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| RESEARCH ARTICLE

Enhancing Smart Farming Management in the Bali Cattle Breeding Center, Sobangan, Bali, Indonesia, through "SIDEWI" Electronic Data Information System

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| ABSTRACT

The Sobangan Cattle Breeding Center is currently relying on a manual recording system administered by the office to document cattle data. Due to the substantial number of cattle, such a manual method proves inefficient. The solution lies in SIDEWI, a comprehensive digital recording system for the data. Therefore, this research assessed the breeding center productivity by integrating a digital recording system with maintenance management, addressing the inefficiencies inherent in manual recording. The integration of data through SIDEWI aimed to enhance the accuracy and efficiency of measuring productivity while supporting improvements in maintenance management. The investigation, conducted at Sobangan Cattle Breeding Center in Sobangan Village, Mengwi Sub-district, Badung Regency, spanned from April to November 2023. The program included basic analysis, system development, training, and mentoring. SIDEWI.id, being a digital system, contained features for efficiently managing and recording growth, reproduction, ownership, and health data. The research had the potential to generate more precise and high-quality data, contributing to increased productivity in the cattle farming industry. Through the system, staff could easily access and evaluate the condition of each cattle, facilitating the integration of smart farming management, enhancing productivity, and, becoming a center of excellence for Bali cattle.

| KEYWORDS

Digital recording; SIDEWI.id; Smart farming; Sobangan Cattle Breeding Center

| ARTICLE INFORMATION

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1. Introduction

In the 2022 beef supply and demand balance, as outlined by the government, per capita consumption is 2.57 kg per year, representing an increase from the 2021 consumption of 2.46 kg per year. With the increasing beef consumption, a corresponding rise in cattle numbers becomes crucial to prevent a deficit that might lead to meat imports. The Ministry of Agriculture is actively promoting local beef production, particularly with Bali cattle, through diverse programs (kementan, 2022). The Sobangan Cattle Breeding Center, established in 1998 in Sobangan Village, Mengwi, Badung, Bali, plays an important role in breeding Bali cattle and covers an area of 9 hectares. The center aims to conserve, develop, and breed Bali cattle, acting as a germplasm reserve that requires protection from extinction. Furthermore, the Sobangan Cattle Breeding Center contributes to the income of farmers and livestock breeders, thereby enhancing the welfare of the local community (Diperpa Badung, 2020).

The integration of robust husbandry management serves as a key strategy for increasing the population of Bali cattle. A fundamental component of this management method consists of the practice of livestock recording. Currently, the Sobangan Cattle Breeding Center oversees 147 adult cattle and 74 calves, totaling 221 (Diperpa Badung, 2022). Effectively maintaining a large number of cattle requires special attention, particularly in the context of recording and documentation. The current recording system at the breeding center remains manual, with data for each cattle recorded in the office and managed by administrative staff. To obtain information, initial contact with the administrator is necessary. However, given the significant demands of cattle maintenance, this manual method proves ineffective (Clemence et al., 2023; Häggman et al., 2019; Sánchez et al., 2020).

Based on the current situation, the integration of a digital recording system becomes necessary to address the inadequacies in livestock documentation. The use of information technology is exemplified in the software called (aplikasi) SIDEWI.id (Aisuwarya et al., 2020; Irawati et al., 2021; Rahmawati & Ratri, 2021). This software offers a comprehensive digital cattle recording system featuring documentation of livestock data, including lineage, identity, pedigree, and mating details (date, bull/semen code, AI (Artificial insemination)/natural mating, dam). SIDEWI.id also comprises information on dam birthing (date, single/twin, normal/dystocia), calf details (date, single/twin, birth weight, gender, dam, bull/semen code, hump height, body length), weaning specifics (date, weaning weight, hump height, body length), vaccination, treatment data (date, treatment type), and mutation records (inflow and outflow).

