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Technical Report

Empowering AmritaSREE: Human-Centered Design through mobile platform and Blockchain Innovations for Self Help Groups

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Abstract

AmritaSREE, an initiative by Sri Mata Amritanandamayi Devi, addresses the critical need for rural development by empowering women through Self-Help Groups (SHGs). These groups aim to provide livelihood opportunities and enhance vocational skills for economically vulnerable women in developing nations. As the initiative gains popularity across India, the management of SHGs becomes an administrative burden, particularly when expanding to different states. To tackle these challenges, a unique IoT solution is proposed, leveraging mobile computing and a human-centered design approach to develop an SHG management application. Furthermore, the project suggests incorporating blockchain technology to ensure transparency and boost trust among group members. The mobile application's finance module ensures accurate financial tracking, reducing administrative work by generating summary reports instead of scrutinizing each transaction. This tech-driven approach not only streamlines SHG management but also facilitates better group compatibility, efficiency, and member empowerment. By embracing these innovative solutions, AmritaSREE aims to propel the economic independence and socio-economic welfare of women in rural areas throughout India.

1 Introduction

The problem addressed in this work revolves around the administrative challenges faced by Self-Help Groups (SHGs) within the AmritaSREE initiative, which seeks to empower economically vulnerable women in developing nations. As these SHGs expand across various states in India, managing their operations becomes increasingly complex. The manual methods of ledger maintenance, group compatibility, and overall administration become significant hurdles, necessitating a more streamlined and technologically advanced solution. The motivation for this research stems from the urgent need for rural development and women's empowerment in developing nations. AmritaSREE, while successful in its mission, encounters managerial difficulties as it expands. The traditional ledger-keeping methods not only pose challenges in terms of accuracy but also hinder transparency. The envisioned scenario involves a rural community where self-help groups rely on manual record-keeping, leading to errors and a lack of transparency. The research aims to address these issues and provide a solution that enhances the efficiency of SHG management.

Consider a rural community where AmritaSREE self-help groups operate. Currently, these groups rely on manual record-keeping methods, leading to potential errors and a lack of transparency. With the proposed IoT solution, imagine a scenario where self-help group members have access to a mobile application tailored to their needs. This application allows secure digital recording and management of financial transactions. Blockchain technology validates each transaction, ensuring transparency and trust among group members. For instance, if a group member needs to borrow money, she can use the mobile application to request the transaction, which is then recorded

and verified on the blockchain ledger. This process ensures accountability, preventing unauthorized or fraudulent activities within the group. Group administrators can view summary reports generated by the finance module, saving time and streamlining administrative tasks.

In the process of developing applications for rural women with limited exposure to technology, various challenges emerge, encompassing issues related to digital literacy, internet connectivity, and cultural relevance. These challenges necessitate the adoption of a human-centered approach to ensure the successful implementation of the app. Given that rural women may have limited familiarity with smartphones and applications, it becomes difficult to design an interface that is user-friendly, catering to their needs and capabilities. The importance of making the app intuitive, featuring simple navigation and clear instructions, cannot be overstated in bridging the digital literacy gap.

Addressing the diverse linguistic and cultural backgrounds within rural communities poses a significant challenge. To foster trust and engagement, the content and user interface of the app must be available in local languages, resonating with the cultural norms and values of the target audience. Additionally, exploring ways and methods to seamlessly integrate mobile applications with blockchain technology presents another crucial challenge. To overcome these obstacles, a human-centered design approach, extensive user testing, and proactive engagement with the community are imperative in developing an inclusive and empowering app for rural women. Several technical characteristics also pose challenges during app development. Designing the app to adapt to various screen sizes and resolutions is critical for ensuring a consistent user experience across devices. Balancing functionality with performance is essential to prevent app lag, particularly on lower-end devices. Furthermore, implementing the security measures is vital to safeguard user data and prevent unauthorized access, given the sensitivity of information users may share.

Currently, SHGs manage their operations using traditional ledger methods and manual record-keeping. However, these methods are prone to errors, lack transparency, and become increasingly challenging to manage as the number of groups expands. There is a need for a more efficient and technologically advanced solution to address these issues. The proposed solution involves the development of an SHG management application using IoT and a human-centered design methodology. The application leverages mobile computing for accessibility and proposes the integration of blockchain technology to ensure transparency and trust among group members. The finance module of the application facilitates accurate financial tracking, reducing administrative workload by generating summary reports instead of scrutinizing individual transactions. The rationale behind this approach is to provide a user-friendly, technologically advanced solution that addresses the specific needs and challenges faced by SHGs. The incorporation of IoT and blockchain technology enhances transparency, efficiency, and accountability, ultimately empowering women in rural communities.

