Development of digital livestock monitoring in Sambilawang Village, Serang, Banten

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Abstract. The stockbreeders in Sambilawang Village face challenges in managing their livestock using traditional methods, resulting in inefficiencies and potential income losses. This study aims to develop a mobile application-based monitoring system to enhance livestock management for stockbreeders in Sambilawang Village while fostering collaboration with potential investors. The proposed system is designed to offer an interactive digital platform that enables stockbreeders to monitor livestock growth, health, and condition efficiently. Notifications will be implemented to inform both stockbreeders and investors about key events such as readiness for sale, breeding, or milking, simplifying the process of buying and selling livestock. The implementation of the digital monitoring platform significantly improves the management of livestock in Sambilawang Village. Stockbreeders can now maintain accurate records and provide timely updates to potential investors, enhancing their income and facilitating collaboration with buyers. The application also streamlines the livestock sales process, reducing disruptions in meat distribution. In conclusion, the development of this mobile application-based monitoring system represents a crucial step in addressing the challenges faced by stockbreeders in Sambilawang Village. By promoting efficient livestock management and fostering collaboration with investors, this solution has the potential to stabilize the stockbreeding profession and benefit the entire community.

1 Introduction

Livestock is one sector that is quite developed in Indonesia. Goat and sheep farming is one such thing. These animals are able to live and adapt in almost all regions in Indonesia. This contributes to increasing the number of livestock from year to year. Sambilawang Village is one of 11 other villages located in Waringinkurung District, Serang Regency, Indonesia. This village has an area of approximately 411.4 Ha and most of the existing area is used as agricultural land and animal husbandry [1]. Surrounding with greenery landscape, mild or moderate climate make this region ideal for doing agricultural and animal husbandry activities. This is shown by the large number of residents who make a living as stockbreeders and breeders [1].

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The conventional paper-based method remains an obligatory tool in the arsenal of stockbreeders for tracking and documenting the growth of their livestock. However, this reliance on manual record-keeping is fraught with common pitfalls, including the propensity for errors such as missed entries, lost records, or data mix-ups. Typically, these records are updated periodically, perpetuating the recurrence of past mistakes and inaccuracies. Additionally, when stockbreeders need to reference historical records, they must painstakingly sift through stacks of paper documents, combing through them one by one to locate the specific information they require. This laborious and time-consuming process not only proves exasperating but also results in inefficiencies, undermining the overall effectiveness of their work.

These challenges assume even greater significance when stockbreeders endeavor to provide precise and dependable information on livestock growth to potential investors. The cumbersome nature of their record-keeping procedures poses a substantial risk of miscommunication and inaccuracies, potentially jeopardizing collaborations with investors and leading to financial losses in livestock sales transactions. Furthermore, these difficulties extend to the intricacies of breeding and milking activities. The stockbreeders encounter significant hurdles in accurately identifying and monitoring crossbreeding endeavors, often resulting in confusion over the lineage of their livestock. Breed mix-ups and uncertainties about the origins of animals further compound the challenges faced by these individuals in managing their livestock effectively.

The various challenges and issues outlined above have the potential to exert a substantial and far-reaching influence on the distribution of meat products, thereby posing a considerable threat to the broader issue of food security. Moreover, these challenges have a ripple effect, extending their impact to the economic sphere as well. The difficulties faced by stockbreeders in terms of accessing reliable markets, securing investments, and finding prospective buyers for their livestock can significantly impede their income-generation capabilities. This, in turn, may lead to a gradual exodus of stockbreeders from their traditional livelihoods, as they seek alternative occupations in response to these challenges. As this shift occurs, it could result in a dwindling livestock production sector, which has far-reaching consequences not only for the livelihoods of stockbreeders but also for the overall economic stability of the region. Therefore, addressing these multifaceted issues is not only imperative for safeguarding food security but also for fostering sustainable economic growth within the livestock industry.

In our contemporary digital age, mobile gadgets, such as smartphones, have become ubiquitous, and this trend is no exception for the stockbreeders residing in Sambilawang Village. This era presents a pivotal juncture for these individuals, urging them to transition from traditional manual practices to more contemporary and tech-savvy approaches. This shift is particularly pertinent when addressing the challenges previously mentioned, as it can play a pivotal role in enhancing livestock productivity and overall agricultural efficiency. As smartphones and digital technologies become increasingly integrated into daily life, harnessing these tools can empower stockbreeders to access a wealth of information, resources, and solutions at their fingertips, ultimately contributing to the modernization and optimization of their livestock-related activities.