The system facilitates the analysis of challenges encountered by a livestock farm, ensuring that the applied solutions positively impact increased livestock productivity and population through enhanced husbandry management. Using a digital livestock recording system guarantees that the generated information is highly beneficial for both governmental and private stakeholders. This data proves particularly valuable for evaluations aimed at advancing sustainable livestock farming practices.

2. Material And Method

2.1 General Design of SIDEWI

SIDEWI, having functioned as an intelligent web-based system, necessitated some crucial device requirements to support its operations in managing livestock data and monitoring cattle productivity. A significant aspect was the flexible access that enabled users, including administrative staff, paramedics, and veterinarians, to use the system through diverse devices, particularly computers or laptops with a stable internet connection, or even through mobile devices or smartphones. The availability of these device options ensured convenient access, thereby enhancing responsiveness and efficiency in cattle management.

The system generated identifiers for each cattle data in barcodes, printed as necktags, and attached to the cattle. The attached barcode could then be directly scanned by users without accounts or the general public using smartphones.

The development of this system uses the model-based system engineering (MBSE) method (https://doi.org/10.1016/j.arcontrol.2021.04.011) due to cyber-physical requirements.

We design this system as follows:

a. The user uses the device to access the Sidewi application. then the user scans the qr-code tag on the cattle.
b. The scan results will be sent to the server via web protocol to the SIDEWI server.
c. The data sent will be processed and stored on the SIDEWI server.
d. The stored data can be accessed via the SIDEWI website.

