DEVELOPMENT OF AN ENTERPRISE RESOURCE SYSTEM FOR POULTRY LIVESTOCK VALUE CHAIN: MODEL DESIGN

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Abstract

The poultry industry in Nigeria faces challenges due to manual record keeping and fragmented data management, which hinder productivity and sustainability. This study presents the design and implementation of a mobile-based Enterprise Resource Planning (ERP) system tailored to the poultry value chain. Using a user-centred approach, qualitative interviews and surveys with 54 stakeholders informed the development of a cross-platform mobile application built using Flutter and Firebase. The key features of the app include vaccination scheduling, feed management, real-time analytics, and offline functionality. User evaluations revealed high satisfaction scores (mean = 4.30/5), particularly for usability (4.08), aesthetics (4.39), and information quality (4.43). The system addresses critical pain points, such as disease management, supply chain inefficiencies, and decision-making delays, and demonstrates significant potential to enhance operational efficiency and profitability. This study contributes a novel framework for digitising agricultural value chains in resource-constrained settings.

Keywords
Enterprise, Mobile Application, Poultry, Productivity, Sustainability, Value chain hub speed

1. INTRODUCTION

Poultry, which is naturally common across Nigeria, outnumbers all other animal species in livestock production. It stands out because of its high turnover rate, quick return on investment, and relatively greater rate of growth in both consumption and trade volume (Burmeister et al., 2018). The poultry sector in Nigeria has been the most demanding in terms of agricultural products, and it offers many opportunities for youth empowerment initiatives to accomplish sustainable development while improving the lives of many. Nigerian livestock production systems may undergo changes. In particular, the adoption of digital technologies, such as mobile applications, can significantly enhance the efficiency and sustainability of agricultural value chains. The poultry and livestock value chains are complex networks of interlinked activities, including feed production, animal husbandry, processing, distribution, and retail. Traditional methods of managing this chain often involve manual record keeping, paper-based documentation, and limited data sharing. These practices can lead to inefficiencies, imprecisions, and delays, thereby affecting the overall productivity and profitability of the industry. Innovative solutions that can improve decision-making, streamline operations, and boost the overall performance of the poultry and livestock value chain are increasingly needed to address these challenges. With their mobility and intuitive user interfaces, mobile applications provide a viable path for the digitisation of these procedures. Mobile applications can help make the poultry and livestock industries more effective, transparent, and sustainable by enabling data-driven insights, facilitating smooth communication among stakeholders, and providing real-time access to information. These digitisations facilitate precise predictions, comprehensive reporting, and great management (Omondi, 2022).

Technology is essential to agricultural business performance, as it improves both efficiency and effectiveness. The availability of well-managed agricultural data will be the basis for initiating precision agricultural management enterprise resource planning. The development and availability of structured, real-time data are necessary for maintaining these agricultural systems (Indrawanet al., 2028). An ERP system is a standardised software program that integrates the capabilities of several corporate operations into a single system (Olejnik et al., 2022). The ERP system has improved automated transactions, operational decision-making efficiency, productivity, and customer service. The use of ERP systems in government agencies is becoming increasingly popular. Since the primary objective of public businesses is "cost minimization" rather than "profit maximization", the majority of the characteristics of the most recent developments in public enterprises are connected. ERP has eliminated the difficult work of managing inflexible systems that frequently result in the growth of overhead expenses, data redundancy, inaccuracy, and inefficiencies (Rushton and Bruce, 2016). An ERP is typically a computer program that updates managers on events occurring within a company and its international relationships in real time (Zhang and Qian, 2022). ERP improves visibility in the procurement process, procurement analysis, supplier performance analysis, supplier payables analysis, and employee expense analysis. A comprehensive end-to-end process can provide a business with a competitive edge, lower expenses, boost profitability, and improve customer satisfaction. ERP is essential for a comprehensive view of the procurement process, thereby identifying opportunities for consolidation and cost reduction (Ncube et al., 2016).

An ERP system enables a user to take complete control of every business operation. An ERP system consists of many modules, each of which manages distinct functions that align with various business activities. Depending on the industry with which the organisation is engaged, ERP system modules vary from one system to another (Samboko et al., 2018). The biggest benefit of an ERP system is the integration of many modules that communicate with one another, providing the system with a great deal of structure and flexibility. An ERP system may be used to combine the functionality of several different systems into one, eliminating the need for separate, tiny systems to manage and support various business divisions. While data about an order held in one module of an ERP system may be seen from other modules rather than being saved in separate modules, data stored in one independent system cannot be directly accessed by another because an ERP system has a centralised database of the organisation's data (Taqafi et al., 2019). Another significant benefit of ERP is that it offers a reliable foundation for information registration and exchange between business activities, which guarantees the timely and correct availability of data for integrated business process management (Irvine, 2015). In the deployment of an ERP system, two points must be noted: first, the implementation of an ERP system is expensive, and businesses that use ERP frequently encounter several startup issues, which cause a short-term decline in performance immediately after deployment (Alarcón et al., 2017). Second, business operations are significantly impacted by ERP deployment. The advantages can only be realised when installation is coupled with well-managed business processes. These ideas highlight the necessity of careful management of the adoption and deployment process to maximise the advantages of an ERP system.

This study demonstrates the creation of a mobile interface for an ERP customised for the Poultry Livestock Value Chain, considering the industry's ongoing transformation. Utilising technology to improve communication, streamline operations, and boost overall efficiency throughout the chicken value chain is the goal of this project, which should ultimately lead to increased profitability. Inefficient supply chains, disease outbreaks, shifting consumer demand, operational complexity requiring technical know-how, regulatory barriers, and a lack of real-time data access for all value chain participants are just a few of the complex issues facing the poultry livestock industry. These issues limit the industry's capacity for growth, financial stability, and security. Furthermore, typical ERP systems lack the agility required in dynamic workplaces because of their desktop-centric design (Ayoade et al.,2023). The proposed technology seeks to provide a comprehensive solution to these issues by improving accessibility, expediting decision-making, enhancing data visibility, streamlining processes, and ensuring seamless communication throughout the value chain. Theoutcomes of the ERP software development and its deployment on a few farms are presented in this study.

Farming methods have been completely transformed by the use of technology in agriculture. Traditional desktop-based enterprise resource planning (ERP) technologies are gradually moving to mobile platforms. This change is especially noteworthy in the poultry sector, where effective administration of intricate processes is essential. To ensure that every employee has access to pertinent information at all times, ERP systems apply and integrate various business functions in organisations, including accounting, human resources, customer relationships, sales, purchasing, and distribution (Alarcón et al., 2017). ERP integrates all departments and activities within a business and improves interdepartmental coordination and collaboration by using a single database for data entry, recording, processing, and monitoring (Thongoh et al., 2021). Redundancies and input mistakes are eliminated, and the reporting function is simple. ERP deployment is a particularly demanding project because of its complexity, high expenses, and stringent timelines. It frequently involves redesigning business processes and implementing new information systems. The efficacy and obsolescence of conventional ERP systems are called into question by the recent rise of Industry 4.0, which emphasises gathering, analysing, and implementing massive datasets to increase corporate efficiency.

