

Software Development based on User Centered Design for Rural Self Help Group

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Abstract—Rural empowerment is possible only by empowering the whole community; in this context, women’s empowerment is pivotal to achieving rural upliftment. There are several studies on women’s empowerment and the role of digital tools in empowering rural communities. In this work, our focus is on designing and developing the software to empower the rural SHG community. Our work also presents details of some of the existing work and introduces a user-friendly software solution to streamline the management and administration of one of the rural Self-Help Groups (SHGs) in India, which works in several hierarchies such as clusters, groups, and users. We adopted a user-centric design of the software solution as it has to accommodate users with diverse digital literacy levels. We used Google Flutter and Node.js framework to develop this software.

Index Terms—Women Empowerment, SHG, Mobile Application, Software Development, Sustainable Development.

I. INTRODUCTION

Women empowerment is the continuous and dynamic process of enhancing women’s education, financial independence, health, and social status, ensuring equal rights, opportunities, and a sense of self-worth in society [1]. The United Nations (UN) has consistently emphasized empowering women as a key factor in achieving sustainable development goals [2]. The UN recognizes that leveraging digital technologies can bridge gender gaps, enhance women’s access to information and resources, and promote participation in economic, social, and political spheres. Women empowerment through digitization and Self-Help Groups (SHGs) is a transformative approach that has gained recognition and support from national governments, Nongovernmental Organizations (NGOs), and private initiatives [3]. One of the recent studies [4] suggests SHGs hold promise as effective mechanisms for advancing the delivery of sustainable development goals. Furthermore, they contribute significantly to policy objectives related to gender empowerment, specifically addressing SDG 5 [4]. Another study on SHGs [5] based on four districts of Rajasthan has demonstrated some success in attaining various Sustainable Development Goals, such as SDG 1, SDG 2, SDG 5, SDG

8, and SDG 10, as shown in Table. I. The study [6] also shows that SHG participation has significant impact on overall empowerment. Digital tools can empower women by providing them with education, healthcare information, and economic opportunities [7]. Hence, we can say that digitization and getting familiarised with digital tools like software applications can also impact the community in their empowerment.

Initiatives like the Digital India campaign aim to make technology more accessible to all citizens, with a particular emphasis on bridging the digital gender divide as well [8]. Empowering women in the community can directly impact the overall empowerment of the community in which they live. AmritaSREE is one such notable initiative by the Mata Amritanandamayi Math that focuses on women’s economic and social development by forming SHGs, providing financial literacy training, and integrating digital tools for skill enhancement [9], [10]. The initiative helps to empower women in rural areas, enabling them to become self-reliant and contribute to their communities. These SHGs, consisting of ten to twenty women residing in close neighbourhoods, gather weekly or biweekly for their activities. This network has grown into an extensive web of over 13,000 SHGs across multiple states in India. Presently, there is a lack of assistance or online tools for the execution and management of these groups [11]. Similarly, these SHG members exhibit diverse characteristics, including varying digital literacy levels, limited exposure to mobile applications, ages between 18 to 60, and diverse professions [10].

In this paper, we discussed the design and development details of the user-friendly software solution designed to assist the management and administration of AmritaSREE SHGs within the clusters, groups, and users, ensuring streamlined operations. The SHG operates within a well-defined hierarchical tree structure, featuring specific functionalities and coordinators assigned to manage each level of the hierarchy. At the bottom level, individual members are organized into groups collectively forming an AmritaSREE SHG. Multiple

TABLE I: SDGs and their connection to Women Empowerment as per the study [5]

SDG	Description	Connection to Women Empowerment
1	No Poverty	Women empowerment addresses poverty through economic inclusion, skills development, and access to resources.
2	Zero Hunger	Empowering women in agriculture enhances food security, promoting sustainable farming practices and equal access to resources.
5	Gender Equality	Directly focuses on women empowerment, promoting equal opportunities, representation, and rights for women in all spheres.
8	Decent Work and Economic Growth	Women empowerment contributes to economic growth by fostering employment opportunities, entrepreneurship, and financial inclusion.
10	Reduced Inequalities	Empowering women addresses social and economic inequalities, promoting equal opportunities, representation, and inclusivity.

groups then constitute a cluster [12] [10]. This software tool is intended to ensure smooth and efficient workflow, enhancing the administrative processes of the SHG management.