SIDEWI Design

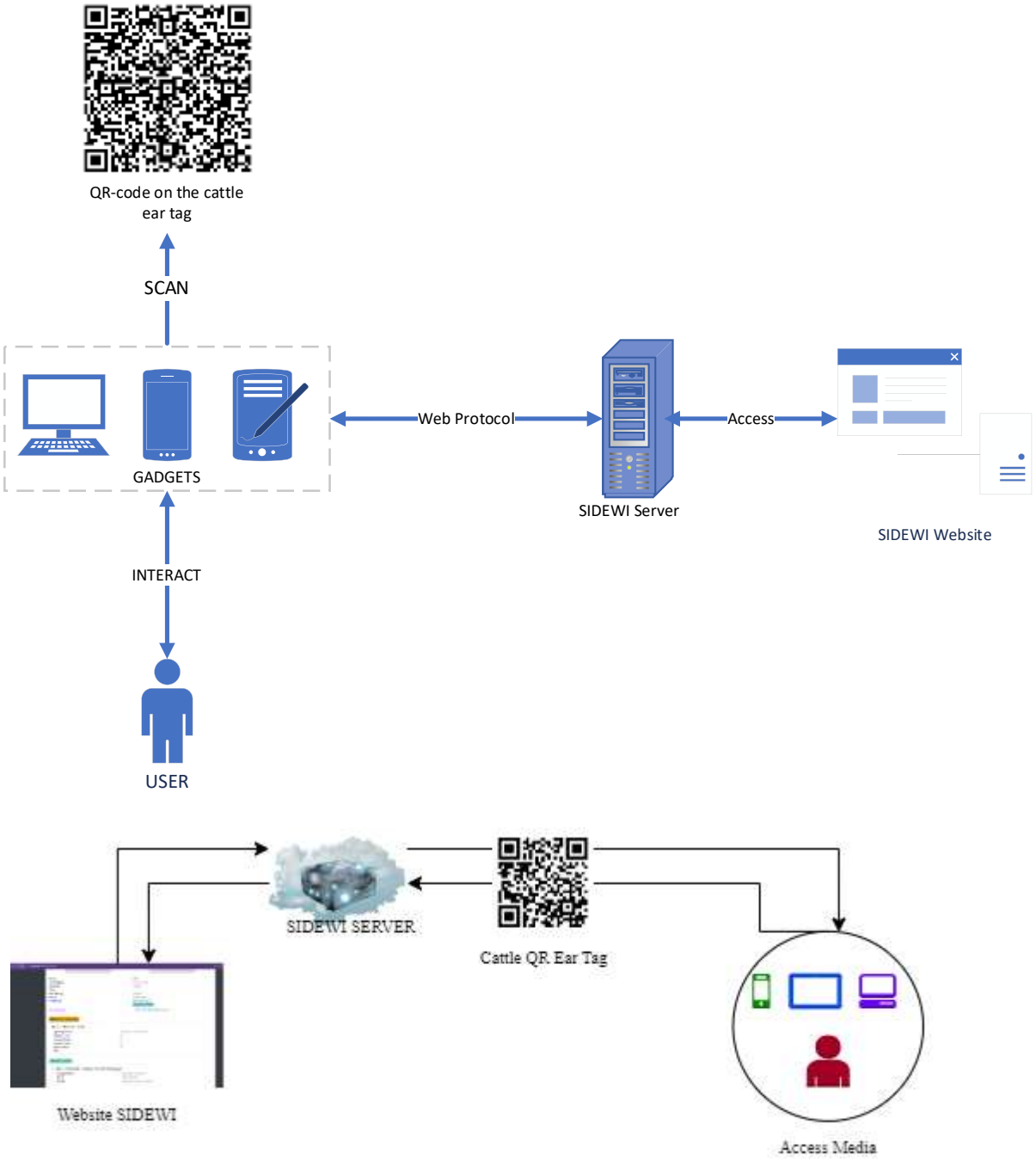


Figure 1. SIDEWI System Design

2.2 Location and Research Period

Conducted from April to November 2023, this research used SIDEWI by conducting trials on several beef cattle at the Sobangan Cattle Breeding Center in Sobangan Village, Mengwi Sub-district, Badung Regency.

2.3 List of Device Requirements

These were the list of device requirements for SIDEWI:

1) Computers or Laptops: Necessary for accessing and managing data through the SIDEWI website. The device should have possessed a stable internet connection.
2) Smartphones or Tablets: An alternative for accessing the system, enabling field officers to record information and access data in real-time at the livestock center location.

3) QR Code Scanner App on Smartphones: Required for users without accounts who wish to access farmer information by scanning the QR code.
4) Stable Internet Connection: Essential for accessing the SIDEWI website and transferring data quickly and securely.

2.4 Integration

The integration of SIDEWI was divided into two main parts, (1) research and system development, and (2) training and mentoring.

The integration method was outlined as follows:

1) Research and Development
   a) The research team identified the needs required by the Sobangan Cattle Breeding Center, which were integrated into the features of SIDEWI.
   b) The research team conducted an analysis to enhance the livestock husbandry management system, such as the aspects of the system.
   c) The outcome of this activity was an integrated digital cattle data recording system accessible online.
2) Training and Mentoring
   a) The research team coordinated with the Sobangan Cattle Breeding Center regarding the procedures for integrating training and mentoring.
   b) The research team conducted training and mentoring in two aspects, (1) the use of SIDEWI for the Sobangan Cattle Breeding Center, and (2) the livestock husbandry management.
   c) The research team analyzed and evaluated the training and mentoring, targeting a minimum of 80% of human resources, specifically administrative staff, and aiming for 70% of field officers at the Sobangan Cattle Breeding Center. The objective was to effectively use the system to enhance productivity.
   d) Training and mentoring in livestock husbandry management included the activities of production mentoring, health status mentoring, reproductive status mentoring, livestock traffic mentoring, and human resources management mentoring.
   e) Training and mentoring in livestock husbandry management aimed at 100% of the Sobangan Cattle Breeding Center human resources to participate in mentoring activities.

3. Result And Discussion

3.1 Overview of the System

The system had various features, including growth, reproductive, ownership, and health data.

1. Cattle data were ID number, gender, birth type, parity, breed/nation, and color.
2. Growth data comprised calf growth at birth and 6 months, covering chest circumference, body length, shoulder height, weight, and body condition score (BCS).
3. Reproductive data consisted of artificial insemination time with the male used, natural mating time (if any) with the male used, pregnancy examination, and birth time.
4. Cattle ownership data included the date the cattle were granted, the name of the owner, contact number, and address.
5. Health data were the date of health check-ups, health activities, clinical signs, diagnosis, medication, and medication repetition notes.