2 Methodology

This study was carried out in a goat farm in Sambilawang Village, called Jawara Farm. Even though this farm is owned privately, it is conducted as coordinator of goat farm cooperative. Thus, in the future, Jawara Farm could promote the use of this mobile application, which we named Modern Farm, to more stockbreeders in Sambilawang Village. The methodology used was Agile Software Development Method. It is a set of software development methods based on iterative and incremental development process, where requirements and development
evolve through collaboration between self-organizing, cross-functional teams that allows rapid delivery of high-quality software to meet customer needs and also accommodate changes in the requirements [2].

Fig. 1. Agile development methodology.

As depicted in the illustration provided, the Agile Methodology places a significant emphasis on iterative processes across various stages of software development, which include analysis and design, development, testing, and deployment, all prior to the final product's official release into production. This approach advocates a continuous cycle of refinement and enhancement, ensuring that each facet of the software undergoes thorough scrutiny and improvement before reaching the deployment phase. This iterative nature is a fundamental hallmark of Agile, fostering adaptability and responsiveness throughout the software development journey. Now, let's delve into the specifics of each of these key processes:

2.1 Requirement analysis

Identifying, communicating and documenting the requirements are the objectives for requirement analysis [3]. These requirements serve as a blueprint for outlining what needs to be accomplished within the project scope, elucidating the "what" rather than delving into the specifics of "how" these objectives will be implemented. In this particular study, the chosen methodologies to achieve these objectives involve the utilization of focus group discussions and the meticulous analysis of observations gathered during on-site visits to farms. These methodologies facilitate a holistic understanding of the requirements, taking into account insights from stakeholders and real-world observations.

The study's deliverables encompass various models, each playing a crucial role in delineating and defining the project's requirements. Among the key outputs are models such as the use case model, which illustrates how various system components interact with one another; the data flow diagram, which visualizes the flow of data within the system; and the flow chart diagram, which provides a detailed, step-by-step representation of specific processes. These models, meticulously detailed and analyzed, culminate in the creation of the Software Requirements Specification documentation, which serves as a comprehensive and structured repository of the project's requirements, ensuring clarity, precision, and alignment with stakeholders' expectations.
2.2 Design

After specifying what feature will be developed, and what are the requirements needed, the next phase is to design the User Interface (UI) of the application. UI is the asset that helps the user to interact with the product's interface for services. For example, User Interface consists of visual design elements including colors and typography [4]. In this process, the UI designer may have made some investment in the UI design as lightweight prototypes, but the iteration planning determines what elements will next be developed as functional software [5]. The deliverables of this phase are designing both the wireframe and the high-fidelity prototype using Figma. It is a vector graphic editor and tool that can be used for prototyping. It is web based, so everyone can use it, flexible and easy to learn.

2.3 Development

In the development phase, Flutter, Django and AWS are used as mandatory tools for building and running the application program. Firstly, Flutter is a set of tools that allows developers to create beautiful apps which could run on any platform such as iOS, Android, Web and Desktop [6]. Usually, it is called a cross platform development framework. In Flutter, the coding is written with Dart. It is a programming language that is developed, maintained and widely used by Google. Also, it has been proved to have the capability to develop massive web applications, such as AdWords [7]. Secondly, the backend for this application uses Django Rest service. It is a flexible toolkit for building a Web APIs for the application [8]. Another benefit of using Django is that the data security and the server itself used a token system for incorporating essential security. Lastly, Amazon Web Service or AWS is used as a cloud computing framework which handles deployment tasks such as hosted services on the internet, storage, servers, networks and database [9]. As a leader on cloud computing service, there are a lot of benefits of using AWS in the modern cloud. Data protection, regulatory compliance, quantifiability, flexibility, cost-effectiveness, multiple storages, auto-scaling, access to the data anytime, data-centric encryption, high-performance processing are a few benefits of AWS cloud [10].

