RFID Technology in Ruminant Management

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ABSTRACT:
The RFID technology has become central to modern livestock management due to its capability to provide accurate identification, real-time monitoring, and reliable traceability throughout the production chain. Studies have shown that RFID enables precise tracking and improves the integrity of livestock records, particularly in meat supply traceability systems [1]. It also supports automated health and activity monitoring through sensor-enabled devices that generate continuous physiological data for early detection of issues [2]. Recent innovations in livestock information systems highlight the growing importance of digital record-management portals that enhance data accessibility and decision-making in precision livestock farming [3]. Furthermore, RFID has been widely recognized for improving farm efficiency, reducing manual labor, and ensuring consistent monitoring of ruminants [4]. Long-range RFID systems have also shown strong potential in analyzing feeding and resting behavior, providing essential insights for enhancing productivity and welfare [5]. The increasing adoption of electronic ear tags demonstrates significant advancements in livestock identification technologies internationally [6], while national initiatives further emphasize the role of RFID in improving data accuracy and animal traceability [7]. This study presents an RFID-based Ruminant Management System designed to integrate identification, genealogical tracking, medical monitoring, and feeding management, following principles and best practices established in literature. The results show that the system successfully aligns with the documented benefits of RFID technologies and supports the modernization of ruminant management.

Keywords: RFID, ruminant management, precision livestock farming, genealogical, data analytics.

Introduction

Livestock management continues to evolve as farms adopt technologies that improve accuracy, efficiency, and real-time visibility of animal information. Traditional methods of record-keeping through handwritten logs or manual tagging often led to inconsistencies, loss of data, and operational inefficiencies. The emergence of RFID technology has addressed these limitations by providing automated identification systems capable of improving the precision and reliability of livestock records. Research has shown that RFID enables consistent and tamper-resistant traceability across the livestock production chain,

ensuring the integrity of records from farm operations to meat supply networks [1].

Beyond identification, RFID has expanded into health and welfare monitoring. Systems equipped with RFID-linked sensors can track temperature, physiological conditions, and behavioral patterns, enabling early detection of health concerns among ruminants [2]. Digital livestock-management platforms have also emerged, demonstrating how RFID systems can be integrated into web-based record portals to support precision livestock farming and centralized data access [3].

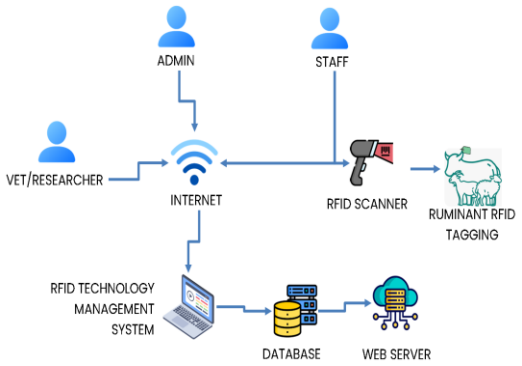
RFID also contributes significantly to operational efficiency. It reduces manual labor, minimizes human error, and strengthens monitoring routines across ruminant farms [4]. In behavioral studies, long-range RFID systems have been used to analyze feeding and resting patterns, supporting improved herd management and welfare assessment [5]. On the identification side, recent technological developments in electronic ear tags provide more durable, accurate, and advanced tracking solutions for livestock operations [6].

In the Philippine context, national agricultural initiatives have adopted RFID chips to enhance data accuracy and streamline livestock inventory systems, showing local readiness for digitized livestock monitoring [7].

Recent studies on mobile application frameworks further emphasize the value of integrating information systems with real-time data collection and centralized digital platforms. Research on designing mobile application frameworks for waste recycling demonstrates how structured data management, system modularity, and mobile accessibility can improve monitoring efficiency, data accuracy, and user engagement in resource management systems [11]. These principles are directly applicable to livestock management systems, where timely access to accurate animal records is essential for decision-making and operational planning.

Guided by these developments, this study introduces an RFID-based Ruminant Management System that integrates the established advantages of RFID technology from identification to behavioral monitoring, while also leveraging mobile and web-based application frameworks. The system is designed to provide structured, accurate, and accessible records that align with modern livestock management practices described in the literature.