According to the Trillium Network for Advanced Manufacturing, individual firms have begun to transition from conventional systems that primarily gather and collect data to systems that facilitate interaction, notification, and decision support. These systems are known as intelligent ERP (i-ERP) systems. The first ERP adopters in South Korea (henceforth, Korea) were Saenong and Kointech, wholesalers of organic products, in 2002. ERP is designed to increase management efficiency and competitiveness. However, due tothe limitations of ERP technology and a lack of knowledge about agricultural product developers, this goal was not achieved yet. The Korean government has acknowledged the necessity of an ERP system in agriculture since 2007. To introduce the ERP system to 100 agricultural enterprises, the Korean government enacted a policy (Obese et al., 2022), and businesses that adopted ERP shifted from using several building types to a single integrated construction process. ERP installation in chicken farming may be used for variouspurposes, including feed optimisation, smooth communication, process improvement, and much more.

In the work of Ncube et al. (2017), a ubiquitous environment was established using radio frequency identification (RFID), closed-circuit Circuit TV (CCTV), and intelligent robotics to gather data. This data was then applied to a ubiquitous setup that allowed the owner to effectively manage their farm and track the weight, food, temperature, humidity, and market price of chickens at any time and from any location. The information was then shared online using an iOS smartphone management system. A smartphone application was created to meet the demands of local chicken farmers in Thailand by disseminating accurate information after researching the farmers' demographics, farm features, and mobile phone usage habits. With featuressuch as information or advice regarding native Thai chicken breeds, farm management, feed and feeding, anddisease control, the Android-based mobile application enhances their productivity and rearing techniques. The overall satisfaction score of the 48 respondents who completed the user satisfaction surveys for this project was 4.15, indicating that the native chicken farmers were satisfied with the mobile app's functioning, appearance, and quality of information (Baker et al., 2022).

A study conducted by Nasaruddin et al. (2020) used a system that included the management system application layer, data service layer, and information sensing layer to construct a cloud database information management system for chicken farming. The wireless sensor network installed in the poultry house was used by the information sensing layer to collect and upload agricultural and production data. The system's flexibility and scalability are increased by using a cloud database as an information storage carrier at the data service layer, which also removes the complicated process of establishing local service clusters. To achieve the visual administration of agricultural information and health farming, the management system application layer has numerous subfunction modules. To create a set of information management systems for poultry farming with broad functional coverage, high service efficiency, safety, and convenience, each module worksindependently and in conjunction with the others. The system's operational function testing findings demonstrate that the developed prototype can gather and handle information about chicken farming. Obese etal. (2022) created a smartphone application to assist farmers in monitoring flock management on their farms. The software was developed using the rearing environment and flock data obtained from commercial broiler farms in accordance with broiler production standards and breeder suggestions. The graphical user interface was designed using the Kivy and KivyMD frameworks, and the application was developed using Python, which complies with the General Public License (GNU GPL). During the flock's growth, the application assisted farmers in assessing the situation for raising broilers on their property and grading the flock using a performance index.

Research conducted by Eya and Weir (2021) sought to capture and enhance livestock goat data for analysis, which stakeholders might utilise to make quick and accurate decisions. A web-based mobile application was developed. Using a black-box approach, the prototype was tested for functionality and passed the tests. It also records actual data on the platform, provides a user-friendly presentation of goat information, and allows the website to document goat livestock data. By providing real-time data to improve decision-making procedures and insights that may result in higher profitability and strategic planning, the instrument offers substantial advantages (Tom et al., 2018) and implements a user-centred design development methodology to create a mobile application, especially for farm management and performance evaluation in fattening beef cattle. Both online and mobile platforms were used to develop the app. The results of the assessment pinpointed the precise expected features of the app, including resource inventory, production analysis, farm accounting records, and production records. A qualitative evaluation of "Good" was indicated by the mean system usability scale (SUS), which was 75.17. In addition to offering financial management capabilities specificallytailored for small-scale beef cattle producers, the app offers an excellent way to track farm activity and recommend feeding schedules and feed (Ariffin et al., 2015). The creation of mobile interfaces for poultry ERP systems is examined in this study, along with how they can improve overall farm management, productivity, and decision-making.

2. MATERIALS AND METHOD

In the methodology adopted, survey materials were utilised in the form of questionnaires across different farms in Nigeria. For system design and modelling, software such as the Flutter framework and Dart programming language were utilised. The application development process is illustrated in Figure 1.

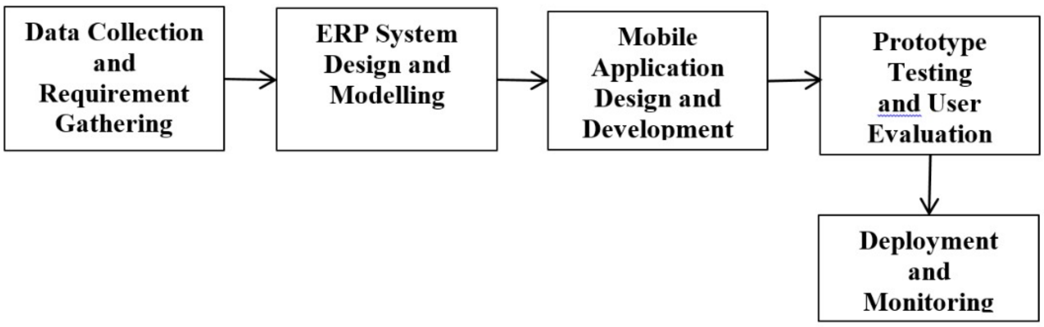

Figure 1: Development Process for the System

The development process using a user-centered design approach consists of 5 key phases (1) data collection and requirement gathering (2) ERP System Architecture Design (3) Mobile Application Design and Development (4) Prototype Testing and User Evaluation (5) Deployment and Monitoring

2.1 Data Collection and Requirement Gathering.

Importantly, data collection from small-, medium-, and high-income chicken farms was necessary for the development of the ERP system architecture to create a reliable design that could be used at various poultry farms. A total of 25 farms that either currently utilise or do not employ a poultry management system were the subjects of structured surveys and key informant interviews. To fully comprehend the limitations of the current traditional system and to further derive conclusive conclusions from their current architecture, farms that do not yet use a poultry management system were given structured questionnaires. To understand the current poultry value chain, the limitations of their current management system, the needs of their users, and, finally, the changes they would like to see added to their current system, if possible. Key informant interviews were conducted with high-income poultry farms that had available poultry management systems. The survey questionnaires and interview responses were then compiled and examined to determine an architecture that will be put into place and maximise productivity from small, middle, and high-income poultry farms.