To assess cattle productivity through an integrated digital recording system with husbandry management at the Sobangan Cattle Breeding Center, SIDEWI could analyze the challenges faced by a farm, particularly in evaluations for the development of sustainable farming. The system could have been used in the livestock industry, farming areas, or People's Livestock Breeding Center to assist in the operational aspects of the livestock industry, both in breeding and fattening units. The summarization of SIDEWI was presented in Figure 2.

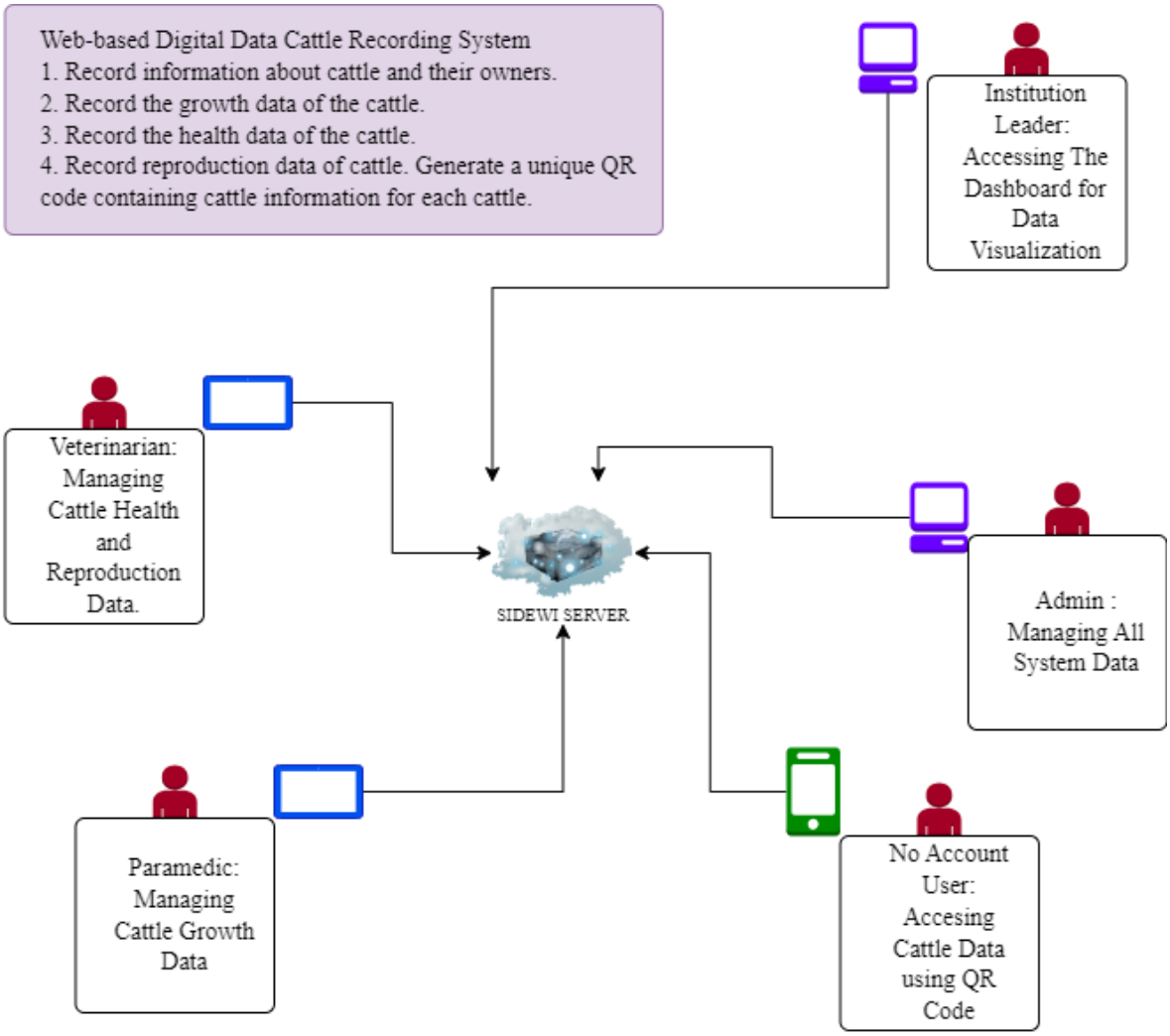
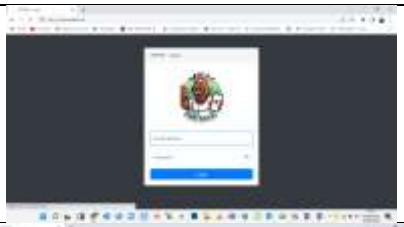
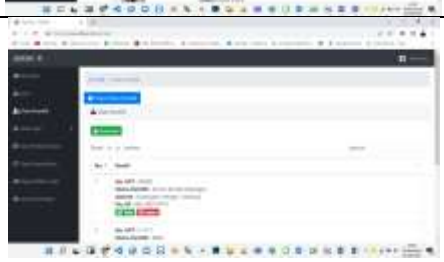