Architectural Framework



The architectural framework presented in the study illustrates the top-level system design and the interaction among its major components. Serving as the conceptual foundation for system development, the diagram outlines how data flows from field-level operations to centralized digital management. The framework begins with the tagging of ruminants using RFID technology, a process conducted under the supervision of a veterinarian to ensure animal safety and proper device placement. Once tagged, the RFID scanners capture the unique identifiers and transmit the collected data to the management system, where it is systematically processed, validated, and organized. All processed information is securely stored in the system database, ensuring data integrity and long-term accessibility. A connected web server enables authorized users including veterinarians, farm staff, and administrators to access real-time data through an online platform, providing continuous availability regardless of location. This architectural setup ensures seamless communication across components, supports accurate and efficient monitoring, and promotes coordinated decision-making among stakeholders. Overall, the framework provides a stable and reliable structure that underpins the system's functionality and contributes to enhanced livestock management efficiency.

Methodology

System Development Methodology

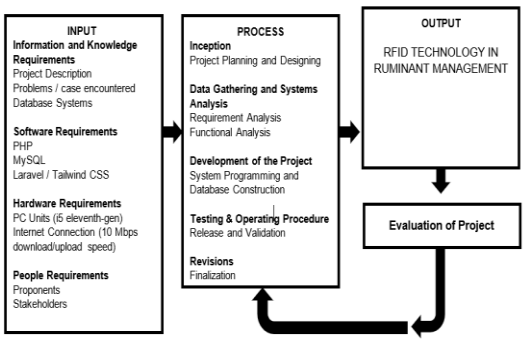
The study employed the Agile methodology, a development approach characterized by its iterative structure and emphasis on flexibility and responsiveness to change.

Agile divides the project into incremental cycles or sprints, enabling the research team to develop, test, and refine system components in manageable phases.

This cyclical process facilitated continuous stakeholder engagement, allowing feedback to be incorporated at each stage and ensuring that system features evolved according to user needs and contextual requirements. Through frequent evaluations and revisions, Agile supported the production of a more reliable and user-centered system. Overall, the methodology enhanced the project's adaptability, improved the efficiency of development activities, and contributed to the delivery of a functional and validated technological solution.

The development of the Ruminant Management System using RFID technology was anchored on the Agile methodology, an adaptive and iterative framework widely recognized for its flexibility and responsiveness to change. Unlike traditional linear approaches, Agile emphasized incremental development, continuous feedback, and active collaboration with stakeholders throughout the project cycle. This methodology enabled the proponents to break down the development process into manageable iterations, ensuring that each cycle produced functional components of the system that could be evaluated, refined, and improved. By adopting Agile, the project was able to respond effectively to the dynamic requirements of ruminant management, such as real-time monitoring, data accuracy, and ease of use for farmers and institutional users. Ultimately, Agile's iterative nature ensured that the RFID-based system evolved in alignment with both technological standards and the practical needs of end-users, resulting in a robust and user-centered solution.

I. CONCEPTUAL FRAMEWORK



The study adopted a structured conceptual framework that guided the development of the RFID-based ruminant management system. The *input* stage consolidated essential project elements, including the problem definition, system specifications, database and software requirements such as PHP, MySQL, Laravel, and Tailwind CSS along with hardware components and key stakeholder considerations. These inputs informed the *process*, which followed a systematic project lifecycle composed of inception, planning, system design, data gathering, analysis, development, testing, validation, revision, and finalization. Through this iterative process, the research produced its primary *output*: a functional RFID-based ruminant management system designed to enhance livestock identification, monitoring, and data management. The final stage involved *evaluation*, where the system was assessed in terms of usability, reliability, and functionality to ensure that it met user needs and operational requirements. Overall, the conceptual framework provided a logical and coherent flow that connected the project inputs, development process, resulting system, and its corresponding evaluation.

Result And Discussion

A. System Interface

This part of the paper shows the results of the study based on its objectives.

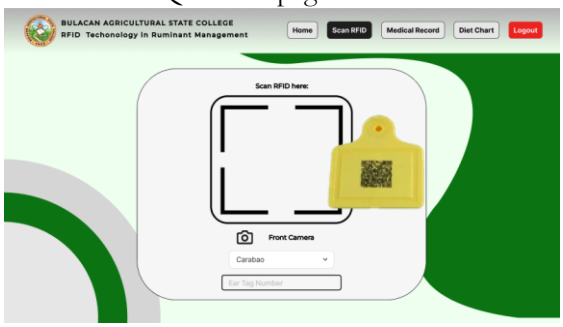
1. Login

This illustrates the login page of the system, which serves as the primary access point for both users and administrators. This page includes dedicated fields for entering a username and password, ensuring that only authorized personnel can proceed. The interface is designed to be user-friendly and responsive across different devices, while also prioritizing security features to safeguard user data. Its straightforward layout helps users easily navigate the login process, making it both accessible and efficient for day-to-day operations.

