood is disease free. Eventually, the blood bags are transported to hospital or blood banks. Afterwards, the blood packets are distributed among hospital, clinics as per requirements. Lastly, blood bags transfused to its final user(patient).

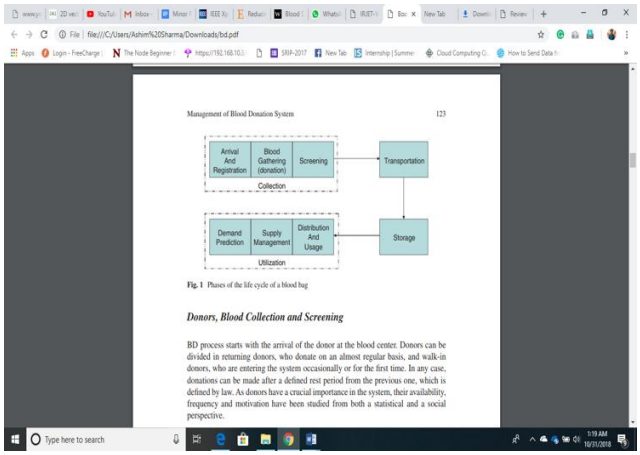

Figure 1: Phases of the life cycle of a blood bag

4.1. Blood Collection

This phase can be further divided into two phases: donor registration and drawing blood from donor.

Donor Registration: In first phase, when donor come at blood donation center, the registration process would take place. The registration process is mainly consist of steps like donor's personal information followed by blood test.
Blood of each donor would be screened individually to prevent infectious blood being transfused to patient in future. Every information about donor and blood bag will be stored in distributed blockchain database. In whole process, the donor will be identified by his/her aadhaar id. After registration donor will be provided with a token number. The registration would be completed by an authorised personnel who would have login access to web interface.
Drawing Blood: In phase two, drawing of blood will take place. At donation bed, the donor will present the token number given to him/her during registration to concerned personal, which will help in fetching details. After checking donor's history, the unique blood packed id (QR Code) will be scanned and linked with the details of the donor. [10] It will help donor and concerned authorities to track the blood bag at any time. At last blood will be drawn from the donor and stored in the blood bag inscribed the QR code. Moreover, the blood packet id and Aadhar number of donor would linked with each other. In distributed system, the blood packet will be considered as asset.

4.2 Transportation of Blood Packets:

This phase is more complex and the whole process has to be monitored accurately. The details of the transit are to be stored carefully and precisely in distributed database. The blood packet should be stored at specified temperature so the blood doesn't get spoiled during transportation.[2]Therefore, while transferring it, management also need to check packet temperature. Hence specialised vehicles are required to transfer blood packets from one location to another.
This process also consist of two phases: displacement of blood and delivery of blood.

Displacement Phase: A list of locations which is hospitals and blood banks along with their latitude and longitude degrees would be provided to management. While dispatching the packets, the management has to scan the QR code of assets that is blood packet and update the latitude and longitude of location where they are sending the asset. In system, they also need to update the minimum and maximum temperature that should be maintained while transferring the blood packet. As all the blood bags are scanned, a total count of blood packets would be made to receiving management.

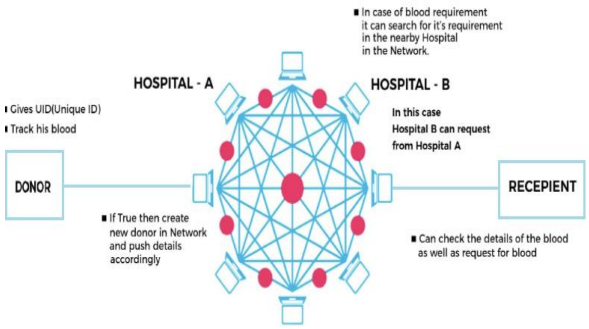

Figure 2: Architecture Diagram of blood supply chain
Delivery Phase :At delivery point of blood packet that is hospital or blood bank, management will receive the information from where the blood packets are dispatched [3] and management will check the temperature of blood packets. If temperature is not in the range of minimum and maximum threshold, smart contract will automatically rule out the packet. The packet will be considered as damaged and cannot be used by recipient. If packet temperature is between the required range, management have to scan the QR code to update, packet is received at delivery point. Once the scanning of blood bags is completed, the distributed ledger database would be updated along with showing the total number of packets available at a particular hospital or blood bank.
This phase will ensure that packets are dispatched and delivered safely and no packet is lost in this procedure.

