

CLOUD-ENABLED SMART BREAST MILK MANAGEMENT AND DONOR RECOMMENDATION SYSTEMS

Manjula A¹, Sasirekha R², Saranya G³, Shalini V⁴, Sharmila A⁵

¹ Assistant Professor, Computer Science and Engineering & Bharathiyar Institute Of Engineering For Women (Autonomous), Salem, Tamil Nadu, India

^{2,3,4,5} UG Student, Computer Science and Engineering & Bharathiyar Institute Of Engineering For Women (Autonomous), Salem, Tamil Nadu, India

ABSTRACT-Breast milk is the most essential source of nutrition for newborn infants, especially for premature and medically fragile babies. However, several mothers face challenges in providing sufficient breast milk due to medical conditions or low lactation. Human milk banks help address this issue by collecting, storing, and distributing donated breast milk to infants in need. Traditional milk bank management systems rely on manual processes and isolated data storage, which can lead to inefficiencies in donor management, milk inventory tracking, and distribution coordination.

This paper proposes a Cloud Enabled Smart Breast Milk Management System that utilizes cloud computing technologies to improve the management and accessibility of donor breast milk. The system provides a centralized platform for donor registration, milk collection tracking, inventory monitoring, and distribution management. Cloud infrastructure ensures scalability, reliability, and secure data storage while enabling real-time data access for healthcare providers.

To enhance system performance, algorithms such as Load Balancing and Round Robin Scheduling are integrated to efficiently manage cloud resources and handle multiple user requests. Additionally, a machine learning-based donor recommendation system using the

K-Nearest Neighbors (KNN) algorithm is implemented to identify suitable donors based on parameters such as health condition, blood group compatibility, location, and milk availability.

The proposed system improves operational efficiency, reduces manual errors, and ensures timely availability of safe breast milk for infants. This technology-driven solution contributes to improved neonatal healthcare outcomes and better management of human milk banks.

1. INTRODUCTION

Breast milk is widely recognized as the most beneficial source of nutrition for newborn infants. It contains essential nutrients, antibodies, and growth factors that support infant immunity, growth, and

cognitive development. For premature and low birth weight infants, breast milk plays a crucial role in reducing the risk of infections and life-threatening diseases.

2. LITRATURE SURVEY

- Victora et al. (2016)-This study examined global breastfeeding practices and emphasized the long-term health benefits of breast milk. The research concluded that breastfeeding significantly improves infant survival, immunity, and cognitive development. It also highlighted the importance of human milk banks in supporting infants who cannot receive breast milk from their mothers.
- Haiden and Unterasinger (2018)-The authors discussed the role of human milk banks in neonatal intensive care units. The study highlighted that donor human milk reduces the risk of severe diseases in premature infants. However, it also pointed out operational challenges such as inefficient data management and lack of digital monitoring systems.
- PATH Human Milk Banking Initiative (2019)-This report analyzed the development of milk banks worldwide and proposed guidelines for donor screening, milk storage, and safe distribution. The report emphasized the need for digital systems to manage donor information and milk inventory effectively.
- Lee and Darmstadt (2020)-The study investigated the impact of donor human milk programs on neonatal health outcomes. The results showed that access to donor milk significantly improves survival rates among premature infants. However, the research identified challenges in donor identification and milk distribution management.
- Arnold (2021)-This research focused on global health policies and regulatory frameworks for human milk banking systems. The author emphasized the importance of standardized

procedures for donor screening, milk processing, and storage management.

- Kumar and Kumar (2022)-The study explored the role of cloud computing in healthcare systems. It highlighted the benefits of cloud platforms such as scalability, secure data storage, remote access, and efficient data sharing between healthcare institutions.
- Zhang et al. (2023)-The research presented machine learning-based recommendation systems in healthcare applications. The study demonstrated how algorithms analyze user data to generate personalized recommendations, which can be applied in donor matching systems.
- Nguyen et al. (2024)-This paper introduced a digital monitoring system for human milk bank management. The system improved donor tracking, inventory monitoring, and distribution efficiency while reducing manual errors.

3. PROPOSED SYSTEM

The proposed Cloud Enabled Smart Breast Milk Management System is designed to improve the efficiency, reliability, and accessibility of breast milk bank operations by integrating cloud computing technologies and intelligent data processing techniques. The system provides a centralized cloud-based platform where donor information, milk collection records, storage conditions, and distribution data are securely stored and managed.

This digital platform allows hospitals, donors, and milk bank administrators to interact with the system through an online interface, enabling real-time data access and better coordination. In this system, donors can register by providing personal details, health status, and milk availability information. The system verifies and stores this data in a cloud database, which can be accessed by authorized healthcare providers. The platform continuously monitors milk inventory and storage conditions to ensure the quality and safety of donated breast milk.