2.2 ERP System Design and Modelling

From the accumulated data, the study was able to directly draw an organogram for the information architecture of the poultry value chain. For the primary drawn architecture for the three levels of poultry farms (high, middle, and low income), three stakeholders were listed: supervisor, manager, and farmers. The general supervisor oversees and supervises the total operations of the poultry farm, while the managers are in charge of specific subsections, such as marketing, inventory, finance, record, maintenance, and machines. The Farming Sections include (Breeder Management, Hatchery Management, Contract Broiler Farming Management, and Layers Management sections.) Customer Relationship Management (CRM) section. Farmers are in charge of the Farming Sections. The top-down architecture of the information flow for stakeholders is shown in Figure 2, and the management sections are shown in Figure 3. Each section has farmers who control the daily tasks and activities and send information to the respective managers of their subsections.

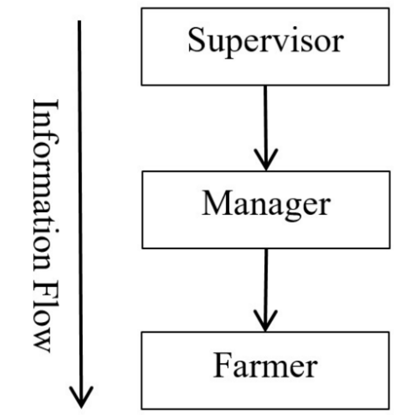

Figure 2: Information Flow for the Stakeholder

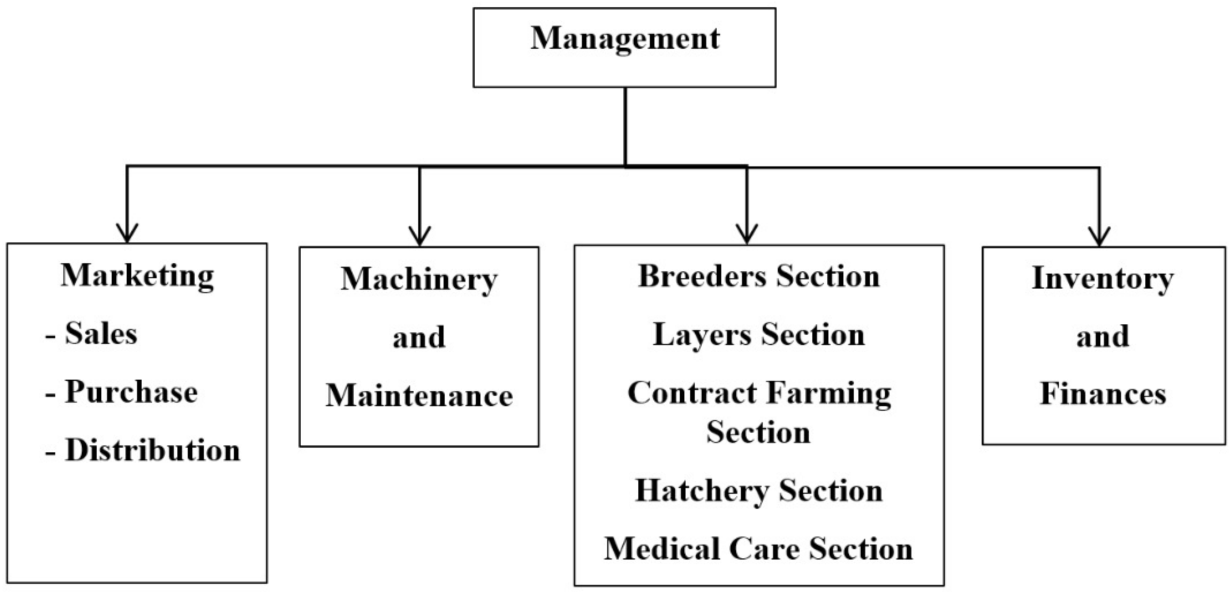

Figure 3: Management Information Architecture

2.3 Mobile Application Design and Development

Further qualitative research was conducted for mobile application development. One-on-one interviews were conducted with more than 10 poultry farm managers and workers. The participants included individuals from small-, medium-, and large-scale farms. A few of the comments from the farmers are summarised as follows:

(i) Many poultry farmers forget the time for vaccination because of the complexity of farm management.
(ii) Many farmers are engaged throughout the day to ensure the performance of the livestock, thereby making it challenging to maximise their time.
(iii) There is a rising need for easy to use software for optimal productivity

It became evident that the app must focus on simplicity and automation to reduce manual effort, offline functionality is critical to accommodate users in areas with poor interest, and that visual, intuitive reports will help managers make better decisions. More user pain points from the research are shown in Figure 4.

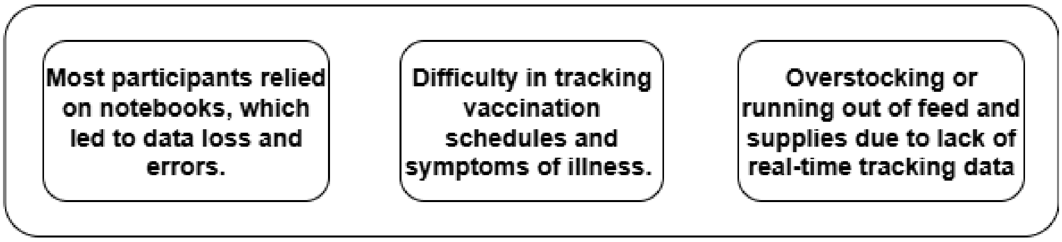

Figure 4: User painpoints from the survey

The Flutter framework and Dart programming language were used to create mobile applications. Google created Flutter, a flexible open-source User Interface (UI) toolkit that allows developers to create natively built apps for iOS, Android, the web, and desktop from a single codebase. Flutter apps are responsive and efficient because they use the Dart programming language, which is intended for high-performance applications. The widget-based architecture of Flutter is one of its best qualities; it enables programmers to design an incredibly configurable and eye-catching UI. Additionally, the framework has a feature called "hot reload", which speeds up development by allowing developers to view code changes in real-time without having to restart the application. Flutter is known for its excellent performance because it compiles directly tonative ARM code, bypassing the need for a bridge or intermediary layers. This results in smooth animation and responsive user experiences. Its rich ecosystem, supported by a vibrant community, offers a wide rangeof plug-ins and tools to simplify development and add functionality. This toolkit is particularly suited for mobile app development but has grown to support web, desktop, and embedded applications. It enables developers to generate gorgeous, uniform designs across platforms, making it a popular choice for designing modern, feature-rich applications.