4.3. Storage of blood packets

When packets are being stored at a hospital or a blood bank, the temperature of storage depot should be monitored and frequently update in distributed database. If at any point of time, the temperature tend to fluctuate more, the hospital staff will be notified about the same by smart contract automatically. After notification, staff have to take necessary action to stabilize the temperature again to prevent damage of blood.[11]
The blood packet will be stored and used in a queue based on first come first out (FIFO) algorithm. In simple words we can say that, the older packet will be utilized first. It will ensure the proper utilization of blood packet because packets should be used within 42 days of donation. This queue will also be maintained by smart contract. If at any point, someone tries to use newer packet, contract will pop up a notification mentioning a packet number that should be used first.

4.4. Utilisation of blood Packets

It is the last phase of supply chain, when the blood needs to be given to recipient. The packet id (QR code) will be scanned from storage by updating the information about recipient. The information would consist of Aadhar id and disease, the recipient is suffering with. The smart contract will check for recipient details and ensure that the person is taking same blood group packet. A pop up notification would be generated, with message displaying the picked blood packet can be used for recipient or not.
After completion of this process, a message will be delivered to donor thanking for donating the blood along the details of recipient.[9]

V. IMPLEMENTATION

Step 1: Donation of blood
If LastDonationDate>Date()-90:
Print "Not Applicable"
Else:
Update():
Donor Details
Donation Date

The input is Donor Aadhar Number. It'll retrieve the donor information and check whether donor has donated blood in last 90 days. If donor has donated blood in last 90 days it'll display message "Not Applicable". Otherwise blood packet asset will be updated with donor details as well as timestamp.

Step 2: ShipToHospital():

updateTemperature()
updateShipToLocation()

The input is Blood packet ID, Temperature of blood packets and new location. These details needs to be update in blood packet asset.

ReceivedAtHospital():
checkTemperature()
If (between Range):
UpdateLocation()
Else:
reject()

The input is blood packet id, temperature of blood packet at new location. Now temperature will be checked if packet is between range of a minimum and maximum temperature then send packet for storage. If not, discard the packet.

Step 3: Recipient():
CheckBloodGroup()
UpdatePatientDetails()
MessageDonor()

In this method input will be recipient aadhar number and disease patient is suffering with. After this smart contract will retrieve details and match the blood group of recipient and blood packet. If group is not matching display a message saying "Invalid Packet". If not, then details will be updated and a message will be sent to donor with recipient details.

Step 4: QueryBloodPacket:
ActivelyLooking():

If PacketBloodGroupCount[i]<Specified Number:
Location[] =
CheckNearestHospital(Longitude,Latitude)
NotifyHospital(Location[i],Location[k])
ShipToHospital()

Smart contract is looking of number of respective blood group packet. If any blood packet count is less than a specified number. It will check for packet in nearest hospital or blood bank. If packet found, notify hospital to send the blood packets.

VI. RESULTS

Shown below are the images of the web interface along with the impact of the proposed system if it had been used in recent years.

The figure given below shows the record of the blood packet. Currently, a blood packet with ID: 5285 which was donated on 11-04-2019 has been used to save a life of patient in hospital. If blood bag is not used, the receiver column will show none. By clicking on create Assets button, the admin links the blood packet with necessary details like blood type in that packet, blood donor, hospital where donor donated the blood.

Figure 3: Asset Description

To add details of a donor, the admin will navigate to participant tab and click on add participant. Admin will have enter details such as name blood type, name Aadhar number, blood donation date(auto-filled) and address. Moreover, the description of the add participants first come first server will be shown at the web page.

Likewise, to bring a hospital or a blood donation centre under the proposed similar umbrella, they can be also added through similar process. On the same lines, a recipient to the blood packet(patient) will a also be added to database via same process.