The specific research objectives of this study revolve around addressing the challenges

faced by Self-Help Groups (SHGs) within the AmritaSREE initiative. Firstly, the aim is to develop a comprehensive SHG management application utilizing both the Internet of Things (IoT) and a human-centered design approach. This involves creating a user-friendly interface tailored to the needs of economically vulnerable women in rural areas. Secondly, the research aims to integrate blockchain technology into the application to enhance transparency and foster trust among SHG members. This strategic integration seeks to revolutionize the traditional ledger-keeping methods, ensuring accuracy and accountability in financial transactions. The third objective involves the implementation of a finance module within the application, specifically designed for accurate financial tracking. This module aims to streamline administrative tasks, enabling summary reports that facilitate efficient decision-making. Lastly, the study intends to evaluate the effectiveness of the proposed solution in real-world scenarios. The evaluation process will focus on assessing how the application streamlines SHG management processes and contributes to the overall empowerment of its members, thereby advancing the mission of rural development and economic self-reliance.
The contributions of this work are

- Login and User Registration of the SHG users.
- Feasibility analysis for Blockchain Enabled Ledger Maintenance Requirement for Rural Self Help Groups.
- Conceptual design of blockchain technology to be integrated with the AmritaSREE system.

2 Literature Survey

2.1 Blockchain, adoption, and financial inclusion in India: Research opportunities

The paper [1] significantly contributes to the exploration of blockchain technology's potential for fostering financial inclusion in India. Its novel focus on specific research opportunities within the Indian context provides valuable insights for policymakers and industry stakeholders aiming to leverage blockchain for societal impact, particularly in the realm of financial services. By addressing the needs of users and bridging the digital divide, the paper contributes practical knowledge to the blockchain literature.
While the paper offers valuable insights, it may face limitations due to the rapidly evolving nature of blockchain technology and financial inclusion efforts. The findings might become outdated quickly, and the paper may not deeply delve into the practical challenges of implementing blockchain solutions in the Indian financial system. Additionally, there might be a reliance on a limited perspective, potentially impacting the representation of diverse viewpoints.

Future research opportunities include further exploration of technology adoption in emerging markets like rural India. Deeper investigation into the practical challenges of implementing blockchain solutions, considering diverse perspectives, can enhance the understanding of the complexities involved. The research has opened avenues for examining user behavior, regulatory aspects, and the necessary technological infrastructure for successful blockchain adoption in India's financial landscape.

2.2 Information and communication technology and the sustainability of microfinance

The paper [2] makes a significant contribution to the world by exploring the role of Information and Communication Technology (ICT) in enhancing the sustainability of microfinance institutions. The research examines how ICT tools, such as mobile banking and digital platforms, can improve financial services' accessibility and efficiency for underserved populations. By identifying the potential of ICT in supporting microfinance sustainability, the paper offers valuable insights for policymakers and development agencies.

The limited access to ICT infrastructure in remote and underserved areas poses a challenge to scaling up digital microfinance services and reaching the financially excluded. The concerns surrounding data privacy, cybersecurity, and digital fraud adversely affect user trust in digital microfinance platforms, impeding widespread adoption. Additionally, the high costs associated with implementing and maintaining ICT solutions present financial barriers.

Research is needed to assess the long-term impact of ICT adoption on the sustainability of microfinance institutions and the socio-economic outcomes of microfinance recipients. Investigating how microfinance institutions can effectively navigate digital transformation and leverage emerging technologies to enhance outreach and operational efficiency.

2.3 Mobile Banking: An Innovative Solution for Increasing Financial Inclusion in Sub-Saharan African Countries: Evidence from Nigeria

The research [3] sheds light on how mobile banking technologies can address the limited reach of traditional banking services, particularly in rural areas, fostering financial inclusion. The study, focusing on Nigeria, provides valuable evidence and insights for policymakers, financial providers, and stakeholders to formulate effective strategies for promoting access to formal financial services in Sub-Saharan Africa.

The paper acknowledges limitations, including the impact of varying technological infrastructure on mobile banking accessibility and usability across different regions. Additionally, socioeconomic factors such as income disparities and digital literacy levels are recognized as influencing mobile banking adoption and usage patterns. Regula-

tory challenges in the realms of financial services and digital technologies are briefly addressed, suggesting that a more comprehensive analysis could offer valuable insights into financial inclusion outcomes.
Future work could delve into examining the role of regulatory frameworks and policies in shaping the mobile banking landscape and their specific impact on financial inclusion outcomes. Further investigations are warranted to explore the broader social and economic implications of mobile banking, including its role in poverty alleviation, income generation, and the empowerment of marginalized communities.

2.4 Empowerment of Women Self Help Groups: Human Centered Design of a Participatory IoT solution

The paper [4] contributes by proposing an IoT architecture and designing a Mobile Application to enhance the empowerment of rural women through self-help groups. The focus is on improving life for these women by addressing the challenges in training, resource, and finance management, providing effective channels and platforms. While the paper makes valuable contributions, it has limitations. It may not fully address various human factors impacting the successful adoption of women's self-help groups. Technical intricacies of financial operations within the organization are not thoroughly discussed, and practical implementation of the IoT solution may encounter challenges such as connectivity issues, hardware limitations, or compatibility problems.
Significant attention should be given to UI design and user functionalities to ensure widespread adoption of the mobile application. Further exploration of character recognition through image processing functions can enhance the application's capabilities. Future work should delve into the application of natural language processing to improve the functionality and user experience of the mobile application.