The application has a simple, user-friendly interface, which doesn't need advanced reading or writing skills to navigate it. Through an intuitive layout and straightforward navigation, we aimed to empower users with limited literacy skills to navigate the app effortlessly. Using the power of technology, mainly through a dedicated mobile application, enhances the efficiency of SHGs, promoting a collateral-free microfinance model. The simplicity of our software design stands as a key factor in optimizing the entire system's functionality—the more user-friendly the application, the smoother its operation, translating to heightened efficiency.

The rest of the paper is organized as following. Section II discuss the relevant literature delving in to how technology enhances women empowerment, flutter framework for HCI, and importance of Node.js for developing software's. Section III details about the SHG Management features alongside user-friendly application design. Section IV shows the implementation details of the Mobile application architecture built in Flutter and Node.js.

II. RELATED WORKS

The literature explores the fields of women's empowerment, investigating the role of the Flutter framework in Human-Computer Interaction (HCI) and understanding the significance of Node.js in software development, which helps to understand the current state of the art.

The growth of the Internet and other digital communication platforms has created new possibilities and opportunities for collaborative learning and information sharing. This occurs through various channels, including the formation of learning digital communities, discussion groups, and chat rooms [13]. There are several pieces of literature that show the penetration of mobile devices and software applications into people's lives. As per [14], the Industrial Revolution 4.0 of the year 2011 has had an impact on society, incorporating the use of various devices in human lives. Later, even mobile application platforms such as YouTube, Instagram, Telegram, WhatsApp, and similar tools emerged for high-speed communication and

information exchange. The rise in digital payment adoption in rural regions has spurred the expansion of the digital economy, opening up fresh possibilities for businesses and entrepreneurs, while enhancing the well-being of communities [15]. Numerous smartphone applications have been developed to empower rural communities across diverse sectors, including delivery of timely information, offering market insights, and providing healthcare services [16]. These applications have played a crucial role in contributing to the improvement of living conditions in these areas.

The work [17] highlights the significance of smartphones and the development of a low-literate community through mobile-based applications. Mobile phones play a crucial role as a primary computational support in diverse sectors, including healthcare, education, finance, and more. Also, as per [18], based on their study of IT-based entrepreneurship motivation and the formation of business groups, the introduction of mobile applications becomes a pivotal strategy to expand the network, connecting and engaging more individuals in a business group.

The widespread use of mobile phones in rural areas can be strategically harnessed to bring women closer to the business ecosystems [19]. This connectivity facilitates communication and opens up opportunities for collaboration, support, and resource-sharing, ultimately fostering a more empowered and self-resilient community. The study [20] offers numerous specific recommendations regarding design preferences, insights into the sources of concerns, and the usage patterns observed among older individuals. The interviews and the focus group discussions were used to identify usage patterns, problems, benefits, and desired and non-essential features.

Developers choose to utilize cross-platform application frameworks due to the convenience they offer. These frameworks allow developers to write code for the application once, using a single codebase, and deploy it simultaneously on both iOS and Android platforms. It significantly saves time and effort as developers do not need to learn separate skill sets for each platform [21]. Flutter, in particular, has gained rapid popularity among developers for its user-friendly nature, extensive widget library, and the ability to create

TABLE II: User Roles and Permissions

Role	Permissions
System Admin/Administrator	<ul style="list-style-type: none"> • Has full control and visibility across the entire system. • Can add, update, and delete users, groups, and clusters.
Cluster Admin	<ul style="list-style-type: none"> • Manages activities within their assigned cluster. • Can add, update, and delete users within their cluster. • Can view and update their cluster details. • Cannot add or delete clusters.
Group President	<ul style="list-style-type: none"> • Manages activities within their assigned group. • Can add and update users within their group. • Can view and update their group details. • Cannot delete groups.
Group Secretary/Treasurer	<ul style="list-style-type: none"> • Manages activities within their assigned group. • Can view and update their group details. • Cannot add, update, or delete users or groups.
Member	<ul style="list-style-type: none"> • Participates within their assigned group. • Can view their group details. • Cannot add, update, or delete users or groups.

visually appealing, high-quality cross-platform applications. The framework and its use of the Dart programming language enable the development of high-performance applications with fast and smooth graphics rendering across various platforms [22] [23]. Flutter employs a declarative approach to create user interfaces. Widgets are only repainted when anything has changed, which speeds up interface rendering [24].