In addition, intelligent algorithms are used to recommend suitable donors based on compatibility factors such as health condition, blood group, location, and milk availability. By using cloud infrastructure, the system ensures scalability, efficient resource utilization, and secure data management across multiple healthcare centers. The integration of load balancing and scheduling algorithms further improves system performance by efficiently managing multiple user requests.

3.1. DONAR REGISTRATION AND MANAGEMENT

The Donor Registration and Management module is responsible for collecting and maintaining information about breast milk donors. In this module, donors can register through the system by providing personal details such as name, contact information, location, and health status. Medical screening details and eligibility criteria are also recorded to ensure that only healthy and qualified donors are allowed to donate breast milk.

The system securely stores this information in the cloud database for easy access by authorized healthcare providers. It also helps milk banks monitor donor availability and donation history.

This module improves donor data management, ensures transparency, and simplifies the process of identifying eligible donors when milk is required. The workflow is illustrated in Fig 1 .



Fig 1. DONAR REGISTRATION AND MANAGEMENT

3.2 MILK COLLECTION AND STORAGE MONITORING

The Milk Collection and Storage Monitoring module manages the process of collecting, recording, and safely storing donated breast milk. After donation, the collected milk is properly labeled with details such as donor ID, collection date, and quantity. The system records this information in the cloud database for easy tracking and management.

It also monitors important storage conditions such as temperature, storage duration, and container status to maintain the safety and quality of the milk. Real-time monitoring helps prevent spoilage and ensures compliance with health standards. This module enables

milk banks to efficiently track stored milk units and maintain a reliable supply for infants in need. The Workflow is illustrated is shown in Fig 2 .



Fig 2. MILK COLLECTION AND STORAGE MANAGEMENT

3.3 INVENTORY MANAGEMENT SYSTEM

The Inventory Management System is responsible for tracking and managing the availability of stored breast milk within the milk bank. This module maintains accurate records of milk quantity, storage date, expiration time, and distribution history. Each stored milk unit is labeled and recorded in the cloud database, allowing healthcare staff to easily monitor current inventory levels.

The system helps ensure that milk is used within the safe storage period and reduces the risk of wastage. It also provides real-time updates on available milk units, enabling hospitals and milk banks to quickly identify and allocate suitable milk supplies for infants in need.



Fig 3 . INVENTORY MANAGEMENT SYSTEM

3.4 DONAR RECOMMENDATION SYSTEM

The Donor Recommendation System is an important component of the Cloud Enabled Smart Breast Milk Management System. It helps healthcare providers identify the most suitable breast milk donors for infants who require donor milk. This module uses intelligent algorithms, such as the K-Nearest Neighbors (KNN) method, to analyze donor information and match it with the specific requirements of infants.

The system evaluates several important parameters including donor health condition, blood group compatibility, geographic location, and milk availability. These factors are processed by the algorithm to calculate similarity scores between donors and recipients. Based on these scores, the system automatically recommends the most appropriate donors who meet the required criteria.

By automating the donor selection process, the system significantly reduces the time and effort required for healthcare staff to manually search through donor records. This improves the efficiency of milk bank operations and ensures that compatible donor milk can be provided to infants quickly and safely, especially in critical healthcare situations.



Fig 4. DONOR RECOMMENDATION SYSTEM

3.5 CLOUD DATA MANAGEMENT

The Cloud Data Management and Processing module is responsible for securely storing and managing all system data using cloud computing technology. It maintains information related to donors, milk collection, storage conditions, inventory records, and hospital requests in a centralized cloud database. Cloud

infrastructure enables authorized users such as hospitals and milk bank administrators to access updated information from different locations in real time.

The system also uses cloud processing techniques to handle multiple user requests efficiently. Algorithms such as load balancing and round robin scheduling help distribute system tasks across servers, ensuring better performance, high availability, and reliable data management for the breast milk bank system.



Fig 5. CLOUD DATA MANAGEMENT

4. SYSTEM ARCHITECTURE

The system architecture of the Cloud Enabled Smart Breast Milk Management System is designed to provide a scalable, secure, and efficient platform for managing breast milk bank operations. The architecture follows a multi-layered cloud-based structure that enables seamless interaction between donors, hospitals, and milk bank administrators. It ensures proper data flow, efficient processing, and reliable storage of system information.

The first layer is the User Interface Layer, where users such as donors, hospitals, and milk bank staff interact with the system through web or mobile applications. Donors can register and update their information, while hospitals can request breast milk and view donor recommendations.

The second layer is the Application Layer, which handles the main system functionalities such as donor registration, milk collection tracking, inventory management, and donor recommendation. This layer processes user requests and manages communication between the interface and cloud services.

The third layer is the Cloud Processing Layer, where system algorithms operate. Algorithms such as

load balancing and round robin scheduling are used to manage multiple user requests and distribute workloads efficiently across cloud servers.