2.5 Consensus Agreement for Secure Transactions in Self Help Groups

In their paper [5], the authors comprehensively explored the structure and operation of financial transactions within Self-Help Groups (SHGs). They proposed a consensus mechanism to verify transactions before incorporation into the digital ledger, discussing the determination of an ideal threshold value for consensus. The research also introduced human-centered design principles, incorporating regional languages and text-to-speech conversion to enhance system usability. Consideration of user demographics, including age, gender, literacy, and technological proficiency, further contributed to an improved user interface.
The challenges highlighted in the paper revolve around achieving consensus in a distributed system for secure transactions within self-help groups. Designing and implementing the consensus algorithm pose complexities, with a need for robust security against potential attacks. The intricacies of the algorithm's design require careful con-

Table 1: *Summary of the Related works*

Title & Year	Problem	Contributions	Limitations	Open problems/ Future work
Consensus Agreement for Secure Transactions in Self Help Groups IEEE (ICCCNT) 2021	Establishing a consensus mechanism for trust, addressing decentralization challenges in maintaining a secure transaction ledger, and ensuring compatibility with existing financial systems are essential aspects to streamline transactions within self-help groups.	The authors suggested consensus agreements for confirming transactions in Self-Help Groups (SHGs) and conducted a study on the ideal consensus threshold value. Human-centered design, incorporating text -to-speech conversion and regional language use, streamlined the software, with user age, gender, literacy, and technological proficiency influencing the interface design.	A distributed system for secure transactions in self-help groups faces challenges in achieving consensus, including the complexity of algorithm design and execution, along with the need for robust security. Ensuring the confidentiality of participant data and transactions is crucial for maintaining privacy and trust among group members.	Implementing a consensus algorithm based on user agreement is essential to maintain data security and prevent data tampering in digital ledgers.
Mobile Banking: An Innovative Solution for Increasing Financial Inclusion in Sub-Saharan African Countries: Evidence from Nigeria Sustainability MDPI 2020	The low penetration rates and limited reach of traditional banking in rural regions, along with concerns about security and confidence in mobile banking and a high level of financial illiteracy, impede the widespread use of formal financial products and services.	The paper analyzes data from a review of mobile banking's effects in Nigeria to shed light on how it might increase financial inclusion for underserved groups. Stakeholders and legislators creating successful financial inclusion programmes in Sub-Saharan Africa can benefit from this data.	The study identifies obstacles to efficient mobile banking, including accessibility-affec ted regional technological disparities. Socioeconomic issues like income inequality and digital literacy have an impact on adoption. Rather than just focusing on regulatory issues, a more thorough investigation might reveal information about financial inclusion.	Future studies will concentrate on how regulatory frameworks affect the environment of mobile banking and how this affects financial inclusion. They will also look at the broader effects of mobile banking on reducing poverty, creating income, and empowering marginalized groups.

Title & Year	Problem	Contributions	Limitations	Open problems/ Future work
Blockchain, adoption, and financial inclusion in India: Research opportunities International Journal of Information Management 2020	Understanding user behavior and acceptability of blockchain -based financial services is unclear, hindering effective bridging of India's digital gap and ensuring data security and privacy in financial systems through blockchain technology.	It contributes valuable insights for businesses and governments looking to leverage blockchain for societal impact, particularly in the realm of financial inclusion and addressing unique research opportunities in India.	Conclusions may become outdated due to rapid developments in blockchain and financial inclusion. Identifies areas for future research but lacks in-depth analysis of real-world challenges in applying blockchain to the Indian banking system.	The report offers insights into user behavior, legal considerations, and the necessary technology infrastructure for successful blockchain deployment, while also addressing specific opportunities and obstacles in adoption.
Empowerment of Women Self Help Groups: Human Centered Design of a Participatory IoT solution IEEE GHTC 2020	Efficiently managing training, resources, and finances is crucial for women's empowerment through organizations. However, manual, telephone, and WhatsApp approaches exhibit limitations in communication, multi-level engagement, and community involvement.	covers the essential elements of developing a user-centered user interface (UI) service that appeals to a wide range of target demographics, such as those with different age ranges, educational backgrounds, skill levels, and levels of mobile phone expertise.	It's possible that not all human factors influencing the uptake and empowerment of women's self-help organizations are covered by the study. It doesn't understand the workings of financial operations, and real-world obstacles like network, device limitations or compatibility problems could a rise when implementing an IoT solution.	Future development of the mobile application must focus on two crucial areas: investigating natural language processing applications and enhancing user acceptance through significant UI design and functionality, including image processing for character recognition.