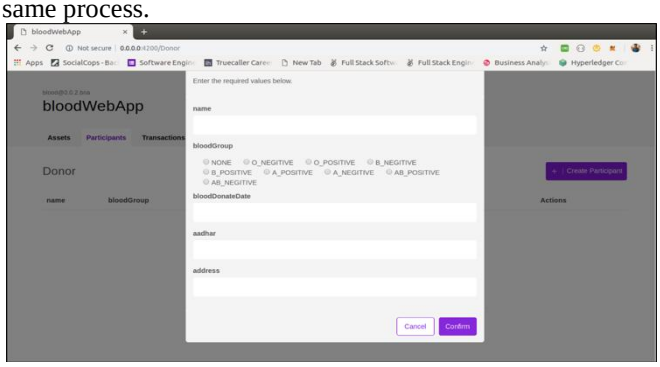

Figure 4: Create Participant(Donor)

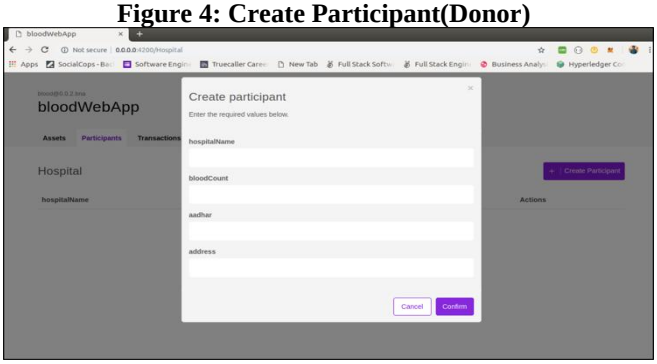

Figure 5: Create Participant(Hospital)

Figure 6: Participant database

When a blood bag is required by a patient, transaction is created in which receiver ID/ patient ID and blood packet ID will be added.

Once the transaction is created, the updated changes will be recorded and displayed in the assets. tab.

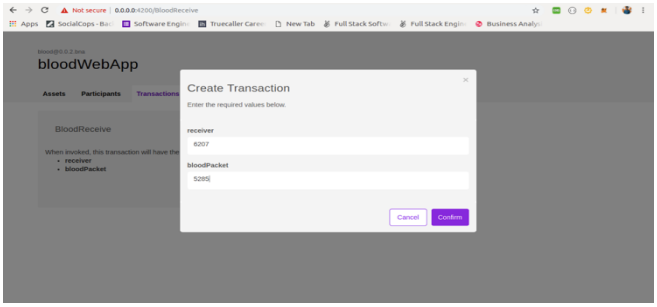

Figure 7: Create Transaction

The image below shows the number of blood units collected and discarded in recent years in India.

Though, about 1 million units of blood is discarded every year, still India is not able to provide adequate amount of blood (12 million units according to World Health Organisation). to its population.

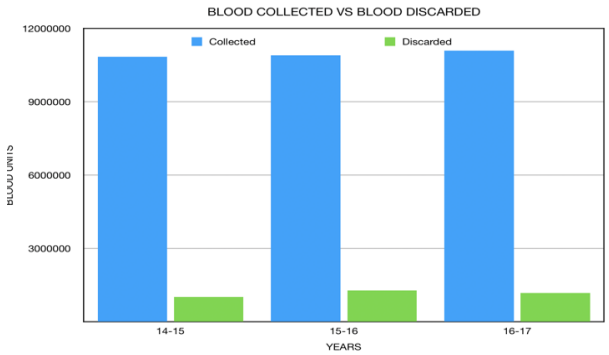

Figure 8: Blood Collected Vs Blood Discarded

In recent year, the discarded blood units was about 1 million units. If the system proposed in this paper is used, we can see that discardation of blood units decrease by by at least 50% every year. As soon as the whole system is in place, the loss of blood packets would reduce drastically.