The final layer is the Cloud Database Layer, which securely stores all system data including donor profiles, milk inventory records, storage conditions, and hospital requests, ensuring reliable and centralized data management.



Fig 6. SYSTEM ARCHITECTURE

4.1 USER LAYER

The User Layer is the topmost layer of the system architecture where all users interact with the Cloud Enabled Smart Breast Milk Management System. This layer includes donors, hospitals, and milk bank administrators who access the system through web or mobile applications. Donors can register their details, update health information, and provide milk availability status through the platform.

Hospitals and healthcare providers can request donor milk, view donor recommendations, and monitor milk inventory availability. Milk bank administrators manage donor records, verify donor eligibility, and oversee system operations. This layer provides a user-friendly interface that enables easy communication between users and the underlying system components.

4.2 APPLICATION LAYER

The Application Layer is responsible for handling the core functionalities of the Cloud Enabled Smart Breast Milk Management System. This layer processes user requests received from the user interface and performs various system operations. It includes modules such as donor registration, milk collection recording, storage monitoring, inventory management, and donor recommendation services.

The application layer ensures proper communication between the user layer and the cloud processing layer. It validates user inputs, manages data flow, and controls system processes efficiently. By coordinating these operations, the application layer enables smooth system functionality and ensures that all tasks related to donor management and milk distribution are executed accurately.

4.3 CLOUD PROCESSING LAYER

The Cloud Processing Layer is responsible for handling the computational tasks and system operations within the Cloud Enabled Smart Breast Milk Management System. This layer processes user requests received from the application layer and executes system algorithms to manage operations efficiently. It uses techniques such as load balancing and round robin scheduling to distribute workloads across multiple cloud servers, ensuring optimal resource utilization and preventing server overload.

The cloud processing layer also supports the donor recommendation algorithm by analyzing donor data and matching it with infant requirements. By performing these tasks in the cloud environment, the system ensures faster processing, improved scalability, and reliable service availability.

4.4 CLOUD DATABASE LAYER

The Cloud Database Layer is responsible for storing and managing all the data related to the Cloud Enabled Smart Breast Milk Management System. This layer securely stores important information such as donor profiles, health records, milk collection details, storage conditions, inventory records, and hospital requests. The data is maintained in a centralized cloud database, allowing authorized users from different locations to access updated information in real time.

This layer ensures data security, reliability, and backup through cloud-based storage technologies. It also supports efficient data retrieval and management for system operations, enabling hospitals and milk banks to quickly access accurate information when required.

5. RESULT AND DISCUSSION

The proposed Cloud Enabled Smart Breast Milk Management System was developed to improve the

efficiency and reliability of milk bank operations through cloud-based technologies. The system was tested by simulating key functionalities such as donor registration, milk collection tracking, inventory monitoring, and donor recommendation. The results showed that the cloud-based platform successfully managed large volumes of data while providing real-time access to authorized users such as hospitals and milk bank administrators.

The donor registration module allowed donors to easily submit their personal and health details through the system, which were securely stored in the cloud database. The milk collection and storage monitoring module effectively recorded milk collection information and tracked storage conditions to ensure the safety and quality of donated milk.

The inventory management system helped maintain accurate records of milk availability and expiration periods, reducing the risk of milk wastage. Additionally, the donor recommendation system efficiently identified suitable donors by analyzing parameters such as health condition, blood group compatibility, location, and milk availability.

The integration of load balancing and round robin scheduling algorithms improved system performance by efficiently distributing user requests across cloud servers. Overall, the proposed system demonstrated improved operational efficiency, reduced manual errors, enhanced data accessibility, and better coordination between hospitals and milk banks.

6. CONCLUSION

The Cloud Enabled Smart Breast Milk Management System provides an efficient and reliable solution for managing the operations of human milk banks. Breast milk is a critical source of nutrition for newborn infants, especially premature and medically fragile babies who cannot receive sufficient milk from their mothers. The proposed system uses cloud computing technologies to create a centralized platform for managing donor information, milk collection records, storage monitoring, and inventory management.

By integrating cloud infrastructure, the system enables real-time data access and secure storage of important information. Hospitals, donors, and milk bank administrators can easily access the system from different locations, improving coordination and communication between healthcare centers. The inclusion of intelligent

algorithms such as load balancing and round robin scheduling helps the system efficiently handle multiple user requests and maintain high system performance.

Additionally, the donor recommendation module plays an important role in identifying suitable donors based on parameters such as health condition, blood group compatibility, location, and milk availability. This helps healthcare providers quickly find appropriate donor milk for infants in need.

Overall, the proposed system reduces manual effort, improves data accuracy, and enhances the efficiency of milk bank management, ultimately contributing to better neonatal healthcare outcomes.

7. REFERENCES

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