Title & Year	Problem	Contributions	Limitations	Open problems/ Future work
Information and communication technology and the sustainability of microfinance Electronic Commerce Research and Applications 2012	For microfinance to be effective and reach a wider audience while maintaining accessibility and affordability, mobile application integration is essential. Adoption of ICT has a critical effect on microfinance's social impact and financial sustainability.	The paper primarily focuses on microfinance sustainability through mobile banking. It also provides insights for policymakers and development by examining the impact of ICT on improving financial services' accessibility for underserved populations.	Scaling digital microfinance is hampered by limited ICT access in remote areas, which affects those who are financially excluded. User trust is damaged by worries about data privacy, which impedes platform adoption. Financial obstacles are caused by the high implementation costs of ICT solutions.	Exploration of how ICT can navigate digital transformation and leverage emerging technologies for improved outreach and efficiency.

sideration to ensure effectiveness and sustainability. Additionally, ensuring the security of transactions and participant data is crucial for fostering trust and privacy among self-help group members.

Future work should focus on the implementation of a consensus algorithm based on user agreement to address the identified challenges. Furthermore, maintaining data security and preventing tampering in digital ledgers should be a priority for the development of a more efficient and secure mechanism for achieving consensus in self-help group transactions. Summary of the background study is presented in Table 1.

3 Proposed Methodology

We've gathered project requirements from different stakeholders in the administration and AmritaSREE SHGs members. For our initial application build, we've selected three permission levels: members, Group Admins, and Ashram Admins. These levels represent a hierarchy in the administration, with increasing levels of authority.

The Ashram Admins have the highest level of authority, enabling them to create new groups, assign Group Admins, modify group details, and access the group's financial information.

Moving down the hierarchy, Group Admins have the ability to create user profiles for members within their group, manage group memberships, edit group details, and manage the group's finances.

At the user level, members maintain limited permissions. They can edit their profiles, view other members within their group, access group details, and have visibility into the group's financial data. This setup aims to maintain transparency while allocating

Table 2: *Permissions*

Ashram Admin	SHG Admin	User
Create SHG	Create User	Edit Profile
Add SHG Admins	Add SHG Members	View SHG Member
Edit SHG Details	Edit SHG Details	View SHG Details
View SHG Finances	Edit/View SHG Finances	View SHG Finances

varying degrees of administrative control based on roles within AmritaSREE. The permissions of each role that are discussed earlier are shown in table 2.

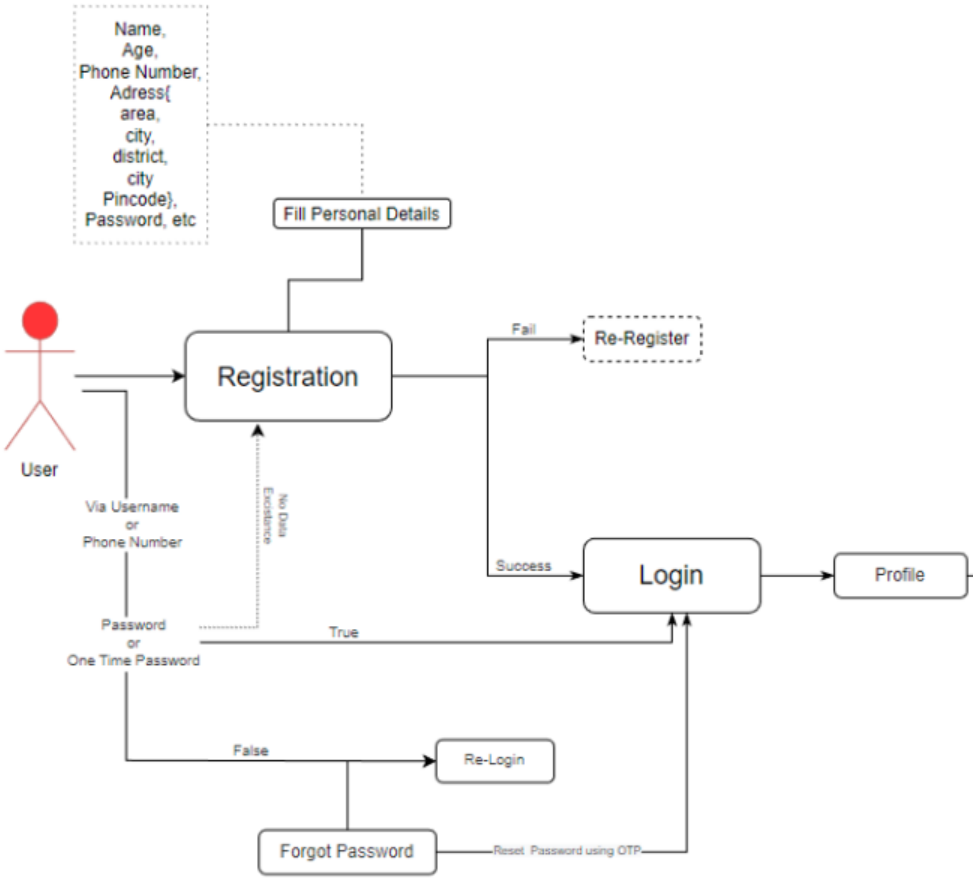

Figure 1: *Activity Class Diagram of the User*

3.1 Login & User Registration Module

This is the starting point for a new user. The user fills in personal details such as name, phone number, address, etc., and proceeds to register. If registration fails, the user has