The study [25] demonstrates how Node.js performs better than PHP and PythonWeb in terms of how many requests the server can handle and how quickly the server can answer a MySQL SELECT query. This work demonstrated how Node.js has an advantage over other server-side languages when building a web application. Node.js, with its minimal core and emphasis on modular, smaller, and simpler code, is built on principles that enhance its internal architecture and development practices.

III. SOFTWARE SYSTEM DESIGN

This section outlines the approach adopted to develop the application and its key features on SHG management. For that, we studied the application's various user bases, characteristics, and roles. We used this information to design the application flow, access roles, authorization needs, and constraints. We also discuss the UI features adopted for the development.

A. SHG User Characteristics

To understand the various user base, we had discussions with different users of SHG management hierarchy. The users' digital literacy is at varying levels, and the users are in different age group as well [10]. Designing a software with different user characteristics require a very careful User Interface Design. User characteristics will help to design the application. The SHG comprises women of 10-20 with varying literacy

levels, limited familiarity with mobile applications, and aged between 18 and 60. Several such groups nearby form a cluster [10].

B. SHG Management Features

For any software to be used by the users, they have to register to the system. The main focus of this work is to create the suitable UI and screen flow to support the registration of the users as well as the roles of users in the overall. The registration process within the hierarchy of the organisation is as shown in the Figure 1. The system has a system administrator; he/she has all the privileges such users of all hierarchy for the efficient testing of the software. He also has the privilege to create the various users, groups, and clusters as well. The software design includes all the capabilities and scenarios in which the system admin needs to work. As we move down the hierarchy, the cluster admin takes charge of managing activities within their assigned cluster. Cluster Admins are solely responsible for loan disbursement and monitor the financial activities of the SHG. Additionally, they can update specific cluster details. Moving further down, the Group President is responsible for overseeing activities within their designated group. Their focus lies on adding and updating users, as well as viewing and updating group details, deposits, loan repayment, and so on. Meanwhile, the role of the Group Secretary/Treasurer involves managing the activities within their designated group such as loan request, loan repayment, and monthly group investment. They are granted the ability to update group details. Permissions are assigned to users based on their roles within the system, as detailed in Table. II.