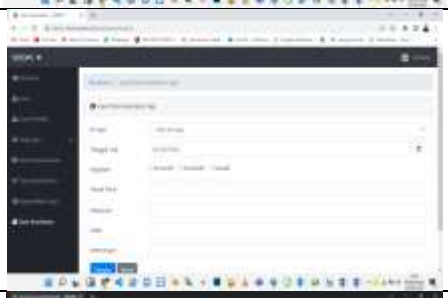
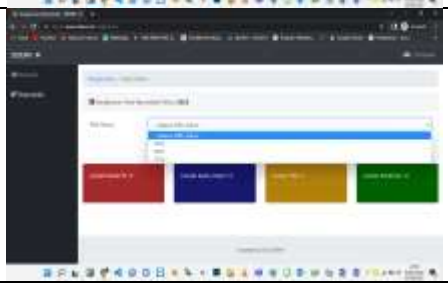
Figure 2. Integration of the digital recording system at the livestock center

The SIDEWI.id system was designed to fulfill five key crucial roles in managing cattle information. Veterinarians, who held the primary responsibility for health and reproduction data, played a central role in recording and maintaining information related to animal welfare. Paramedics were responsible for managing cattle data, recording growth, and documenting reproduction. Meanwhile, farming institution leaders had special access to a dashboard presenting essential summaries of operational status and could access brief information about reproduction records to support strategic decision-making. Admins, operating as system administrators, were responsible for total coordination. This included setting user access levels and managing cattle data, growth, health recording, reproduction recording, and owner data. Lastly, no-account users had limited access, they could only scan QR codes to access owner information. This close collaboration ensured efficient and accurate data management, providing a solid foundation for better decision-making in the farming industry (Bahlo et al., 2019; Dunne et al., 2021).

3.2 Features of SIDEWI.Id

SIDEWI.id could be accessed through the website address www.SIDEWI.id, and users could use several features, including :