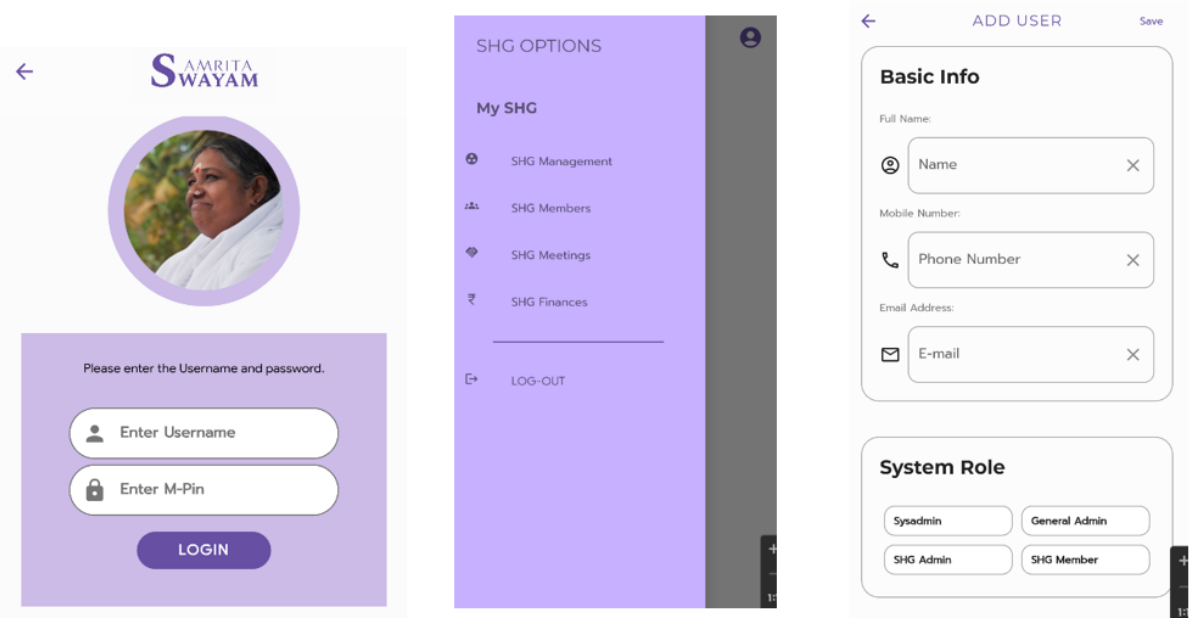

Figure 2: *Group Admin UI*

the option to re-register. After successful registration, the user logs in using a username, phone number, and password. If the login is successful, the user accesses their profile. The user can try to log in using a one-time password (OTP) generated through email-id as well. The activity class diagram of the following proposed methodology in shown in Fig. 1. The app stipulates two different functionalities and use case scenarios. Fig. 2 refers to the Group admins and Fig. 3 refers to regular users.

3.2 Blockchain Conceptualization

This Fig. 4 is an abstract representation of how transaction data might be organized and managed within a blockchain ledger for this system. Here's a breakdown of its components:

Week-by-Week Transactions: The top part of the diagram shows a series of blocks that represent transactions made by users within a group during specific weeks. Each block contains transactions from individual users (User_1, User_2, ..., User_n) for that week. This suggests that the blockchain ledger is organized into blocks that are grouped by the week in which the transactions occurred. The variables W, W_D, W_L, and O_L represent different financial figures within the block, with the subscript indicating whether it's for deposits (D), loans (L), or outstanding amounts (O). The notation $(\text{W\_i})\hat{*}$ indicates an occurrence of either 0 or 1, likely referring to whether a specific transaction or event took place in that week.

Detailed Block Structure: The detailed section at the bottom of the diagram provides an in-depth exploration of the information encapsulated within a single block