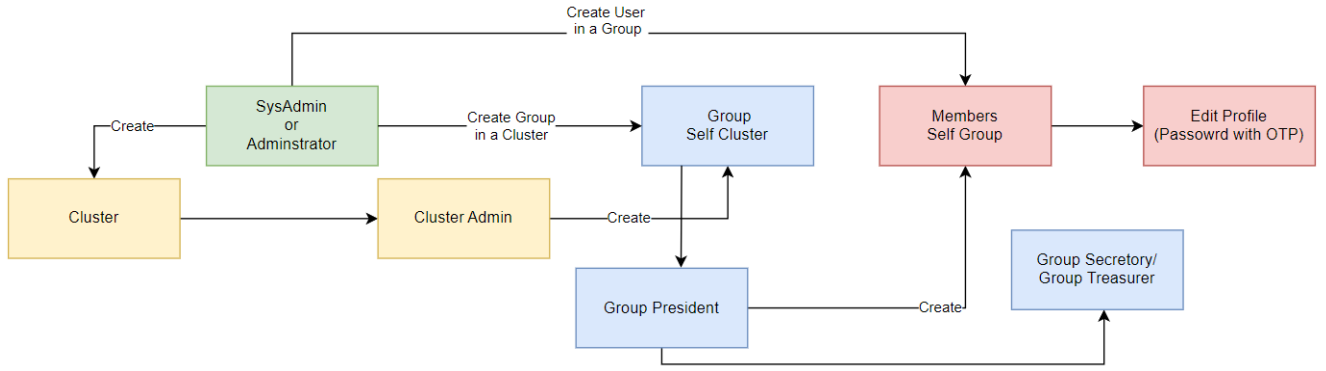
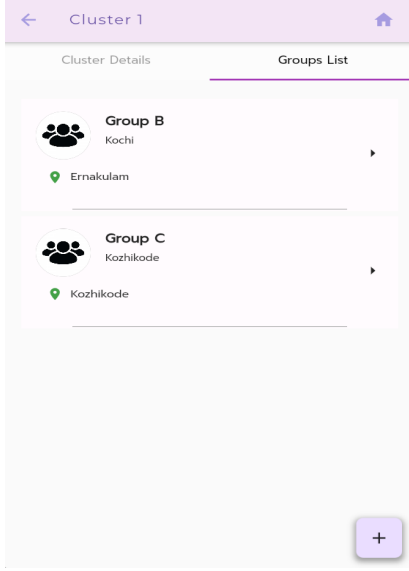
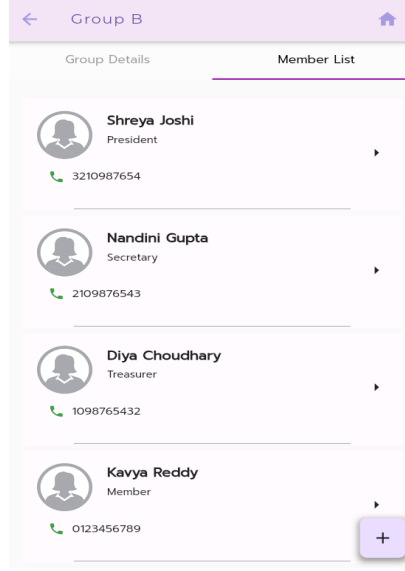


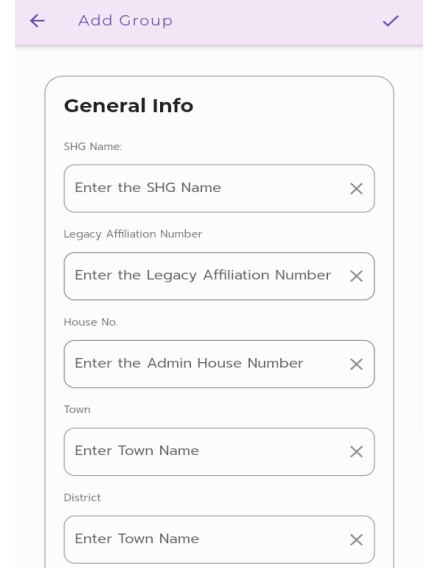
Fig. 1: Administrative hierarchy of the organisation



(a) SHG List within a Cluster



(b) Member List within a SHG



(c) Add new SHG to the System

Fig. 2: Screenshots of the Application indicating icon based UI

C. Application Design Principles

1) *Linear Navigation of Application*: Considering the varying digital literacy and age groups, it was necessary to think of a linear application workflow, i.e. linear navigation through the application, as some of the users in each group might be new to even using mobile applications. This is especially true with elderly individuals, similar to their experience with traditional media like books, where the content is fixed, and they follow the predetermined order set by the creator [26]. This makes it easy to use the system, and they need to put less cognitive involvement into using the system by memorizing things that could be more intuitive to them. This approach makes it easier for users to anticipate forthcoming functionalities and engage with the application through muscle memory. The linear structure provides a sense of continuity and predictability, fostering a more intuitive and comfortable user experience for individuals.

2) *Icon based UI*: Elderly users with eye problems in reading and semi-literate users who need some help in read-

ing often encounter challenges navigating through a textual interface due to difficulties reading and comprehending written content [27]. In recognising these challenges, employing visual elements such as icons becomes crucial to enhance user interaction. Using universally recognisable symbols, such as a + icon for adding content, a ✓ icon for saving, and a × icon for canceling, significantly contributes to a text-free interface, as shown in Fig. 2. These icons transcend language barriers, making them easily understandable for users with varying literacy levels. Furthermore, incorporating such iconography aligns with a more inclusive design approach and caters to users navigating the application with greater ease and independence. It ensures that essential functionalities are not contingent on textual comprehension, promoting accessibility and usability for a broader user demographic.