The Firebase platform, a comprehensive platform created by Google that offers a range of tools and services to assist developers in creating and expanding applications, served as the backend foundation. With features that improve app functionality and expedite backend development, it is especially well-suited for server-side, online, and mobile development. Firebase streamlines backend operations, such as database administration, hosting, and authentication. Developers can easily incorporate secure user sign-in mechanisms, such as phone numbers, email addresses, or social logins (such as Google or Facebook), with Firebase Authentication. Scalable, cloud-hosted NoSQL databases, such as the Firebase Realtime Database and Firestore, enable smooth real-time data synchronisation between devices. Analytics and engagement features are also included in the Firebase. While tools such as Cloud Messaging and Remote Config aid in providing individualised experiences, Google Analytics for Firebase provides insights into user activity. Firebase Hosting provides a quick and safe way to host static content and launch web applications. While solutions such as Crashlytics offer real-time crash reports to enhance app reliability, other services such as Cloud Functions allow developers to create unique server-side logic without having to worry about managing servers. Firebase ML also integrates machine learning capabilities, enabling developers to design sophisticated features without requiring an in-depth knowledge of artificial intelligence.

3. RESULTS AND DISCUSSION

For mobile application development, an information architecture that guides the user workflow is shown in Figure 5. This shows the different embedded processes in application development, from the start to onboarding and the different functionalities of input and output.

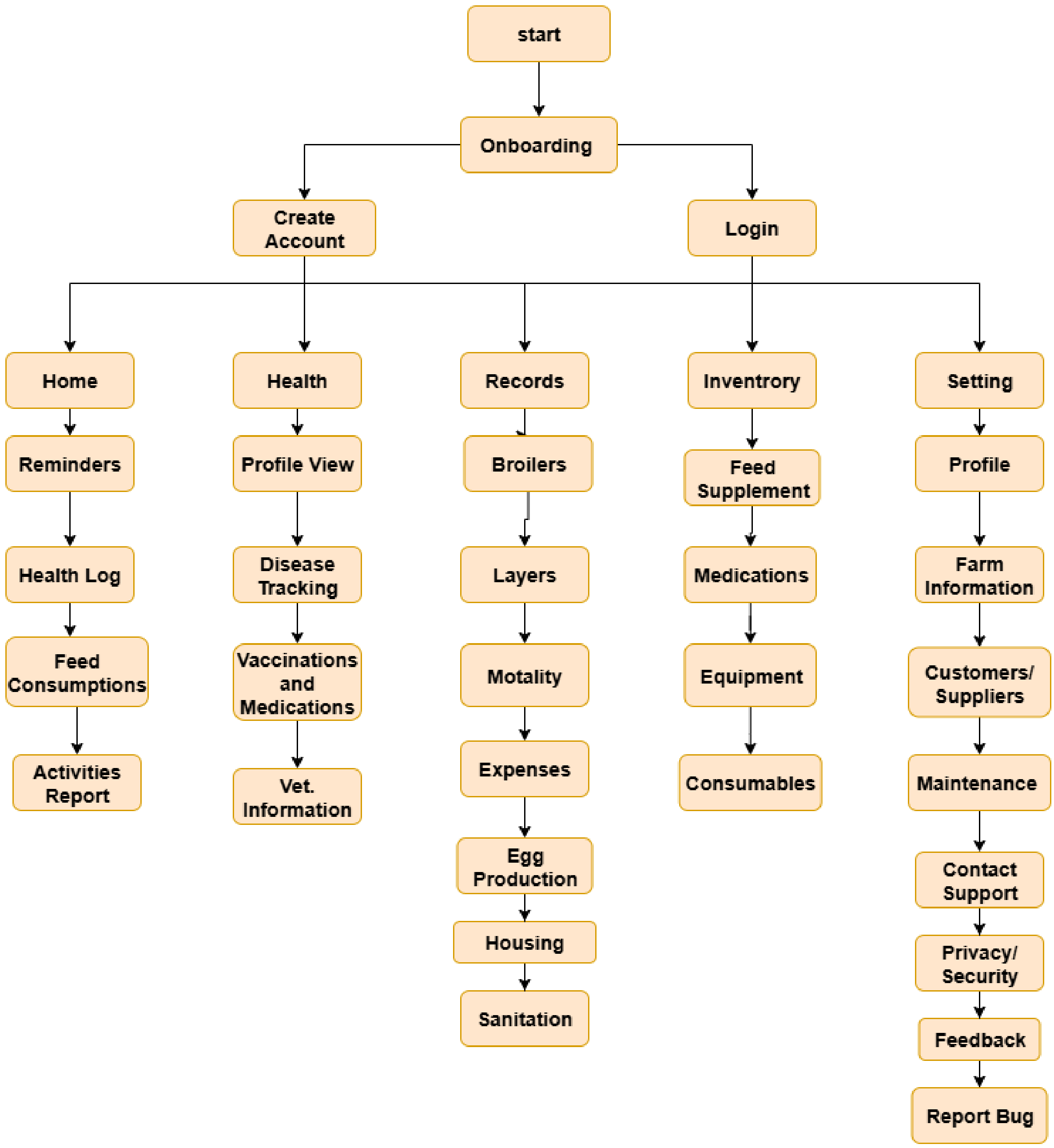

Figure 5: Information Architecture for the Flow of the Application

Using this information architecture, the application was developed using the Flutter framework, and a few screens of the application are shown in the following images.

