

AI-Based Digital Record Keeping System for COE Dairy

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Abstract - The AI-Based Digital Record Keeping System for COE Dairy is an intelligent, mobile-based platform designed to automate the storage, management, and retrieval of dairy farm records. The system leverages a Flutter-based cross-platform application integrated with a Firebase cloud backend to enable real-time data entry, synchronization, and analytical processing. It systematically captures daily operational data including milk production, animal health status, feed consumption, vaccination schedules, and financial records. AI-driven modules perform milk yield prediction using a hybrid ARIMA and LSTM forecasting model, feed optimization analysis, health anomaly detection, and automated profit-loss reporting. The system eliminates manual paper-based registers, reduces data entry errors, and provides administrators and staff with actionable insights through a centralized dashboard. An offline-first design ensures uninterrupted data capture even in low-connectivity rural environments. The proposed solution enhances operational efficiency, improves decision-making accuracy, and establishes a scalable foundation for smart and sustainable dairy management.

Key Words: *Digital Record Keeping, AI-Based Dairy Management, Flutter Application, Firebase, Milk Yield Forecasting, ARIMA-LSTM, Farm Management System.*

I. INTRODUCTION

In the modern era of digital transformation, the agricultural and dairy sectors are increasingly adopting mobile-based technological solutions to improve operational efficiency and data management. Dairy farms generate a substantial amount of information on a daily basis, including milk production records, animal health details, feeding schedules, breeding data, vaccination reports, and financial transactions. However, many dairy units still rely on manual registers and paper-based documentation, which are prone to errors, data loss, duplication, and time-consuming retrieval processes. Such conventional methods significantly limit effective monitoring and informed decision-making.

To address these challenges, an intelligent and mobile-based solution has been developed through the project titled "AI-Based Digital Record-Keeping System for COE Dairy." The system is designed as a Flutter-based mobile application that enables real-time data entry, management, and monitoring through a centralized digital platform. It systematically collects and stores dairy-related data in a structured database while monitoring key parameters such as milk yield, animal health status, feeding patterns, vaccination schedules, and financial records.

Users interact with the application through a user-friendly and responsive interface built using Flutter, ensuring cross-platform accessibility and smooth performance across mobile, web, and desktop platforms. The backend manages secure data storage and processing using Firebase cloud services, while integrated AI-based analysis assists in generating insights and improving decision-making. By combining mobile technology with intelligent data analysis, the system enhances accuracy, reduces manual workload, and improves overall efficiency in dairy management.

The proposed system supports role-based access control with distinct interfaces for administrators and staff members. Administrators can monitor live inventory, generate analytical reports, manage feed stock, and oversee all farm

operations through a centralized admin dashboard. Staff members can record milk production, log feed usage, and set reminders for medical and vaccination events. The system further supports hybrid forecasting using ARIMA and LSTM models to predict tomorrow's milk yield, enabling proactive feed planning and profitability estimation.

II. RELATED WORK

Several research studies and existing systems have explored the application of Artificial Intelligence and machine learning techniques in dairy farm management, milk production forecasting, and agricultural data analytics. These studies provide a strong foundation for the development of intelligent digital record-keeping systems for dairy operations.

Cardona and Paredes (2025) proposed a hybrid MLP and LSTM neural network model for dairy production prediction. Their approach combined Multi-Layer Perceptron (MLP) for nonlinear pattern learning with Long Short-Term Memory (LSTM) networks for time-series forecasting. The study achieved high prediction accuracy ($R^2 = 0.99$) with low RMSE, demonstrating the effectiveness of deep learning models in milk yield forecasting. However, their work primarily focused on prediction accuracy and did not integrate a complete digital record management system with mobile-based user interaction.

Badr et al. (2022) utilized the ARIMA time-series model for forecasting milk production trends. ARIMA is a classical statistical method widely used for linear trend analysis in agricultural datasets. Although ARIMA provides reliable forecasting for structured data, it lacks the capability to capture complex nonlinear relationships compared to deep learning models.

Buyuksahin and Ertekin (2018) introduced a hybrid ARIMA-ANN model to improve forecasting accuracy. Their method first modeled linear components using ARIMA and then applied Artificial Neural Networks (ANN) to predict residual errors, combining both outputs for improved performance. This hybrid approach demonstrated better results than individual models but focused mainly on forecasting methodology rather than real-time farm data management.

Existing dairy management systems generally support digital data entry and basic reporting; however, many lack integrated AI-based forecasting, real-time cloud synchronization, offline mobile support, and automated alert mechanisms. Furthermore, few systems combine milk production forecasting, feed planning, profitability analysis, and centralized cloud-based monitoring within a single scalable architecture.

The review of related work indicates a gap in integrating advanced AI forecasting models with a secure, cross-platform digital record-keeping system. The proposed AI-Based Digital Record-Keeping System for COE Dairy addresses this gap by combining Flutter-based cross-platform access, Firebase cloud infrastructure, real-time synchronization, and hybrid ARIMA-LSTM forecasting into a unified dairy management platform.