IV. SOFTWARE IMPLEMENTATION

To develop this software, we chose to use the Flutter framework backed up by Google and Dart programming

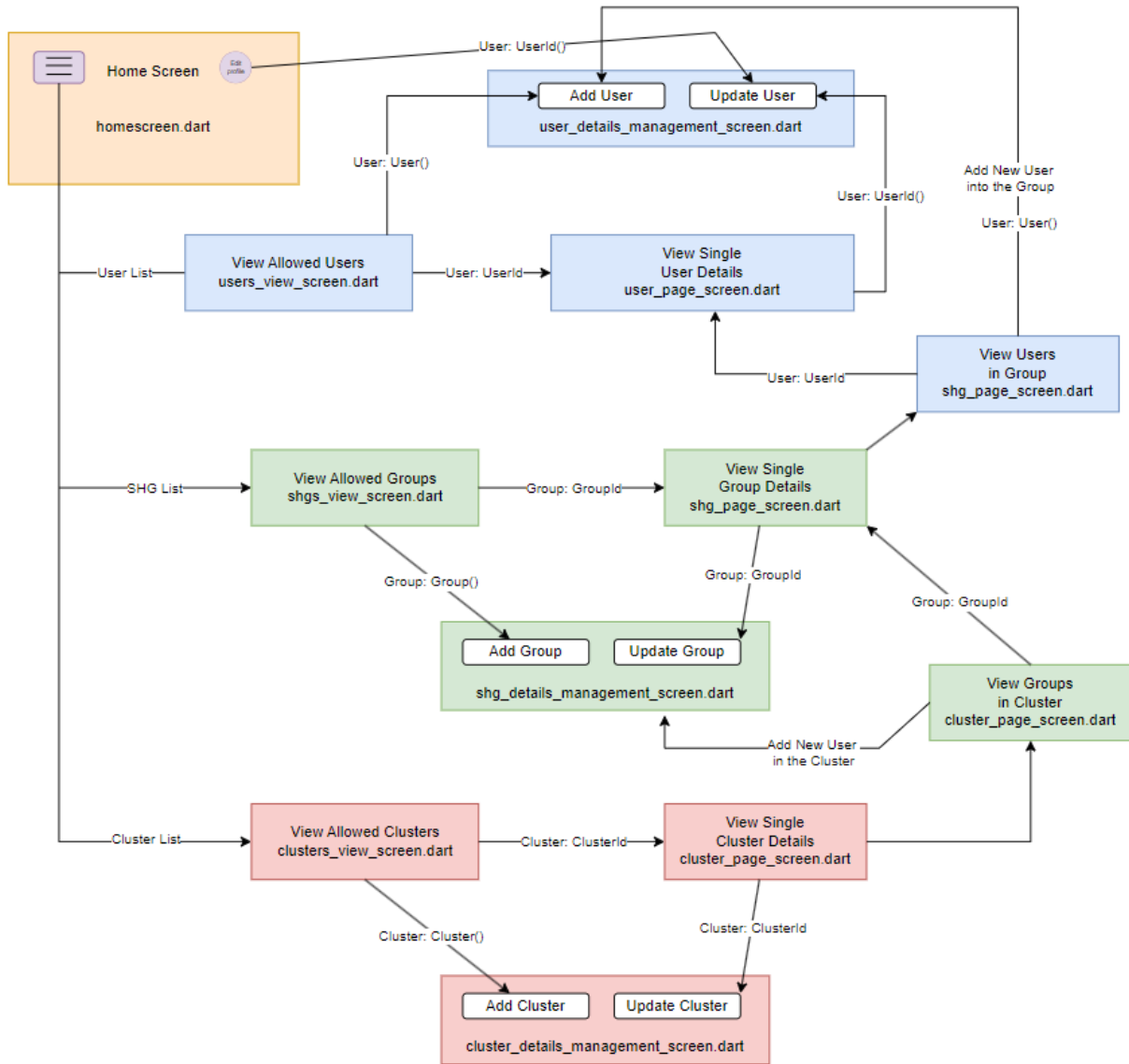


Fig. 3: Screen Flow from a System Admin/Administrator perspective

language for the front-end, along with Node.js for the back-end. Additionally, we utilized the services of MySQL as the database for the application. Figure. 3 shows the screen flow of the system designed using Flutter. The system involves SHG management features. Different screens handle adding, updating, and viewing users and groups.