2. User's Dashboard

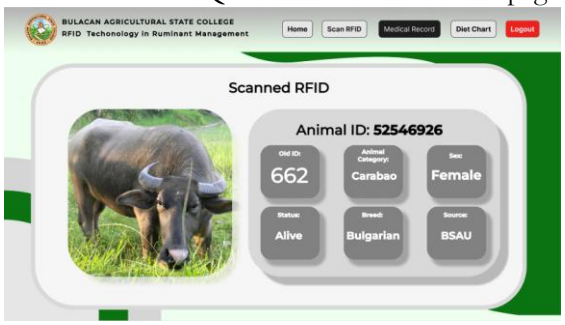
This presents the user-side dashboard of the system. This page features a card-style layout that displays the list of ruminants, with each card showing the count for a specific type of ruminant. This visual arrangement allows users to quickly view and monitor the current inventory briefly, providing a clear and organized overview of the data.

3. Scan QR Code page



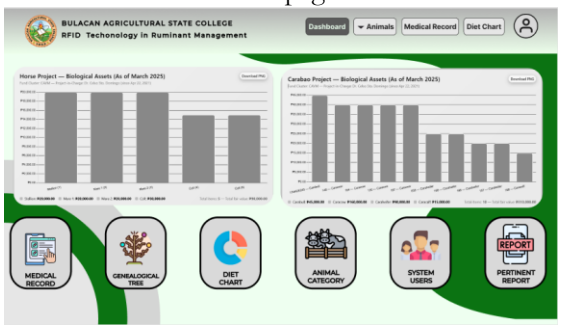
This displays the QR Code scanning page from the user side of the system. This feature allows users to scan the QR code attached to a ruminant for quick and accurate identification. As an alternative, users also have the option to manually enter the ruminant's ear tag number. This dual-input setup ensures flexibility and ease of use, especially in varying field conditions.

4. Scanned QR code of the Ruminant page



This shows the information page that appears after a ruminant has been successfully scanned. This section displays key details such as the ruminant's unique ID, category (e.g., cattle, goat, or sheep), sex, status, breed, and source. By providing these essential data points in a clear and organized manner, the system helps users easily verify and manage individual ruminant records.

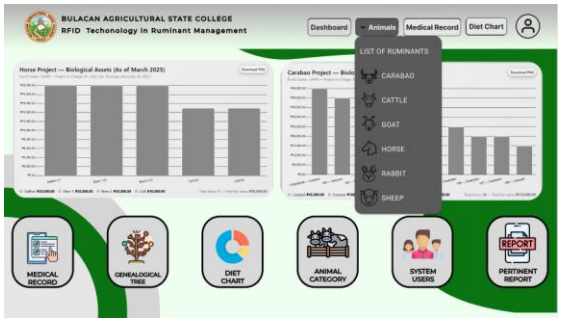
5. Administrator's page



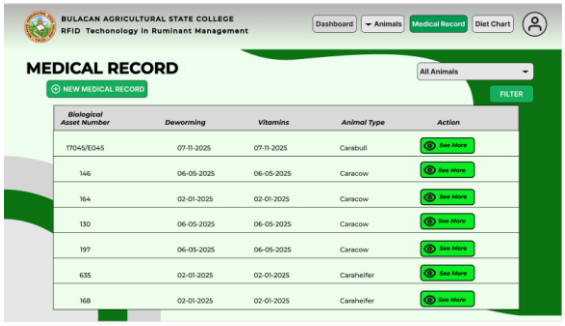
This shows the Administrator's dashboard, which serves as the central hub for managing the system. Through this interface, the administrator can easily access and navigate various features and functions such as user management, system monitoring, data tracking, and configuration settings. The streamlined layout of the dashboard ensures efficiency, allowing administrators to oversee operations and make timely decisions with ease.

This presents the genealogical tree of the selected ruminant, allowing the administrator to view its lineage, including both maternal and paternal ancestors. This feature provides valuable insights into the animal's genetic background, which is essential for informed breeding decisions, health monitoring, and overall herd management

6. List of Animals

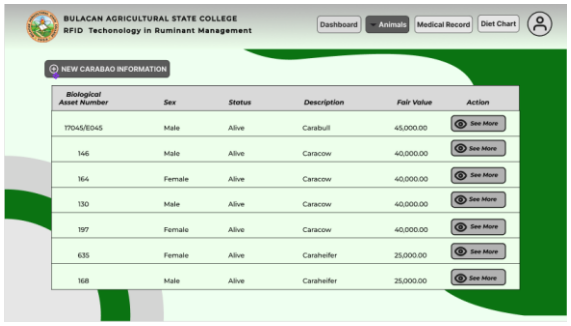


This shows the dropdown list containing all registered ruminants in the system. This feature allows user to quickly select and access specific animal records, streamlining the process of data retrieval and management.