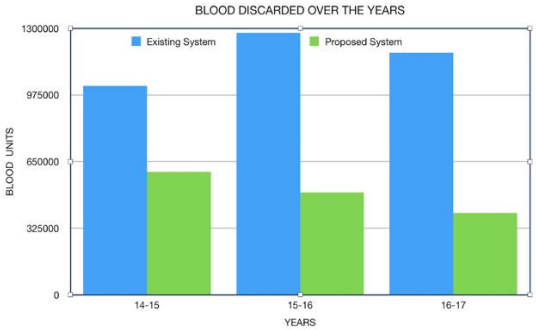

Figure 9: Blood Discarded Over The Years

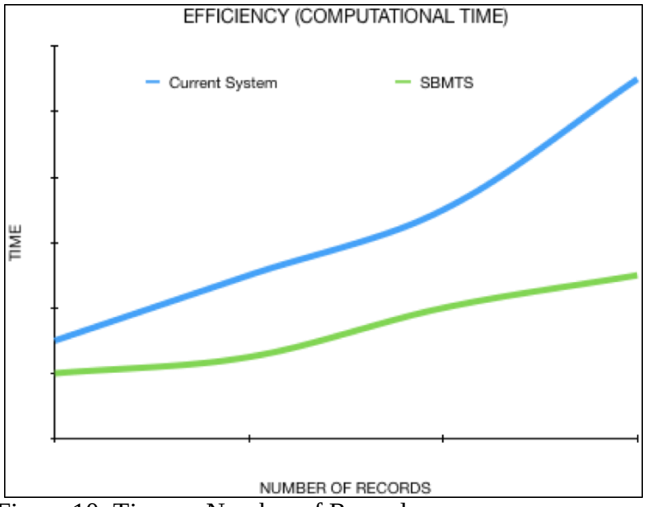

Figure 10: Time vs Number of Records

As the time and number of records increase, the computational time of the current system increase exponentially whereas in SBMS, the increase in computational time is less, linear in nature.

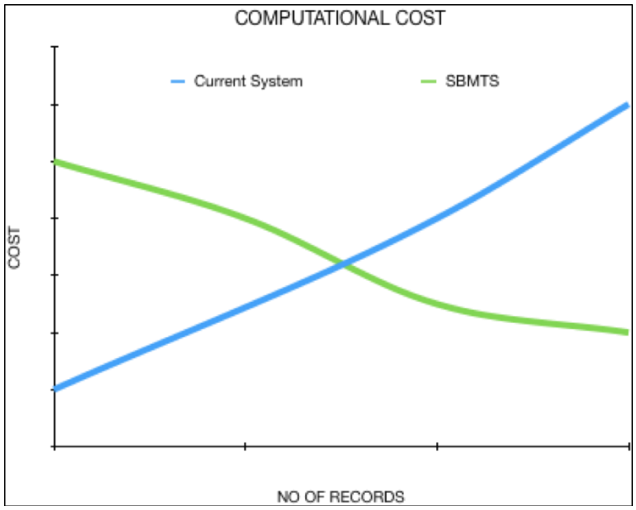

Figure 11: Cost vs Number of Records

The computational cost of the current system increases as number of records increases. In SBMS, initial computational cost is high but as number of records increase over time, the cost reduces. Hence, overall cost of of SBMS is less than the current system.

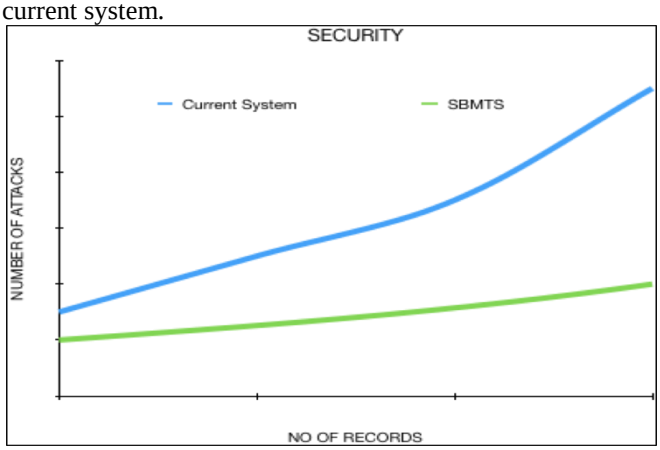

Figure 12: Number of Attacks vs Number of Records

Number of attacks increase with increase in records.

With current system attacks infiltrating the system is very high whereas in SMBS number of attacks infiltrating the system is less at the same number of records.
Therefore, blockchain will increase the efficiency by eliminating the manual efforts and paper processing. It will provide accurate source of the blood packets. Moreover, a custody of chain will ensure that blood bags were handled by sincere, trustworthy and capable personnels.

VII. CONCLUSION

The paper presents an alternative way to manage and track the blood packets in a healthcare ecosystem. It presents a highly efficient and objective path to minimise the discrepancies in the logistics of blood management system and provides timely availabilities in blood packets at the concerned centre such as hospitals.
Concussively, it aims to solve the problems faced by traditional blood management and tracking system and operational logistics. With the use of the application blockchain, wireless internet access, personalised data and enabled notifications, it helps us to reduce human errors and discrepancies. Moreover, it results in streamlined workflow and efficient operational logistics.