2.4 Testing

The testing phase was done to ensure quality after the application was built. Overall, two stages were used. The first test was a unit test conducted by the development team right after every module was finished to develop. To ensure the program or code had minimal bugs and errors. However, due to the nature of the agile method, the unit testing could be performed in parallel with development step [11]. The second phase of testing was executed in collaboration with the end-users, and it followed a predefined acceptance testing scenario. The primary objective was to allow users to directly assess the software's performance, ensuring that it aligns effectively with their specific requirements and adequately addresses their business needs. Any issues or errors identified during this testing phase were diligently addressed and resolved to ensure that the software met the necessary criteria for acceptance certification from the client before its final approval [12].
3 Results and discussion

3.1 Requirement analysis

Requirement analyses were gathered from the perspective of application users which then visualize using several tools. The focus group discussion was attended by farmer representatives from Jawara Farm and the research team from the university. This led to brainstorming so that the research team could dig deeper into the problem, and what application is needed. To ensure the requirements, an on-site visit was done right after the focus group discussion. It is necessary since frequent and intense interactions are needed for acquiring, sharing and applying technical and domain knowledge in terms of software development which is inherently a knowledge intensive undertaking [13]. Figure 2 shows the result from this step as a use case diagram and followed by features description table. Overall, the documentation from this step was allocated in the Software Requirement Specification (SRS) document.

Fig. 2. Use case diagram livestock monitoring application.
Table 1. Features description.

<table>
<thead>
<tr>
<th>No</th>
<th>Features Name</th>
<th>Users</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Login</td>
<td>Farmer, Buyer</td>
<td>Authenticate registered user</td>
</tr>
<tr>
<td>2</td>
<td>Register</td>
<td>Farmer, Buyer</td>
<td>Create new user to authenticate</td>
</tr>
<tr>
<td>3</td>
<td>Statistics</td>
<td>Farmer</td>
<td>Display livestock’s data in graph</td>
</tr>
<tr>
<td>4</td>
<td>Input Livestock</td>
<td>Farmer</td>
<td>Input livestock’s data</td>
</tr>
<tr>
<td>5</td>
<td>Fattening</td>
<td>Farmer</td>
<td>Display and edit all fattening livestock’s data</td>
</tr>
<tr>
<td>6</td>
<td>Breeding</td>
<td>Farmer</td>
<td>Record and display all livestocks that are ready to breed</td>
</tr>
<tr>
<td>7</td>
<td>Milking</td>
<td>Farmer</td>
<td>Record and display all milking livestocks and its milk production</td>
</tr>
<tr>
<td>8</td>
<td>Farm</td>
<td>Farmer</td>
<td>Display all farms that are handled by farmer. Farmer can add another farm to this feature.</td>
</tr>
<tr>
<td>9</td>
<td>Shed</td>
<td>Farmer</td>
<td>Display all sheds that are handled by farmer. Farmer can add another cage to this feature.</td>
</tr>
<tr>
<td>10</td>
<td>Education</td>
<td>Farmer</td>
<td>Videos and educational modules that can be accessed free of charge by a farmer</td>
</tr>
<tr>
<td>11</td>
<td>History Transaction</td>
<td>Farmer</td>
<td>Retrieve all transaction data</td>
</tr>
<tr>
<td>12</td>
<td>Search</td>
<td>Farmer</td>
<td>Search the livestock by its ID or by QR code scanning</td>
</tr>
<tr>
<td>13</td>
<td>Profile</td>
<td>Farmer, Buyer</td>
<td>User’s profile</td>
</tr>
<tr>
<td>14</td>
<td>Purchase</td>
<td>Buyer</td>
<td>Display all ready to sell livestock’s data</td>
</tr>
<tr>
<td>15</td>
<td>Payment</td>
<td>Buyer</td>
<td>Payment method options to pay sold livestock</td>
</tr>
</tbody>
</table>

3.2 Design

An initial version of the application was developed to transition the use case diagram into a more tangible and fully-realized context. The process began with the creation of a low-fidelity wireframe, which served as a rudimentary blueprint for the application's layout and structure. This wireframe provided a basic visual representation of the application's components and their arrangement. Subsequently, this low-fidelity wireframe was meticulously transformed into a high-fidelity prototype, which incorporated a wealth of graphical elements, enhancing its visual appeal and user-friendliness. In terms of color scheme, the predominant choice was the soothing and elegant shade of tosca, complemented by a light mode for the screen's background, ensuring a comfortable and visually appealing user experience.
To provide a visual reference for these developmental stages, Figure 3 has been dedicated to showcasing the wireframe, providing insight into the foundational structure of the application, while Figure 4 presents the finalized high-fidelity prototype, which represents the application in a more polished and feature-rich form. These figures collectively offer a comprehensive view of the evolutionary journey from the conceptual use case diagram to the tangible and visually engaging prototype application.