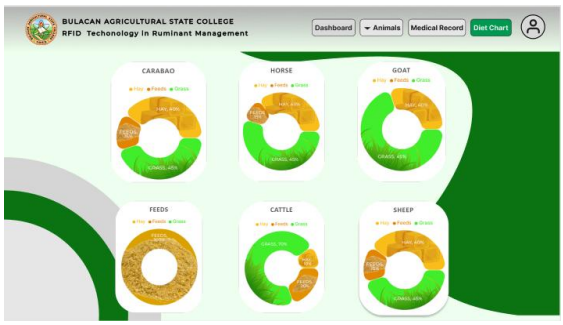
This presents the Medical Record page, where the administrator can view and manage the health records of all registered ruminants. This page allows the administrator to add new medical information as needed. Additionally, the Action column provides quick access to individual ruminant profiles, enabling the administrator to view detailed medical history for each specific animal.

7. Ruminant Information



This shows the profile view of selected ruminants from the administrator's dashboard. Once a specific animal such as a carabao is selected, the administrator can access comprehensive details including the Animal ID, sex, status, breed, and source. This centralized view enables the administrator to efficiently monitor and manage individual animal records, ensuring accurate and up-to-date information is readily available for decision-making and documentation.

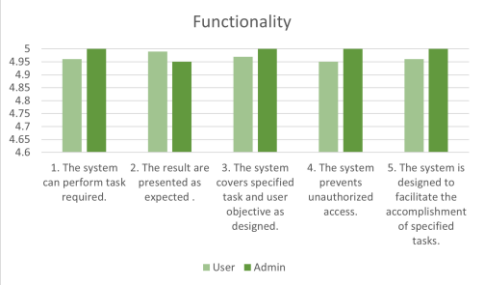
8. Diet Chart



This displays the Diet Chart page as accessed by the administrator. This section allows the administrator to view and manage the daily feeding composition of each ruminant. The chart presents a detailed breakdown of the animal's diet, including specific percentages of grass, commercial feeds, hay, and other dietary components. Through this feature, the administrator can ensure that each ruminant receives a balanced and appropriate diet, contributing to their overall health, well-being, and productivity. Additionally, the administrator may update or adjust dietary information as needed based on the animal's condition or nutritional requirements.

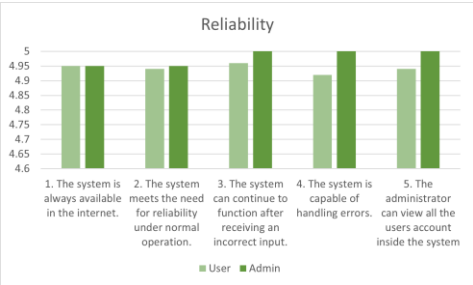
II. SYSTEMS EVALUATION RESULT

Systems Functionality



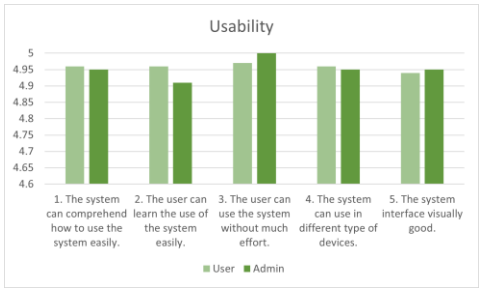
The graph shows the comparison of functionality evaluation between users and administrators shows that both groups rated the system very highly, with administrators giving mostly perfect scores (5.00) and users providing slightly lower but still excellent ratings (4.95–4.99). Users placed the highest value on the accuracy and reliability of the system's results, while administrators emphasized security, task facilitation, and overall dependability. Despite minor variations, both perspectives affirm that the system is highly functional, secure, and effective in meeting organizational objectives and user needs.