A. Software Technologies

1) *Flutter*: Flutter allows developers to build applications for multiple platforms (iOS, Android, web, desktop and watch) using a single codebase. This can significantly reduce development time and effort compared to developing separate codebases for each platform. Dart Flutter plays a pivotal role in the development of a application for the streamlined management and interaction with SHGs, a commitment to user-centric design and functionality. Flutter's widget framework allows for expressive and flexible UI development through its

declarative and composable nature. The widget serves as the main component for the screens. Flutter widgets are highly customizable and can include everything from buttons and text fields to complex layouts and animations. They are organized in a tree structure, forming the visual hierarchy of the app. The widget is responsible for delineating the UI layout employed in the display of data. The application uses the Provider package for state management. It separates the UI logic from the business logic by keeping the state in separate providers, such as AuthProvider and SharedPreferencesProvider. The styling of the user interface adheres to a consistent color scheme, fostering a visually appealing and user-friendly experience. Flutter also simplifies hardware interaction by providing easy access to device features like camera, GPS. Due to all the advantages Flutter has gained popularity, leading to an active community. This community supports developers with a

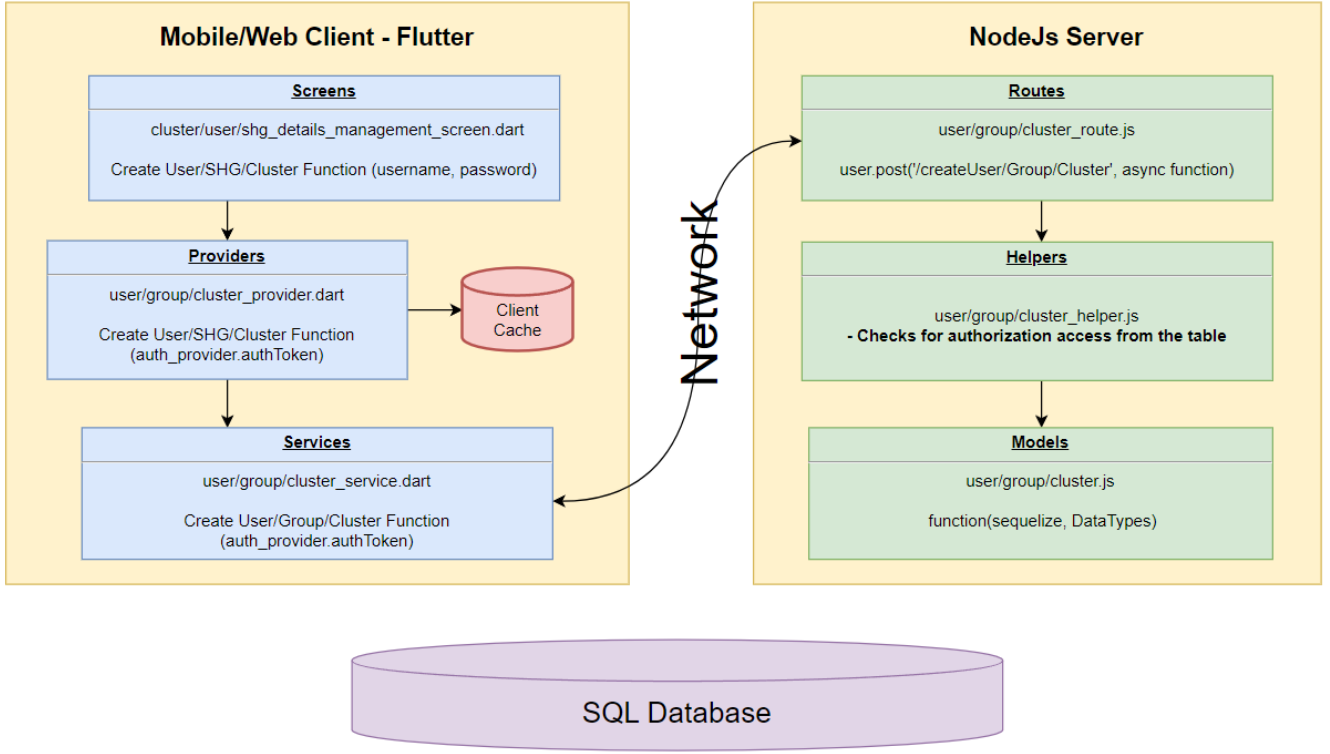


Fig. 4: Software Architecture of the Application

wealth of resources, plugins, and third-party packages.

2) *Node.js*: Node.js utilizes an event-driven architecture that makes it efficient for handling concurrent requests. Moreover, Node.js has a rich ecosystem of open-source libraries and packages through npm (Node Package Manager), incorporating rapid development. JavaScript is a widely-used, easy to learn language, and developers can quickly transition to server-side development with Node.js. Node.js is used as server-side programming language because of its huge community, reliability, and compatibility with the full stack web development [28]. Addressing the issue of scalability, the usage of Node.js with caching will allow the system meet the future scalability requirement, thus using Node.js will ease the process of horizontal scaling. Node.js offers the advantage of reducing the delays in response time for the requests [29].

B. Software Architecture

The high-level architecture of the mobile application for the technical operations is inspired from the work [30]. The architecture comprises a client-side system that encompasses the user interface and application logic, where the Screen manages individual views and interacts with providers to handle data and services to generate API calls to the external Server. On the server-side, the architecture includes a Server component responsible for handling client requests through defined Routes, directing them to specific functions and interacting with the Database to manage data. Helpers provide utility functions, and Models represent the data tables used in the