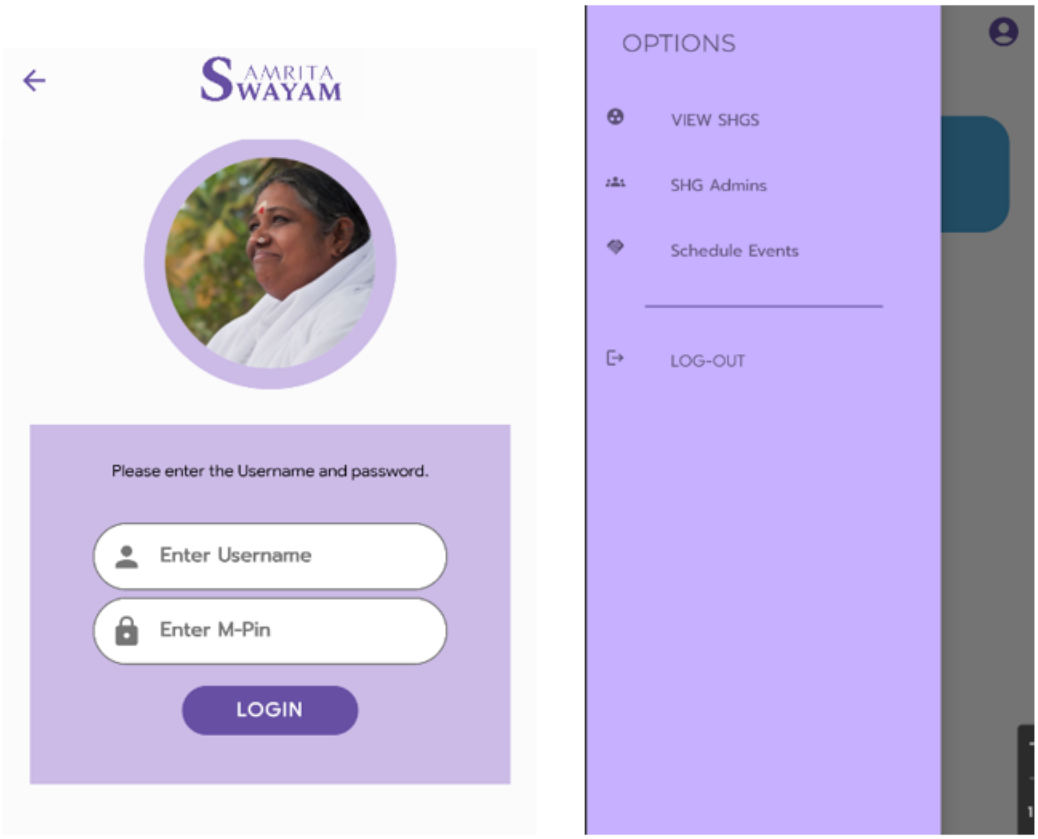

Figure 3: *Regural User UI*

in the ledger. This granular view encompasses several key elements, starting with the User ID and Group ID, serving as unique identifiers for both the user and the group involved in the transactions. Additionally, the Date field captures the specific date of the transactions recorded within the block. Delving into financial specifics, the section includes details about Deposits, offering insights into the weekly term deposit and the cumulative total deposit up to that point. Furthermore, the block outlines Loan Transactions, presenting information on any loan repayments made during the week and the remaining outstanding loan balance after those repayments. Finally, the Interest segment delineates the total interest for the month, the interest paid in the given week, and the outstanding interest balance. This comprehensive breakdown within a single ledger block provides a nuanced understanding of the financial dynamics and transactions associated with a user and their respective group.

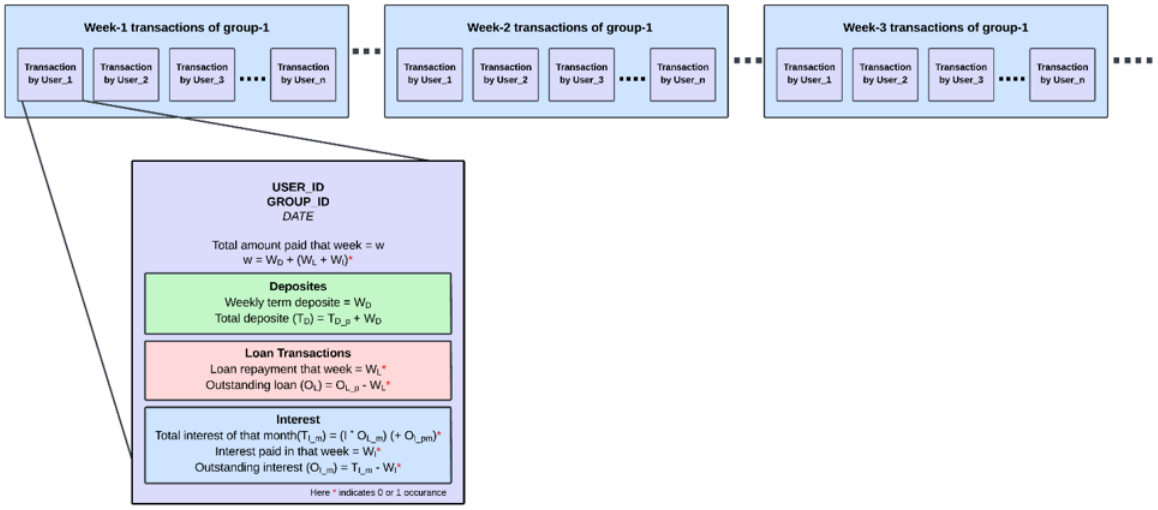

Figure 4: *Blockchain visualization for AmritaSREE*

4 Experimental Results

4.1 Experimental Setup

The Fig. 5 is a block diagram representing the architecture of a mobile application using Flutter for the frontend and Node.js for the backend, with a MySQL database for data storage. Here's a breakdown of the components and their interactions:

4.1.1 Flutter Section (Client-Side):

Flutter distinguishes itself in the realm of cross-platform development through its unique amalgamation of interface objects, rendering capabilities, and an extensive set of essential libraries, encompassing animation, graphics, and I/O functionalities. The utilization of the Dart programming language, compiled Ahead of Time (AOT), enhances the performance of the application, ensuring rapid and smooth graphics rendering across a variety of platforms. A standout feature of Flutter is its hot reload capability, allowing developers to witness real-time changes on simulators and emulators without the need for program restarts. The framework's primary interface elements are widgets, responsible for shaping the program's user interface and managing dynamic data. By organizing the code into modular widgets and classes and utilizing Flutter's rich widget library, you create a maintainable and flexible UI for your mobile app. The separation of concerns, state management, and widget composition make it easier to extend and enhance your app's functionality in the future.

- Screen: This is the user interface of the app where users interact. It presents the data and sends user requests to the provider.

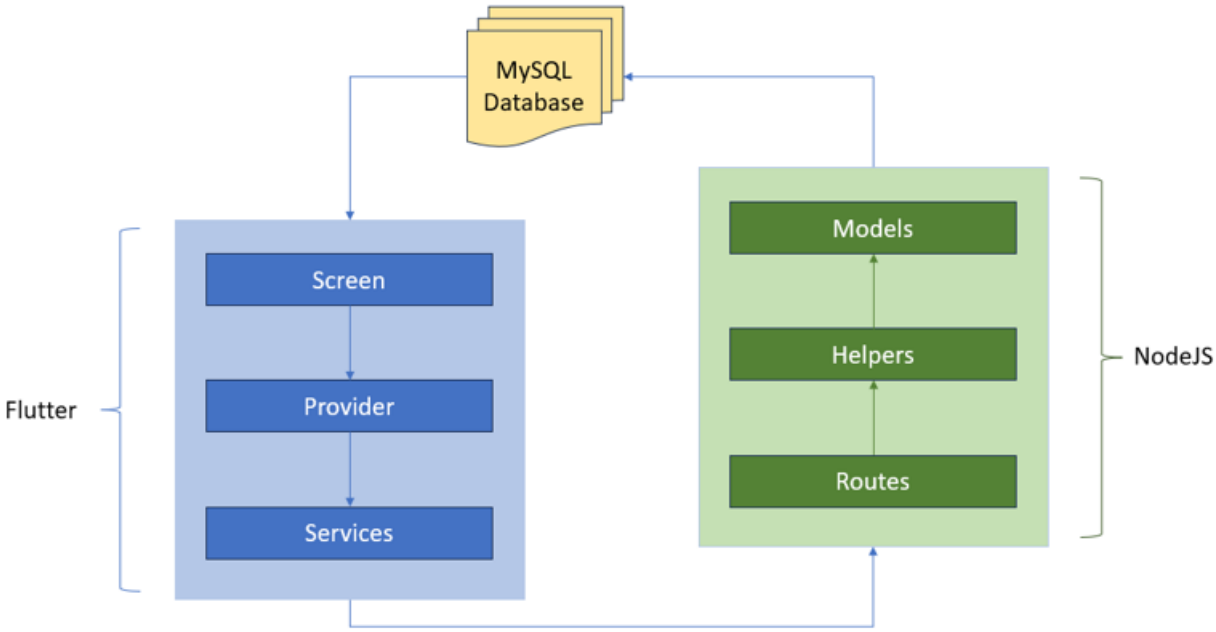

Figure 5: *Architecture for Mobile application*

- Provider: This acts as an intermediary for managing the state and facilitating communication between the UI (Screen) and the services that fetch or send data.
- Services: These are responsible for making API calls or running business logic. Services interact with the Node.js backend to send and receive data.

4.1.2 Node.js Section (Server-Side):

Among the choices available such as Node.js, Ruby, Django, PHP, Spring Boot, and ASP.NET, Node.js stands out as a preferred choice for developing mobile apps for various significant reasons. Mobile apps usually require real-time features, such as chat, notifications, and live updates. Due to its event-driven, non-blocking architecture, Node.js excels at meeting these real-time requirements. Node.js is able to manage several concurrent connections due to its scalability. This is crucial for mobile apps that could experience unforeseen traffic surges. Node.js has an active community and a plenty of open source resources including libraries, documentation, and tools that will speed up the development process.

- Models: These define the structure of the data used within the application, often mirroring the structure of the tables in the MySQL database.
- Helpers: This layer contains utility functions or shared code that supports the operation of models and routes but doesn't fit directly into the business logic.

- Routes: They handle HTTP requests and determine what actions to take based on the specific endpoint that is being requested. This is where the business logic of the application resides, processing inputs from the client side and interacting with the database.