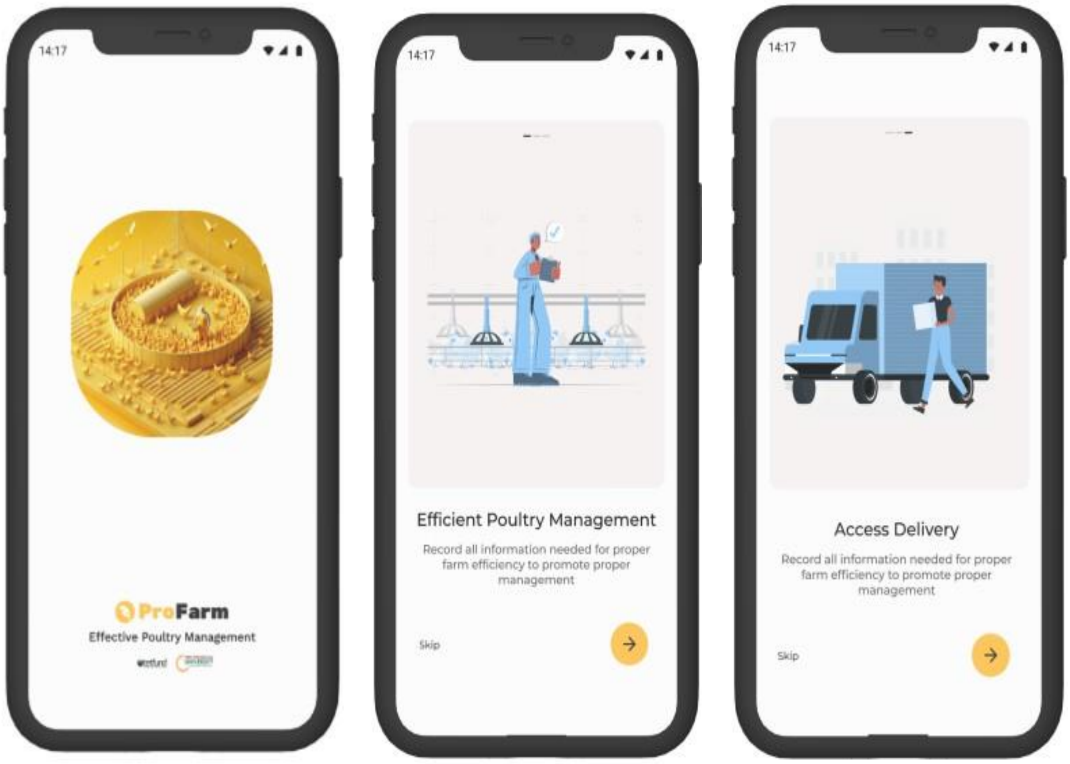

Figure 6: Onboarding Screens

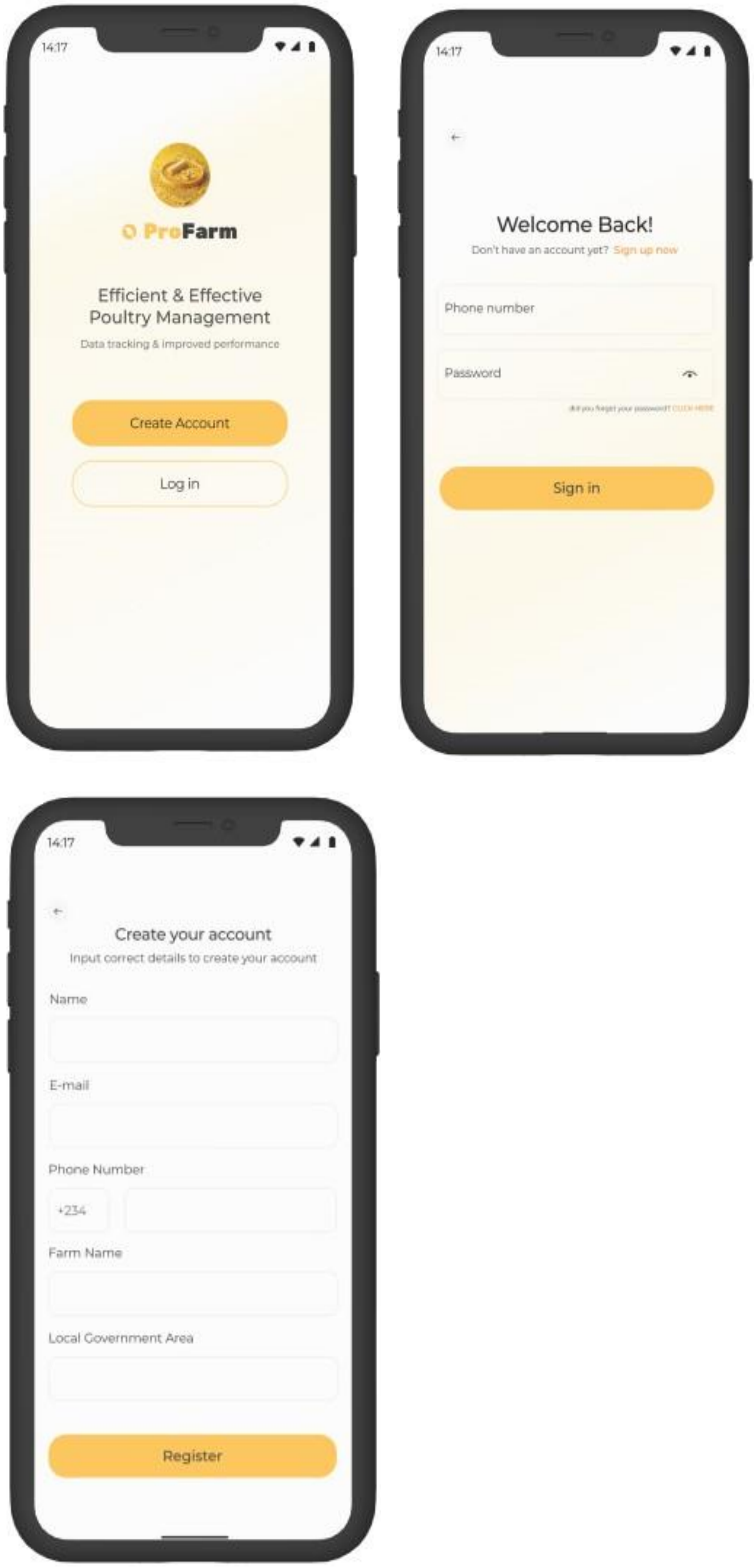

Figure 7: Sign and Log In Screens

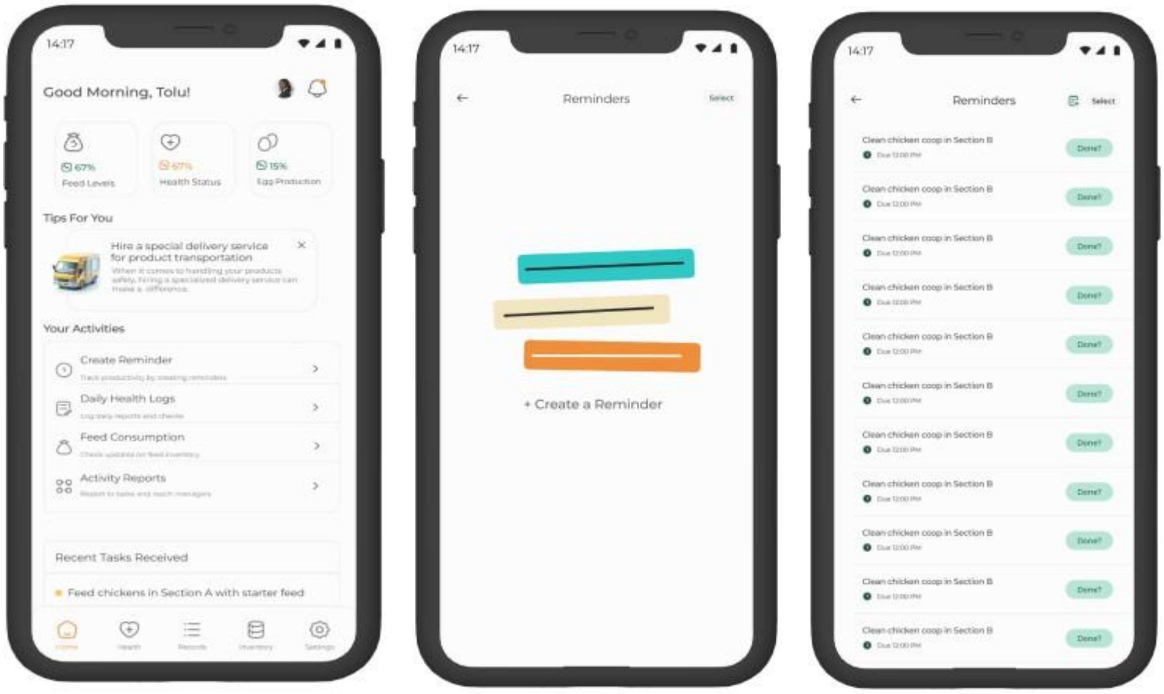

Figure 8: Welcome Dashboard and Reminder Pages

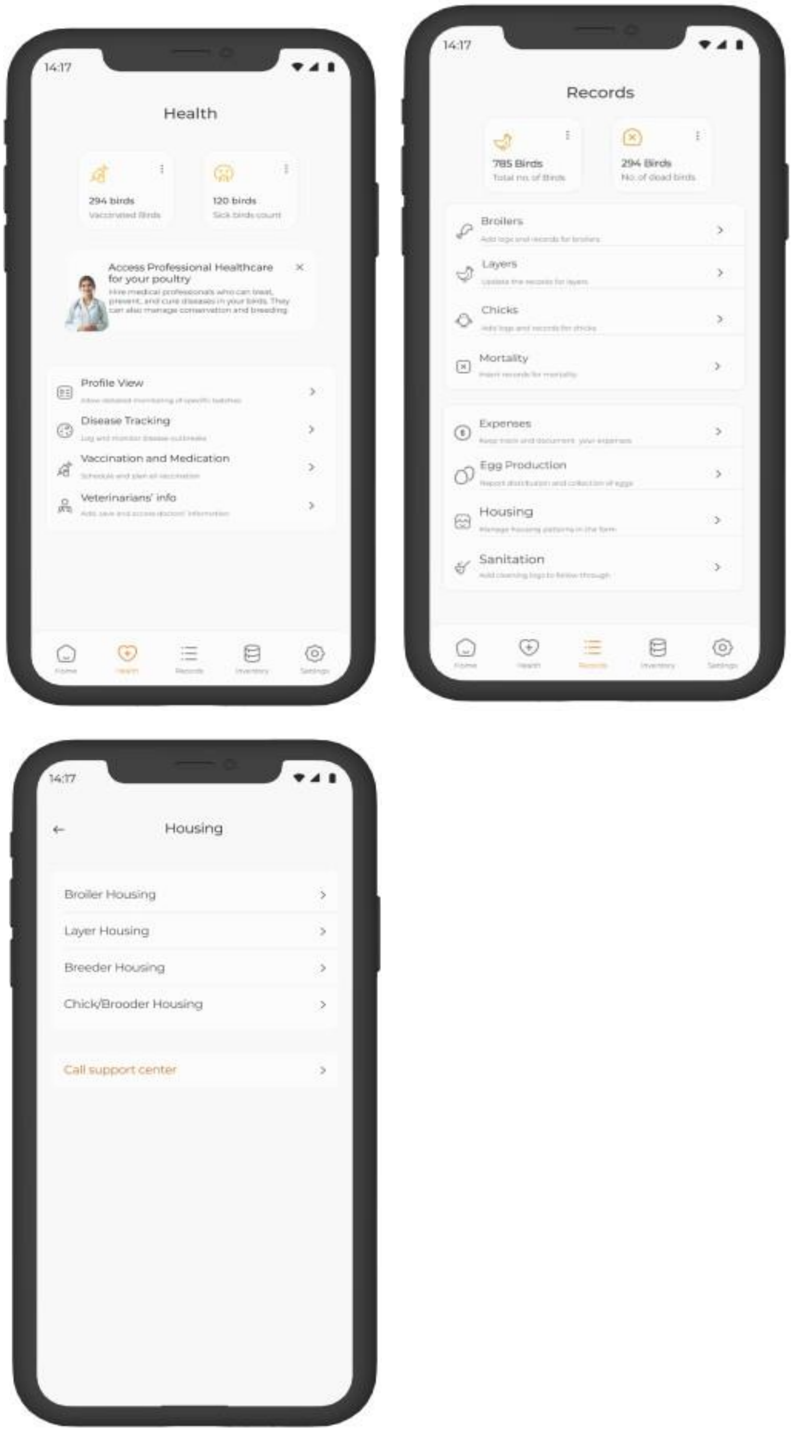

Figure 9: Health and Housing Screens

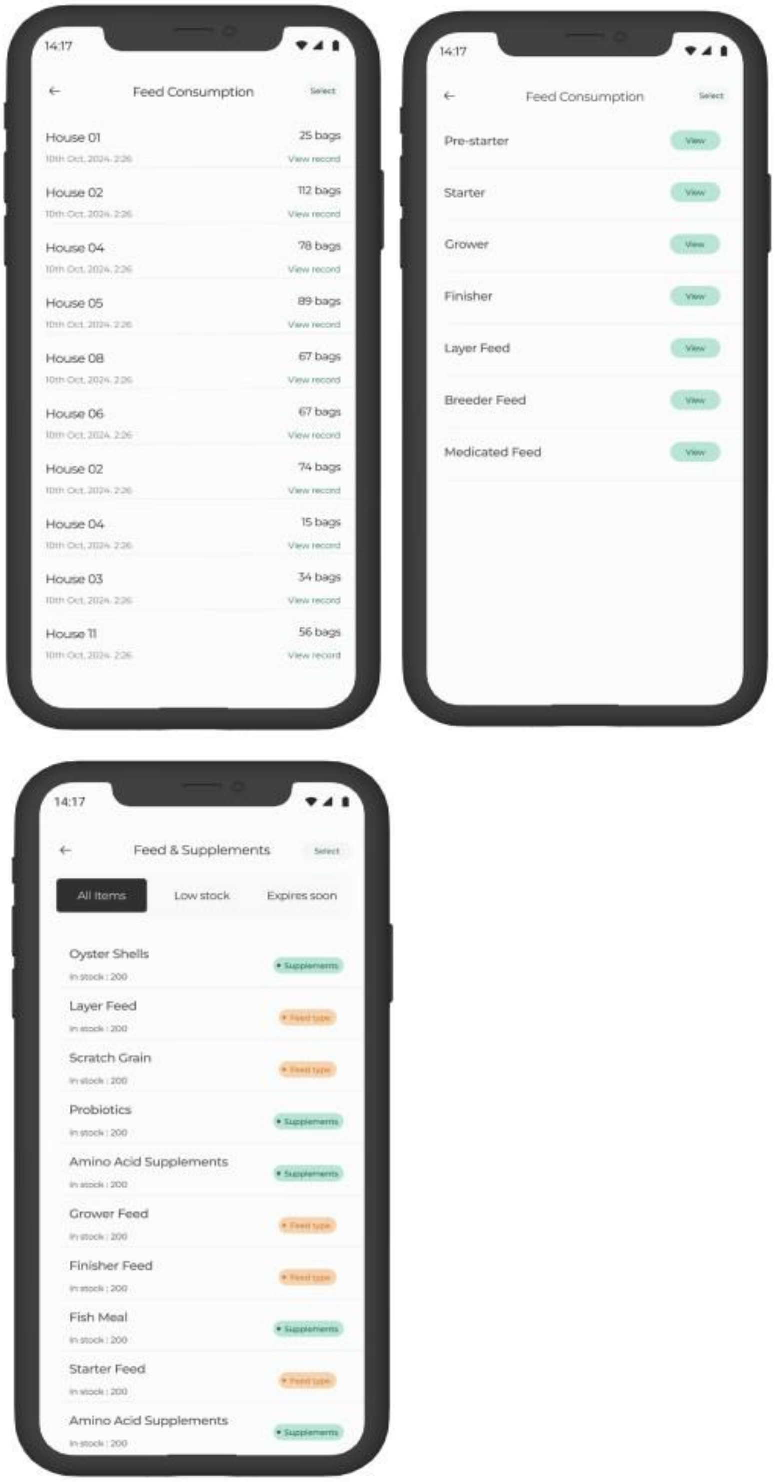

Figure 10: Feed and Supplements for Different breeds

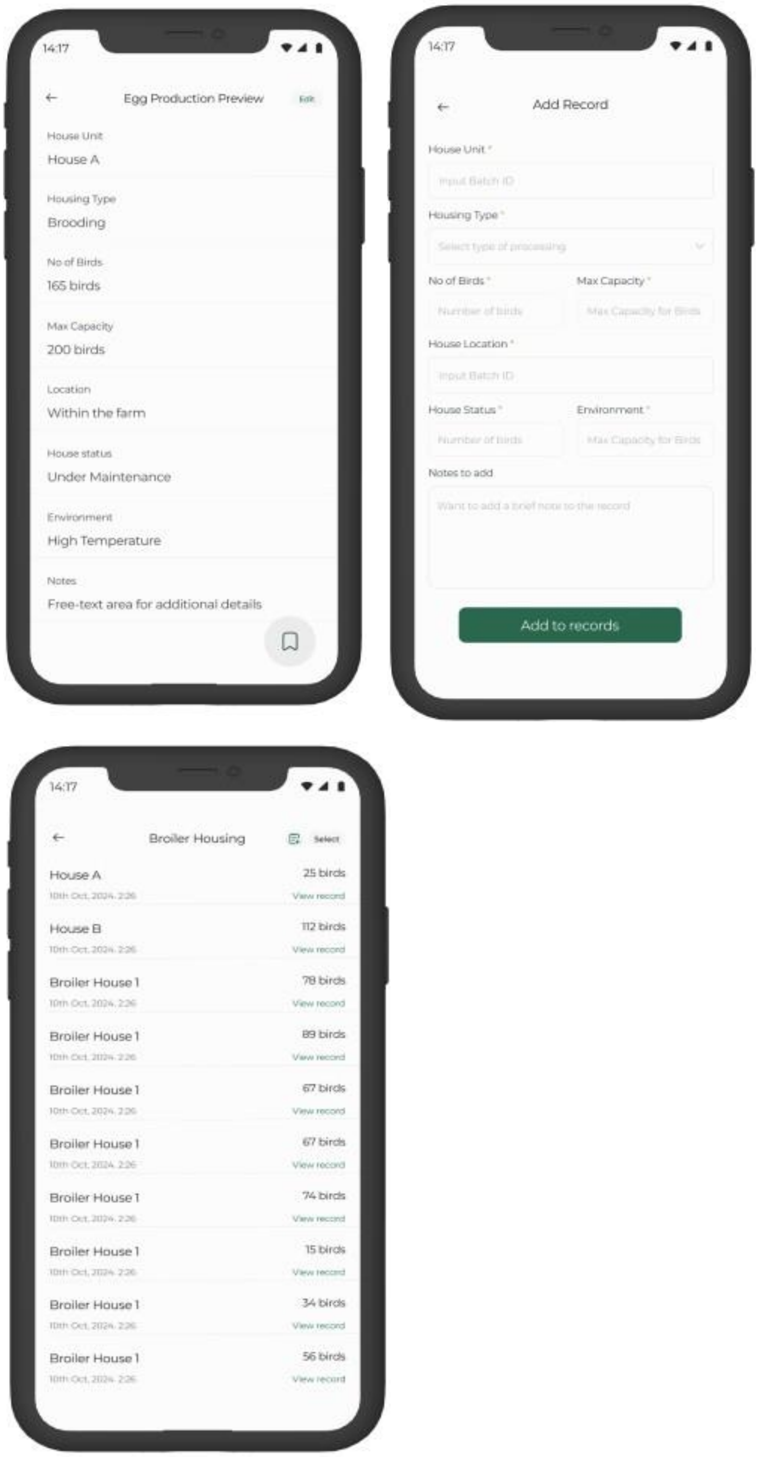

Figure 11: Adding Records and Tracking records screens

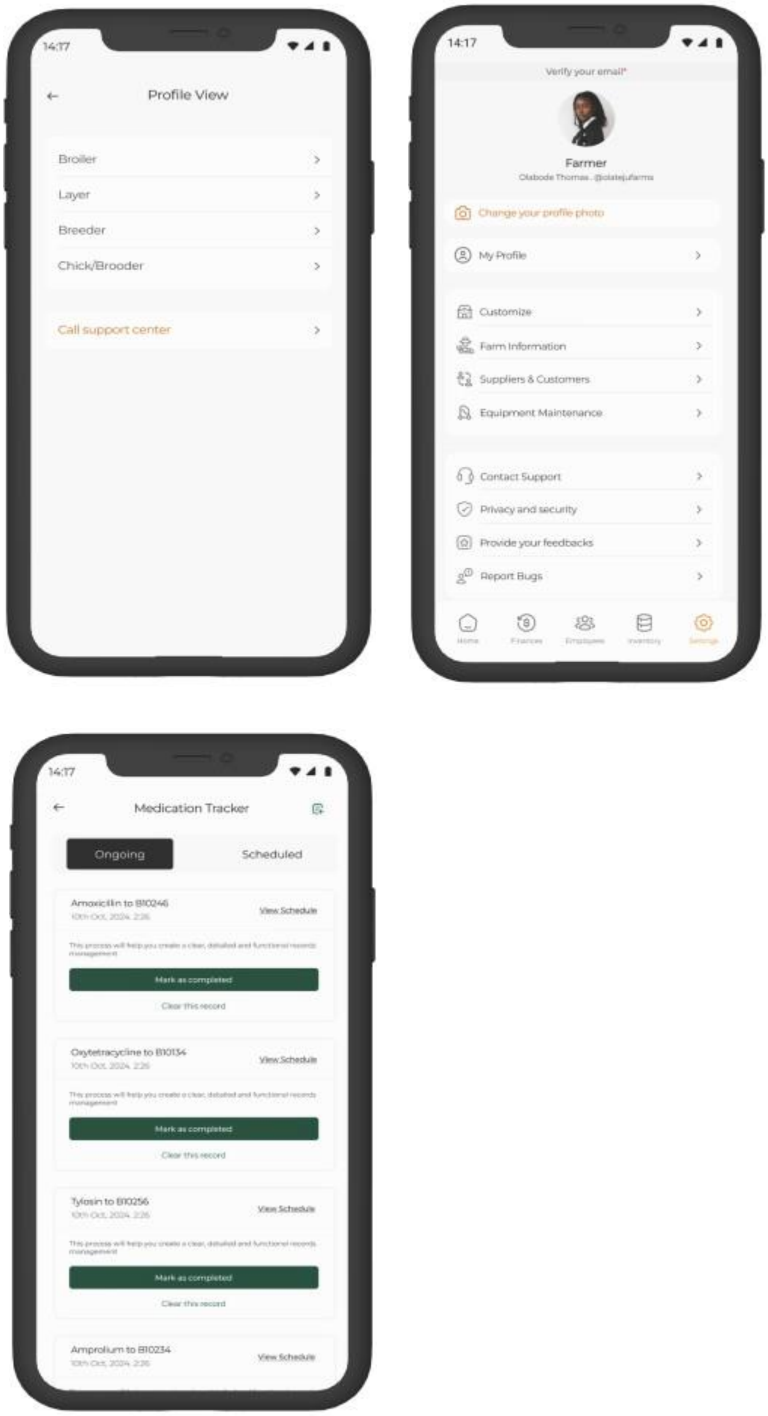

Figure 12: Profile Sections and Medication Information

The screens exhibited here were determined to be the most pertinent for the task because of the large number of screens in application development. Following the completion of the ProFarm application, a selection of farm workers from among the three stakeholders (supervisors, managers, and farmers) was given the opportunity to install the app.

Furthermore, a questionnaire was created and given to the selected farmers to determine the degree of customer satisfaction with mobile apps. Functionality (performance, usability, navigation, and gestural design), aesthetics (graphics, layout, and visual appeal), and information quality (content, utility, and visual information) were assessed to gauge user satisfaction with the ProFarm app. Subsequently, a total satisfaction rating was assigned. A five-point Likert scale