![Wireframe of monitoring livestock application.](image1)

**Fig. 3.** Wireframe of monitoring livestock application.

![High-fidelity prototype of livestock monitoring application.](image2)

**Fig. 4.** High-fidelity prototype of livestock monitoring application.

### 3.3 Development

The development phase is time to turn the design into coding. It used an agile approach in which collaboration is the top priority during the development process. After first iteration, then receive feedback from stockbreeders thus refine the prototype and move on towards second or next iteration so on. By doing this method, it shows efficiency for developers to adjust or enhance the prototype into the real mobile application. The result of the mobile application has been established and can be downloaded and installed on the Google Playstore. While the dashboard application for administrator could be accessed via web portal. Overall, the dashboard shows all the livestock statistics which illustrated through several charts such as weight, age and treatment history. The screenshot from dashboard application can be seen in Figure 5.
At the heart of this system lies a fundamental tool: the QR code, which plays a pivotal role as a mandatory identifier for each individual farm animal. This QR code constitutes the gateway to a wealth of information associated with the animal and can be easily accessed via a dedicated mobile application or platform. Intricately tied to each animal's unique identity, the QR code serves as a digital key unlocking a trove of essential data. This information-rich repository includes critical details such as the animal’s age, weight, species classification, a comprehensive health record, and an extensive history of treatments administered throughout its life cycle. Essentially, this technology-driven approach harnesses the power of QR codes to provide a comprehensive and accessible means of tracking, monitoring, and managing the individual profiles of farm animals, enhancing efficiency, transparency, and precision in livestock management.

### 3.4 Testing

To ensure the running process of the application functions, the unit testing was performed by developers at the first level of testing before user acceptance testing (UAT). The Blackbox method was applied during the UAT process to evaluate and check the suitability of the application. Before testing, test cases were designed based on experiments with various inputs. If during the testing phase the application succeeds in showing the expected output, then the verdict will pass, otherwise it will fail. The table below presents the result from blackbox method as indicated from the test case for each feature.

<table>
<thead>
<tr>
<th>No</th>
<th>Test Case</th>
<th>Testing Scenario</th>
<th>Expected Result</th>
<th>Verdict</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Login</td>
<td>User enters their valid credential: enter a valid phone number, enter a valid password. User selects the login button which means the user go to the homepage</td>
<td>The screen displays an input field. User should be able to log in successfully so user can access the app</td>
<td>Pass</td>
</tr>
<tr>
<td>2</td>
<td>Register</td>
<td>User input their personal data info. User able to create password. User is reassured all the information are correct.</td>
<td>Register page displayed new user created. New User have valid credentials. New user able to log in with valid credential</td>
<td>Pass</td>
</tr>
</tbody>
</table>

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**Fig. 5.** Dashboard of the livestock monitoring application.
<table>
<thead>
<tr>
<th>Step</th>
<th>Feature</th>
<th>User Interaction</th>
<th>System Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Statistics</td>
<td>User selects the register button which means a new user has created.</td>
<td>Retrieve the data from the database. Data displayed accurately.</td>
</tr>
<tr>
<td>4</td>
<td>Input Livestock</td>
<td>User on the home page. User clicked on the statistic feature. User able to see the data.</td>
<td>Input data field displayed. User can input the data in the input field. The data stored are directly integrated with the other features. Live stocks data updated.</td>
</tr>
<tr>
<td>5</td>
<td>Fattening</td>
<td>User on breeding screen. User can see valid fattening live stocks whether in good condition, bad condition, or ready to sell. User can see a list of fattening live stocks. User can select live stocks to modify. User can edit the live stocks data. User can save any changes made to the live stocks data.</td>
<td>All condition live stocks data are displayed. List of fattening live stocks displayed. User can see detailed information on registered fattening live stocks. User can edit live stock data. Live stock’s data updated.</td>
</tr>
<tr>
<td>6</td>
<td>Breeding</td>
<td>User on the homepage screen. User clicked on the breeding feature. User on breeding screen. User can see breeding livestock list. User clicked on the plus “+” sign. User inputs the livestock data. User get to choose the male livestock. User can save the changes made and store them in the database.</td>
<td>All breeding livestock lists are displayed. User can input the livestock mating data. User get to choose the male and female livestock that are ready to mate. Breeding data updated.</td>
</tr>
<tr>
<td>7</td>
<td>Milking</td>
<td>User on homepage screen. User clicked on the milking feature. User on the milking screen. User can see all milking livestock lists. User clicked on the plus “+” sign. User input the milk produced by the livestock in liters.</td>
<td>All milking livestock lists are displayed. The user successfully inputs the amount of milk produced by liters. User can choose the livestock that is producing the milk. Users can save the changes made. Milking Data Updated.</td>
</tr>
</tbody>
</table>
User can choose the livestock that has produced the milk. User click on the save button to save the changes made.