III. METHODOLOGY

The methodology of the AI-Based Digital Record-Keeping System for COE Dairy is designed to create a structured and intelligent digital management pipeline that enables real-time data entry, secure storage, synchronization, and analytical processing of dairy farm records. The process begins at the client layer, where authorized users interact with the Flutter-based application available on mobile, web, and desktop platforms.

The application supports offline functionality, allowing users to enter milk production data, animal health records, feeding schedules, vaccination details, and expense information even without an internet connection. The locally stored data is synchronized with the cloud database once connectivity is restored, ensuring data consistency and reliability.

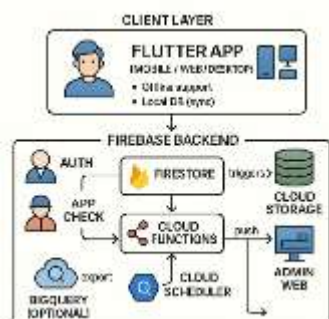
Once the data is submitted from the Flutter application, it is securely transmitted to the Firebase backend. Firebase Authentication ensures that only authorized users, such as administrators and staff members, can access and modify records. The primary data is stored in Cloud Firestore where it is organized into structured collections representing animals, production logs, health reports, and financial records.

Cloud Functions perform intelligent operations such as validating entries, calculating total milk yield, identifying production trends, generating alerts for vaccination schedules, and detecting unusual variations in animal health or productivity. Relevant reports can be stored in Cloud Storage, while scheduled tasks are managed through Cloud Scheduler for periodic data analysis or automated report generation. The system also supports optional export of large datasets to BigQuery for advanced analytics.

IV. SYSTEM ARCHITECTURE

The proposed system architecture is designed to provide an efficient, scalable, and intelligent digital record-keeping solution for the Center of Excellence (COE) Dairy. The architecture follows a cloud-native and layered design approach that integrates a cross-platform client application with a secure and serverless backend infrastructure. The system enables real-time data synchronization, offline data handling, automated analytics, and AI-driven decision support.

The client layer is implemented using a Flutter-based application supporting mobile, web, and desktop platforms. This



Firebase Authentication provides secure role-based user management, ensuring only authorized personnel can access the system. Cloud Firestore serves as the primary NoSQL database storing all dairy records in structured, real-time synchronized collections. Firestore triggers activate Cloud Functions for automated backend processing. Cloud Scheduler manages time-based automation, and Cloud Storage archives analytical reports in PDF and CSV formats.

The Admin Dashboard provides centralized monitoring with live inventory metrics including total animal count, staff count, pending reminders, and feed stock levels. The Staff Dashboard offers individual staff access to record production, manage feed usage, view assigned animals, and set reminders. The system supports two user roles — Admin and Staff — with distinct permissions and UI flows.

V. PROPOSED SOLUTION

The proposed solution is a comprehensive, intelligent, and mobile-based dairy management application built using Flutter and Firebase. The system connects administrators and staff members through a streamlined digital platform with role-based access control.

The application features a Staff Dashboard where users can manage their animals, record milk production, log feed usage, set medical reminders, and generate individual monthly PDF reports per animal. Administrators access a dedicated Admin Dashboard providing a live inventory overview, hybrid milk yield forecasting, feed stock management, and staff account creation.

improves data management and decision-making compared to traditional manual record-keeping methods.

One of the primary outcomes was a substantial reduction in manual effort and data entry errors. The use of a Flutter-based digital interface eliminated handwritten registers, resulting in improved data consistency and completeness. Offline data capture and automatic synchronization ensured uninterrupted record keeping, even during network outages, proving particularly effective in rural deployment scenarios.