application. The Database stores and manages the application's data, responding to requests from the Server. The architecture is shown in Fig. 4. This architecture promotes scalability, security, maintainability, and efficient data flow within the software system. Authentication in the server involves verifying the user's identity, it determines whether the identified user has permission to perform a specific task. User authentication safeguards against unauthorized access, preventing them from obtaining sensitive information, this provides overall security of user data. Token-based authentication is used as verification process to fetch the authorization access to the user. The User Authorization permissions of the SHG system is as shown in the Table. II.

C. Software Functionalities

The system application functionalities are organized within a hierarchical framework to facilitate user registration and role management. At the top tier is the System Administrator, with privileges for establishing the cluster and cluster admins. Moving down the hierarchy, Cluster Administrators take charge of specific clusters, overseeing loan disbursement, monitoring financial activities of SHGs, and updating cluster details, creating Groups and Group Presidents. Group Presidents focus on managing designated groups, handling user additions and updates, and overseeing group details, deposits, and loan repayments. Meanwhile, Group Secretaries/Treasurers are responsible for managing group activities, including loan requests, repayments, and monthly investments, with permissions tai-

lored to their specific roles. This hierarchical design ensures a systematic approach to user registration, role assignment, and efficient management of diverse administrative responsibilities within the system.

V. CONCLUSION

Empowering women is a critical factor that contributes to rural development. Digital empowerment has so much power in the transformation of a community. Existing studies show that digital tools have the potential to empower women by offering them access to economic opportunities. In this work, we discuss the development process of a software solution for one of the SHG groups, which was intended for women's empowerment. The software solutions are expected to streamline the process of the SHG Administration at each level of the SHG hierarchy. The software design focused on user-friendly approaches such as linear navigation and icon-based design for ease of use. As the software is developing for a large user group, the utilization of Node.js as server-side programming helps to withstand the larger number of users, ensures the application's scalability and avoids delays in response time for requests. The ease of administration process would facilitate to growth of the SHG network.

ACKNOWLEDGMENT

We would like to thank our beloved chancellor Shri. (Dr) Mata Amritanandamayi Devi, for her support and guidance.

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