REFERENCES

1. Ming Jiang, Bo Xing, Zhonghua Sun, Ping Fu, Hexin Chen, Mianshu Chen, … Yu Wang, "A Dynamic Blood Information Management System Based on RFID." IEEE Engineering in Medicine and Biology 27th Annual Conference , (2005)
2. Kim, D.-S., Yoo, S. K., Kim, H., Chang, B., Bae, H., & Kim, S. "Location Based Blood Bag Management using active RFID and Ubiquitous Sensor Network." ,6th International Special Topic Conference on Information Technology Applications in Biomedicine, (2007)
3. Kshetri, N., &Loukoianova, E. "Blockchain Adoption in Supply Chain Networks in Asia." IT Professionals, (2019)
4. Kaid, D., &Eljazzar, M. M., "Applying Blockchain to Automate Installments Payment between Supply Chain Parties". 14th International Computer Engineering Conference (ICENCO) (2018)
5. Ali, R. S., Hafez, T. F., Ali, A. B., & Abd-Alsabour, N, " Blood bag: A web application to manage all blood donation and transfusion processes." International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), (2017)
6. Hirsch, R. L., &Brodheim, E. "Blood Distribution Systems and the Exchange of Information between Hospital Blood Banks and Regional Blood Centers". Vox Sanguinis (1981)
7. Belien, J., &Forcé, H. . "Supply Chain Management of Blood Products": A Literature Review. SSRN Electronic Journal (2011)
8. Esmail, M. Y., & Osman, Y. S. H."Computerized Central Blood Bank Management System (CCBBMS)." 2018 International Conference on Computer, Control, Electrical, and Electronics Engineering (ICCCEEE) (2018)
9. G. Muddu Krishna; S. Nagaraju,"Design and implementation of short message service (SMS) based blood bank", 2016 International Conference on Inventive Computation Technologies (ICICT)
10. Uzun, V. "QR-Code Based Hospital Systems for Healthcare in Turkey". IEEE 40th Annual Computer Software and Applications Conference (COMPSAC), (2016)
11. Kim, S.-J., Yoo, S. K., Kim, H.-O., Bae, H.-S., Park, J.-J., Seo, K.-J., & Chang. "Smart Blood Bag Management System in a Hospital Environment". Lecture Notes in Computer Science, (2006)
12. Adarsh N, Arpitha J, Md. Danish Ali, Mahesh Charan N, Pramodini G Mahendrakar "Effective Blood Bank Management Based On RFID in Real Time Systems", International Conference on Embedded Systems - (ICES 2014)
13. Anish Hamlin M R, Albert Mayan J, "Blood Donation And Life Saver-Blood Donation App", International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT)information Technology: New Generations (2016)
14. Radha R.Mahalle1, S. S. Thorat2 1Electronics and Telecommunication Department, GCOE, Amravati, India 2 Assistant Professor,Electronics and Telecommunication Department, GCOE, Amravati, India, "Smart Blood Bank Based On IoT: A Review"
15. Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., & Santamaria, V. (2018). "To Blockchain or Not to Blockchain: That Is the Question". IT Professional, 20(2018)
16. Basit Shahzad, Jon Crowcroft, "Trustworthy Electronic Voting Using Adjusted Blockchain Technology", Access IEEE, vol. 7, pp. 24477-24488 (2019).
17. Mertz, L. "(Block) Chain Reaction: A Blockchain Revolution Sweeps into Health Care, Offering the Possibility for a Much-Needed Data Solution" IEEE Pulse (2018)
18. Adsul, A. C., Bhosale, V. K., &Autee, R. M. "Automated blood bank system using Raspberry PI. 2nd International Conference on Inventive Systems and Control", ICISC, (2018)
19. Mittal, N., &Snotra, K. "Blood bank information system using Android application", Recent Developments in Control, Automation & Power Engineering (RDCAPE) (2017)
20. Boonyanusith, W., &Jittamai, P. "The Development of Web-Based System for Blood Requisition within Blood Supply Chain". Seventh International Conference on Information Technology: New Generations (2010)

AUTHORS PROFILE

T. Senthil Kumar is anAssistant Professor professor at SRM Institute of Science and Technology.

Dr. S. Prabakaranis a professor at SRM Institute of Science and Technology was awarded his Ph.D in 2008.

ASHIM SHARMA is an UG student studying computer science engineering at SRM Institute of Science and Technology is areas of interest are blockchain and java development

DEVVRAT VAIDYAis an UG student studying computer science engineering at SRM Institute of Science and Technology is areas of interest are python, data science and java development