| 8 | Farm | User on homepage screen. User clicked on the farm feature. User on the farm screen. User can see lists of all farms managed by Modernfarm.id. User clicked on the plus “+” sign. User filled out the farm data. User clicks on the save button to save the changes made and the new farm will be displayed on the farm screen. | All farm lists are displayed accurately. User can fill out the input field. User can add the new farm. The new farm will be registered on the farm feature. | Pass |

The assessment of the application's performance, as indicated by the "pass" verdict across all testing criteria, signifies a robust and reliable functionality, validating its readiness for real-world deployment. Concurrent with the testing phase, a comprehensive discussion was undertaken to solicit valuable feedback from stockbreeders, shedding light on their perspectives and insights regarding the application. The consensus emerging from these discussions strongly underscores the application's readiness for practical implementation. However, it was evident that stockbreeders would benefit from an intensified training program to maximize their proficiency in utilizing this application to its full potential.

To address this need, a dedicated team has been assembled with the specific mandate of facilitating comprehensive training sessions for stockbreeders residing in Sambilawang Village. These training initiatives aim to equip them with the requisite knowledge and skills to effectively leverage the application, ensuring its seamless integration into their daily livestock management practices. This proactive approach not only underscores our commitment to ensuring the successful adoption of the technology but also signifies a pivotal step towards enhancing the agricultural landscape in the region.

4 Discussion

The discussion section will address specific aspects of the livestock monitoring application's development and potential challenges.

4.1 Application development and user involvement

The livestock monitoring application, developed as part of this research, underwent a rigorous development process and user acceptance testing. Active participation of stockbreeders in the assessment process was pivotal in ensuring the application's suitability for real-world deployment. This approach aligns with best practices in software development, where end-users play a crucial role in shaping the final product to meet their needs and preferences.
4.2 Challenges and proposed solutions

Despite the significant achievements, a few challenges need further attention. Firstly, the use of QR codes for livestock identification has encountered resilience issues due to budget constraints. QR codes, currently printed on laminated paper and attached to the animals, are vulnerable to damage or displacement by other animals. While a temporary solution may involve reprinting the QR codes, it is not sustainable in the long term. Transitioning to more robust RFID tags for identification, as suggested in reference [14], would be a practical step to address this challenge.

4.3 Technology literacy and training

Another crucial challenge to address is the need for intensive application training, especially considering that many stockbreeders may have limited familiarity with technology. Bridging this knowledge gap is vital for ensuring the effective use of the application. Future efforts should prioritize the development of comprehensive training programs tailored to the specific needs and technological literacy levels of stockbreeders. This approach will empower stockbreeders to leverage the application's full potential.

5 Conclusion

In conclusion, the development of the livestock monitoring application signifies a significant milestone in enhancing the livelihoods of stockbreeders in Sambilawang Village. The collaborative effort with farmers to design and refine the application has not only ensured the application's user-friendliness but also its real-world applicability. Nevertheless, challenges remain, such as the resilience of QR codes and the need for comprehensive training. Addressing these issues is paramount to the application's long-term success. As the journey continues to refine and improve this digital solution, the endeavor aims to revolutionize livestock management practices, empower stockbreeders, and strengthen partnerships with potential investors. Ultimately, the aim of this endeavor is technological innovation, community engagement, and economic growth for a prosperous future for both stockbreeders and the entire village.

References

1. N. Rohman, (2022)