was used to gauge user happiness (1 = extremely dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, and 5 = very satisfied). The data were analysed using descriptive statistics, such as averages, percentages, and frequencies. To indicate the level of satisfaction of app users, intervals for the Likert scale scores were established (mean 1.00-1.80 = extremely unsatisfied, 1.81-2.60 = unsatisfied, 2.61-3.40 = neutral, 3.41-4.20 = satisfied, and 4.21-5.00 = very satisfied).

A total of 54 farmers who owned cellphones running Android and IoS operating systems were recruited to participate in the user satisfaction survey. The respondents' satisfaction ratings under the different criteria and with regard to user interaction with the created mobile application are displayed in Table 1. The user satisfaction survey served as a helpful first assessment of the app's potential and as a guide for enhancing its quality. With an average rating of 4.08, the users expressed satisfaction with the program’s operation. With average scores of 4.39 and 4.43, respectively, the consumers expressed greater satisfaction with the information quality and aesthetics. Users were generally satisfied with the ProFarm mobile app, as indicated by the overall satisfaction score of 4.30. This suggests that respondents would be open to experimenting with this new technology to assist them with their chicken farm value chains.

Table 1: Summary of the User Satisfaction Scores for the ProFarm mobile app. (n==54)

Criterion	Mean	SD	Evaluation
Functionality			
Performance	4.34	0.82	Very Satisfied
Ease of Use	4.01	1.08	Satisfied
Navigation	3.96	1.06	Satisfied
Gestural Design	4.02	0.87	Satisfied
Average Functionality Score	4.08	0.96	Satisfied
Aesthetics			
Graphics	4.30	0.98	Very Satisfied
Layout	4.42	1.08	Very Satisfied
Visual Appeal	4.46	0.71	Very Satisfied
Average aesthetics score	4.39	0.92	Very Satisfied
Information Quality			
Content usefulness	4.60	0.81	Very Satisfied
Visual information	4.51	0.97	Very Satisfied
Credibility	4.19	0.85	Satisfied
Average information score	4.43	0.87	Very Satisfied

Overall Satisfaction score	4.30	0.91	Very Satisfied

4. CONCLUSION

The development of an ERP system for the poultry value chain using a mobile application marks a significant milestone in modernising and streamlining operations in the industry. By integrating comprehensive functionalities, such as inventory management, supply chain tracking, financial monitoring, and farm productivity analytics, into a user-friendly mobile platform, this system empowers stakeholders at every level of the poultry value chain. The solution not only enhances operational efficiency and decision-making but also fosters transparency and traceability, which are critical for meeting regulatory standards and building consumer trust. Furthermore, the mobile-first approach ensures accessibility for farmers, suppliers, and distributors, even in remote locations, bridging the digital divide in the agricultural sector. This ERP system positions the poultry industry to adapt to evolving market demands, embrace technological advancements, and achieve sustainable growth in the future. Its implementation will serve as a benchmark for similar innovations in other agricultural sectors, paving the way for a more efficient and interconnected agribusiness ecosystem in Brazil. This study describes the data collected from small-, medium-, and large-scale farmers which was utilised to develop an ERP Model architecture and further used to develop an information architecture for the mobile application. The user satisfaction survey conducted showed an overall satisfactionof 4.30, indicating that these selected farmers were satisfied with the ProFarm Mobile application in terms of its functionality, aesthetics, and the information quality provided. In terms of future studies, the researchers plan to develop the app to include artificial intelligence to make statistically analysed decisions for the supervisors and suggest a way forward based on the data input and further utilise blockchain smart contract technology to increase information security. This would increase the farmers access to intelligent decision making and reduced information security concerns

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