FEATURE	BENEFIT
	Login Page → Users in this system consisted of several user levels {admin, veterinarians, paramedics, leaders}. To log in, it was mandatory **to register with the admin**.
	Initial Dashboard Page → This page provided information **about the number of managed cattle**, categorized based on types. Cattle mutations, whether in dead or gifted status, were also summarized. All the data could be downloaded in Excel file format.
	User Management Page → The page could only be accessed by admin-level users, where the admin created new users to access the system in accordance with their levels. **Users included admin, veterinarians, paramedics, and leaders.** User data could be downloaded in Excel file format.
	Owner Data Management Page → Admin-level users could add information related to cattle owners, where the first owner represented the Livestock UPT (Technical Implementation Unit). In the **scenario of a cattle grant**, the admin added data for the **granted owner**. Therefore, when changing the **status of the cattle** to a grant, the list of names that appear became the list of owners created on this page.
	Cattle Data Management Page → Paramedics and admin-level users could add **cattle data as the main subjects** recorded. In this data, information comprising ID, name, gender, breed, and others, were entered. The data on such page was related to growth, reproduction, and health. When a new cattle was input, each would have a specific QR code, which was downloaded and directly used on the cattle by printing and placing it as a **cattle ear tag**. Users without accounts could **scan the code** with their **smartphones** to identify the related cattle identity and the history of cattle growth and health.
	Growth Management Page → This page was accessed by paramedics and admin-level users. The purpose of the page was to record cattle growth data, spanning **from birth to measurements every six months**. The required data included weight, chest circumference, body length, shoulder height, and BCS. The selection of cattle for entering growth data was made from the **cattle list previously inputted on the data page.**

	Reproduction Management Page → This page was accessed by veterinarian and admin-level users. The page was created sequentially following the standard operating procedures (SOP) in the cattle reproduction process. The initial step was to select the parent for the reproduction procedure. The user must decide whether the reproduction process would include Artificial Insemination and Natural Mating. Pregnancy examination data associated with the selected action could only be entered through **buttons** on data {Artificial Insemination, Natural Mating}, with options for positive or negative examination results. Birth data was only entered through **buttons** on pregnancy examination data with a **positive status.**
	Cattle Ownership Page → Accessible by admin-level users, this page **managed the ownership of the existing cattle list**. When cattle were to be grated, ownership could be changed by selecting from the list of owner data **previously created** on the owner data page.
	Health Management Page → Accessible by veterinarians and admin-level users, this page facilitated the input of information about cattle health check results. Health record procedures adhered to the SOP on the farm, with health check categories being Promotive, Preventive, and Curative.
	Reproduction Summary Dashboard Page → This page offered **a brief record of the number of cattle reproductions** and was exclusively accessible by institution leaders and admin-level users as the relevant source of information.

3.3 Implementation Requirements at the Sobangan Cattle Breeding Center

SIDEWI, functioning as a web-based system, had several crucial device requirements to support its operations in managing cattle data and monitoring productivity at the Sobangan Cattle Breeding Center. A prominent aspect was the flexible access that enabled users, including administrative staff, paramedics, and veterinarians, to access the system through computers or laptops with a stable internet connection or even through mobile devices or tablets. These device options provided ease of access, thereby enhancing responsiveness and efficiency in cattle management.

The operational success of SIDEWI heavily relied on the availability of a stable and reliable internet connection. In situations with limited connectivity, it became necessary to consider additional infrastructure, such as signal boosters or the provision of alternative internet connection options. Additionally, printing devices were optional but were required when specific data or reports needed to be printed. Meeting the device requirements was crucial in ensuring that SIDEWI could function effectively and be easily accessed by various devices, thereby contributing to optimizing cattle management and improving productivity at the breeding center.

3.4 Impact of Integration at the Sobangan Cattle Breeding Center

The integration of SIDEWI, as a comprehensive data recording and management system, had the potential to significantly impact the Sobangan Cattle Breeding Center. This system had several features that could enhance efficiency and accuracy in managing cattle data, supporting better decision-making in livestock management. The impacts of using SIDEWI were as follows:

1. Increased Recording Efficiency: SIDEWI replaced inefficient manual recording with digital recording, reducing the risk of human errors, and speeding up the data recording process for cattle, growth, reproduction, and health.
2. Higher Data Accuracy: With neater and more accurate records, information about each cattle became reliable, enabling farm managers to make decisions based on more accurate data.
3. Improved Maintenance Management: SIDEWI enabled better maintenance management through more efficient livestock growth and health monitoring, thereby helping detect health issues earlier and take appropriate preventive actions.
4. More Effective Ownership Management: The system facilitated the grant process, and ownership changes more effectively with the cattle owner management feature, assisting in managing the ownership efficiently.
5. Support for SOP Integration: SIDEWI guided users in using SOP in reproductive and cattle health management, thereby ensuring that actions taken were always in line with established procedures.
6. Impact on Livestock Productivity: Through better recording of growth, reproduction, and health, the system could potentially increase cattle productivity at the Sobangan Cattle Breeding Center. Better management resulted in healthier and more productive livestock.
7. Concise Information for Decision-Making: With a dashboard showing a summary of reproduction data, leaders and administrators had access to crucial information for strategic decision-making. This aided in long-term planning and more effective livestock management. With the adoption of SIDEWI, the Sobangan Cattle Breeding Center had the potential to become more efficient in its management, increase productivity, and ensure that procedures in line with SOP were well-followed. The adoption of the system would have contributed to the development and sustainability of the cattle farming sector in the region.

4. Conclusion

In conclusion, the digital recording system through SIDEWI had great potential for integration in the livestock industry, whether in companies, areas, or community center. In the context of the Bali cattle breeding center in Sobangan Village, the use of the system facilitated access and evaluation of the condition of each cattle. This became a crucial step in using smart farming management, which had the potential to make the center a leading hub in developing Bali cattle farming. SIDEWI offered comprehensive features, including management, growth, reproduction, ownership, and health data. Therefore, the system not only aided in more accurate and efficient data recording but also enhanced understanding of the total condition and development of cattle. Through the integration of SIDEWI, the livestock industry in the Sobangan Cattle Breeding Center had the potential to gain significant benefits in improving productivity and operational efficiency. With improved data management and reliance on more accurate information, the center was capable of achieving excellence standards, thereby becoming a center of excellence in the care and development of Bali cattle.

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Conflicts of Interest: The authors declare no conflict of interest.

References

[1] Aisuwarya, R., Hersyah, M. H., Putri, R. E., Ferdian, R., & Fatimah, F. (2020). Implementasi teknologi NFC untuk recording data sapi perah kelompok tani Lembu Alam Serambi kota Padang Panjang. Journal of Appropriate Technology for Community Services, 1(2), 74–81.

[2] Bahlo, C., Dahlhaus, P., Thompson, H., & Trotter, M. (2019). The role of interoperable data standards in precision livestock farming in extensive livestock systems: A review. Computers and Electronics in Agriculture, 156, 459–466.

[3] Clemence, O., Luambano, I., & Mwantimwa, K. (2023). Adoption and application of electronic records systems in higher learning institutions. Information Development, 02666669231158336.

[4] Dunne, F. L., Evans, R. D., Kelleher, M. M., Walsh, S. W., & Berry, D. P. (2021). Formulation of a decision support tool incorporating both genetic and non-genetic effects to rank young growing cattle on expected market value. Animal, 15(2), 100077.

[5] Häggman, J., Christensen, J. M., Mäntysaari, E. A., & Juga, J. (2019). Genetic parameters for endocrine and traditional fertility traits, hyperketonemia and milk yield in dairy cattle. Animal, 13(2), 248–255.

[6] Irawati, D. A., Prapcoyo, H., & Widiyaningsih, I. (2021). Sistem Informasi Manajemen Pemeliharaan Ternak Sapi. Prosiding Seminar Nasional LPPM, 2(1).

[7] Rahmawati, D., & Ratri, P. R. (2021). Implementasi Sistem Rekording Dan Aplikasi Pakan Berbasis Limbah Kulit Edamame Sebagai Upaya Pengembangan Kapasitas Usaha Peternakan Sapi Perah. Prosiding Seminar Nasional Terapan Riset Inovatif (SENTRINOV), 7(3), 401–411.

[8] Sánchez, Z., Galina, C. S., Vargas, B., Romero, J. J., & Estrada, S. (2020). The Use of Computer Records: A Tool to Increase Productivity in Dairy Herds. Animals, 10(1), 111.