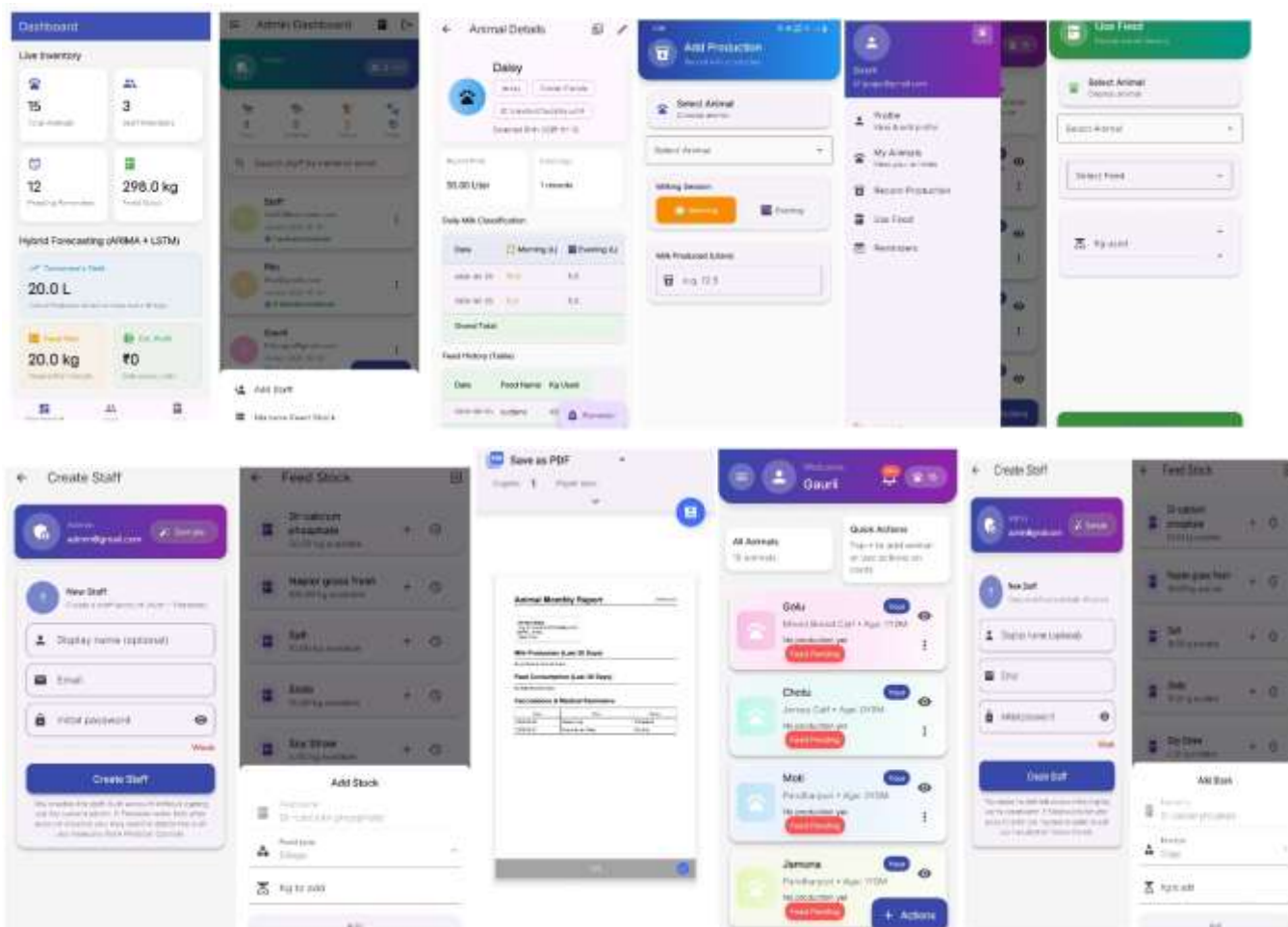
The Firestore-based real-time data storage mechanism enabled instantaneous synchronization across multiple devices. Data latency was found to be minimal, allowing administrators to access updated records without delay. Event-driven triggers successfully invoked Cloud Functions for automated processing, validating the reliability of the serverless backend architecture. The system demonstrated stable performance under continuous data ingestion.

The AI-based analytics modules delivered meaningful insights for dairy management. The hybrid ARIMA+LSTM milk yield prediction model provided accurate forecasts based on historical production data, enabling better planning and resource allocation. The dashboard displays tomorrow's forecasted yield, required feed plan in kilograms, and estimated daily profit. Feed optimization analysis helped identify cost-efficient feeding strategies, while health anomaly detection alerts allowed early identification of potential cattle health issues.

Periodic analytics executed using Cloud Scheduler ensured timely generation of daily, weekly, and monthly reports. The system successfully generated animal-wise monthly PDF reports capturing milk production records, feed

consumption logs, and vaccination reminders. Automated profit-loss summaries and productivity trends supported strategic decision-making. Feedback from system users indicated improved usability, faster data access, and increased confidence in data accuracy.

VI.RESULT



VII. CONCLUSIONS

This paper presented an AI-based digital record-keeping system developed for COE Dairy to overcome the limitations of traditional manual dairy management practices. By integrating a Flutter-based multi-platform client application with a secure, cloud-native Firebase backend, the system enables reliable data capture, real-time synchronization, and intelligent analytics.

The incorporation of AI-driven modules such as hybrid ARIMA-LSTM milk yield prediction, feed optimization, health alert generation, and automated PDF report generation transforms raw operational data into actionable insights, thereby improving productivity, decision-making accuracy, and operational transparency. The role-based access control model ensures secure multi-user operations across admin and staff roles.

The successful implementation and evaluation at COE Dairy demonstrate that the proposed system is scalable, cost-effective, and well-suited for real-world dairy environments, particularly in rural settings. The system provides a strong foundation for future advancements in smart and sustainable dairy management, including integration with IoT-based sensors, advanced deep learning forecasting models, and veterinary advisory modules.

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