Systems Reliability



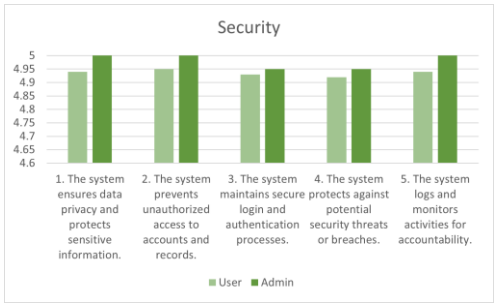
The graph shows the evaluation of the system's reliability demonstrates consistently high ratings from both users and administrators, reflecting strong confidence in its dependability. Users provided weighted means ranging from 4.92 to 4.96, while administrators rated slightly higher, often giving perfect scores of 5.00. Both groups equally agreed on the system's availability on the internet (4.95), while administrators expressed full confidence in its ability to function after incorrect inputs, handle errors, and provide access to user accounts—areas where users gave slightly lower yet still excellent ratings. Overall, the results affirm that the system is highly reliable, with administrators showing a stronger emphasis on error handling and operational resilience, and users confirming its stability and availability in normal use.

Systems Usability



The usability evaluation shows that both users and administrators rated the system very highly, indicating that it is easy to use, learn, and navigate. User ratings ranged from 4.94 to 4.97, reflecting their strong agreement that the system is user-friendly, requires little effort to operate, and works effectively across different devices. Administrators also provided excellent ratings, ranging from 4.91 to 5.00, with the highest score given to the system's ease of use without much effort. While users slightly outscored administrators in most indicators, the overall results confirm that both groups find the system highly usable, visually appealing, and accessible, supporting its effectiveness in promoting a positive user experience.

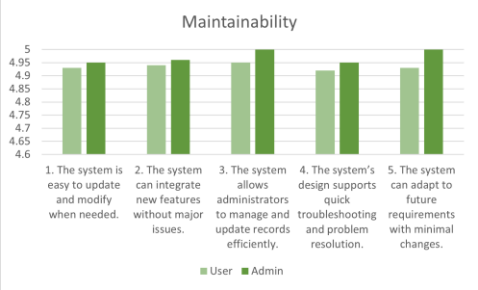
- Systems Security



The graph shows the evaluation of the system's security indicates that both users and administrators have a very high level of confidence in its ability to safeguard information and prevent unauthorized access. User ratings ranged from 4.92 to 4.95, reflecting strong agreement that the system maintains secure login, protects data privacy, and offers sufficient safeguards against threats. Administrators rated even higher, with several perfect scores (5.00) particularly in the areas of access prevention and activity monitoring, underscoring their trust in

the system's control mechanisms. Overall, the results affirm that the system is highly secure, with both groups recognizing its effectiveness in protecting sensitive information and maintaining accountability.

o Systems Maintainability



The graph shows the assessment of maintainability reveals that both users and administrators strongly agree on the system's ability to adapt, be updated, and remain sustainable over time. Users rated between 4.92 and 4.95, highlighting satisfaction with the system's ease of modification, integration of new features, and support for troubleshooting. Administrators provided slightly higher scores, including perfect ratings for record management and adaptability to future needs, demonstrating their confidence in the system's long-term viability. Taken together, the results suggest that the system is designed with maintainability in mind, ensuring that it can continue to evolve and meet organizational demands with minimal disruption.

Conclusion

The integration of RFID technology provides BASC with a transformative pathway toward modernizing livestock monitoring, enhancing traceability, and enriching its instructional and research programs. By enabling accurate data collection and real-time visibility, RFID systems can significantly improve farm management practices and support evidence-based decision-making. However, successful adoption requires addressing challenges such as implementation costs, infrastructure needs, and gaps in technical competencies. These concerns underscore the importance of institutional commitment, targeted capacity-building initiatives, and a phased, well-structured deployment strategy. With adequate support and sustained training efforts, BASC is well-positioned to leverage RFID technology to advance both agricultural productivity and academic excellence.

Recommendations

It is recommended that the institution continue enhancing its livestock monitoring initiatives by adopting advanced identification and data-driven technologies that support accuracy, efficiency, and sustainable farm management. Strengthening the integration of these systems within academic programs will help equip students with relevant skills aligned with modern agricultural practices. Ongoing training and capacity-building efforts for faculty, students, and stakeholders are also encouraged to ensure effective system use and long-term adoption. Future improvements may include exploring mobile platforms, automated notification features, cloud-based data management, and emerging innovations such as IoT, AI, and blockchain to support smarter and more transparent operations. Building partnerships with external agricultural communities and ensuring alignment with national standards will further enhance the system's relevance, scalability, and overall impact.

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