In the context of the application's architecture, a MySQL database serves as a foundational component responsible for persistently storing and managing the application's data. Its integration into the system involves seamless interaction with the Node.js backend, establishing a bidirectional flow of data and requests. The Flutter application initiates this flow by sending requests to the Node.js backend through the Provider and Services layers. Subsequently, the Node.js backend processes these requests within the Routes, potentially utilizing Helpers and interacting with Models to execute database operations. The MySQL database, in turn, receives queries from the Node.js backend and returns relevant data. This orchestrated exchange of information completes a cycle, with the backend sending responses back to the Flutter client. The overarching architecture strategically separates concerns, with Flutter handling presentation and user interaction, Node.js managing application logic and database interactions, and MySQL dedicated to data storage. This modular approach enables independent development and scalability of the frontend and backend components, fostering a flexible and efficient system.

4.2 Experiment: Merkel Tree

We conducted an experiment to evaluate the effectiveness of Merkle Trees in confirming the integrity of extensive data collections and detecting inconsistencies among nodes. Our process involved implementing code to construct a Merkle Tree using the SHA256 hashing algorithm for a specified directory and subsequently comparing the Merkle Trees of two directories to detect disparities. The experiment consisted of two primary phases.

Firstly, we developed a mechanism to create the Merkle Tree for a given directory. This involved recursively navigating through the directory, hashing each file or subdirectory, and aggregating these hashes to generate a unified hash for the entire directory.Secondly, we designed a process to compare the Merkle Trees of two directories. This involved a recursive traversal through both directories to compare the hashes of their files and subdirectories. Any divergence in these hashes indicated discrepancies between the directories, flagging potential data integrity issues.

For our test, we curated a dataset representing transactional data at the SHG (Self-Help Group) level. The dataset follows the format shown in Fig. 6. The dataset comprised a 'node_1' directory containing four subdirectories, each representing transactional data for a specific week. Each subdirectory housed four transactions conducted by various SHG members. Additionally, we created a corresponding 'node_2' directory mirroring

'node_1' but with a manipulated transaction in the second week. Upon running our program, we successfully identified differences in the generated hashes for the 'week2' subdirectory, specifically pinpointing the manipulated 'file22.txt' transaction. This highlighted inconsistencies across the data copies, demonstrating the Merkle Tree's capability to validate integrity and detect anomalies in large datasets.

```
------------------------------
Info: SAME : week1
Info: DIFFERENT : week2
Info: SAME : week2\file21.txt
Info: DIFFERENT : week2\file22.txt
Info: SAME : week2\file23.txt
Info: SAME : week2\file24.txt
Info: SAME : week3
Info: SAME : week4
```

Figure 6: *Output for Merkle Tree Integrity Verification*

The Merkle Tree's effectiveness in ensuring data integrity is fundamental to its application in blockchain technology. In a blockchain network, where multiple nodes maintain copies of the blockchain, Merkle root values serve as a crucial means to cross-verify data integrity. When a node alters or tampers with data in its blockchain copy, comparing Merkle root values with those of other nodes detects discrepancies. Through a consensus mechanism, the network identifies valid data and can reject tampered blocks, ensuring the overall integrity and consistency of the blockchain data.

5 Conclusions

The undertaken research focused on creating a customized blockchain platform, specifically tailored to the unique requirements of the AmritaSREE initiative. The proposed AmritaSREE Block-Structure and the formulated financial module were key components, demonstrating a commitment to addressing the specific needs of rural Self-Help Groups (SHGs). An experiment was conducted to assess the effectiveness of Merkle Trees in verifying data integrity within large collections and identifying inconsistencies among nodes. Challenges related to technology adoption, sustainability, user training, and digital literacy were systematically addressed. A staged approach to software development, training, and continuous feedback loops were implemented to facilitate gradual familiarization and skill development among SHG members, ensuring the suc-

cessful diffusion of technology. The research presented a level-1 database design for the mobile application, highlighting the completion of the Login and Registration Module. A significant contribution was the presentation of the research work, titled "Examining Blockchain Enabled Ledger Maintenance Requirement for Rural Self-Help Groups," at the IEEE Region10 Humanitarian Technology Conference 2023. Two ongoing papers detailing the development of the AmritaSREE mobile application and a comprehensive blockchain survey are poised for submission to a conference. The ongoing implementation of two-factor authentication for login and self-registration underscores the commitment to robust security measures. The future scope of the project includes the continued implementation of additional modules for the mobile application, such as two-factor authentication. Testing prototypes with users for UI feedback and functionality analysis is in progress, contributing to iterative improvements. The research team aims to further refine and expand the blockchain-based AmritaSREE Block-Structure. Additionally, ongoing papers and survey work suggest a commitment to contributing valuable insights to the broader academic and technological community. Continuous development, testing, and feedback analysis underscore the commitment to refining the system and ensuring its effectiveness in empowering rural SHGs through innovative blockchain-enabled solutions.

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