Technologique: A Global Journal on Technological Developments and Scientific Innovations
2024, Vol. 2, No.1, 40 – 48 | ISSN Online: 3028-1415 | ISSN Print: 3028-1407
DOI: https://doi.org/10.62718/vmca.tech-gjtdsi.2.1.SC-0724-004

Advancing Layer Feed Formulation with Mobile Technology

Article History:
Received: 03 July 2024
Accepted: 08 February 2024
Published: 29 July 2024

Crismar D. Betangcor[1], Mark Ariel S. Milano[1], Jean Richel B. Santander[2], Judith B. Barlaan[2]

[1]Student, BS in Information Systems, Jose Rizal Memorial State University, Zamboanga del Norte, Philippines
[2]Faculty, College of Computing Studies, Jose Rizal Memorial State University, Zamboanga del Norte, Philippines

Abstract

Advancements in technology have equipped poultry farmers with innovative tools to improve production efficiency. One unique innovation is the development of Personal Digital Assistants (PDAs) for feed formulation, enabling farmers to meet the nutritional needs of layer chickens while minimizing costs. This paper details the design and development of an Android-based mobile application called Penny-wise Layer Feed Formulation PDA. The primary objective is to create a user-friendly platform that aids farmers in formulating optimal feeds efficiently. This research contributes uniquely to existing technology by offering a tailored solution designed explicitly for layer feed formulation, distinguishing it from generic agricultural applications. The study employed a developmental research methodology, specifically the Rapid Application Development (RAD) Model, to design and develop the application. Furthermore, descriptive research methods were used to evaluate the application's effectiveness based on the ISO/IEC 25010:2011 software quality standards. Tools such as Android Studio, Java, and SQLite were utilized during the development process. Evaluation results demonstrate that the mobile application is very much functional, usable, reliable, and maintainable. It received high ratings, with an average weighted mean of 4.15 and above, indicating that the application is highly effective and practical. These favorable assessments suggest that the application can significantly assist poultry farmers in optimizing feed formulations, thereby enhancing production outcomes and reducing costs. The study concludes that the Penny-wise Layer Feed Formulation PDA is an effective and beneficial tool for poultry farmers, providing substantial advantages in terms of usability and reliability. This research emphasizes the critical role of integrating technology into agricultural practices to boost productivity and efficiency. By leveraging such innovative tools, poultry farmers can achieve better resource management and production efficiency, contributing to sustainable farming practices. This application is highly recommended due to its potential to transform feed formulation processes in the poultry industry.

Keywords: Poultry Farmers, Feed Formulation, Layer Chickens, Personal Digital Assistant (PDA), Mobile application, ISO/IEC 25010:2011

INTRODUCTION

Egg farming is a critical pillar in the agricultural sector, driven by the escalating global demand for affordable and nutritious protein sources. Eggs, noted for their high biological value and cost-effectiveness in meeting daily animal protein requirements (Molnár & Szollosi, 2020), play an essential role in the diet of populations worldwide. In the Philippines, per capita egg consumption has risen to 4.58 kg annually, marking a notable 6.26% increase from the previous year and elevating the country to the 96th position globally in egg consumption (Helgi Library, 2021). Despite this growing demand, advancements in the egg industry primarily focus on business operations, resulting in significant technological gaps that hinder productivity and efficiency in farming practices.

These gaps in technological support leave farmers reliant on outdated methods that are not conducive to meeting the increasing demands of the market. Achieving optimal nutrition in layer chicken poultry farming is crucial for sustainability and productivity (Bailey, 2020). Feed quality, including its nutrient content, is a key factor in this process (Khan et al., 2008). Proper nutrition, including vitamins, minerals, proteins, and fats, is crucial for sustaining egg production and quality in laying hens (Bouvarel et al., 2011). Filipino egg farmers rely predominantly on manual estimation for feed formulation, a labor-intensive and error-prone practice exacerbated

by the significant feed requirements of approximately 1.75 lbs. per laying hen per week (McCrea, 2018).

Moreover, expensive pre-made feeds or ad hoc mixing methods for layer chicken must consistently meet nutritional standards (Kasule et al., 2014). This situation can lead to various issues, including poor growth rates and low egg production (Kariuki et al., 2021). However, studies have shown that it is possible to reduce costs and waste by carefully formulating rations using local feedstuffs (Henuk, 2003). Responses of laying chickens to diets formulated following specific feeding standards were found to be at least equal to or better than those of other standards (Ehtesham et al., 2002). These findings underscore the urgent need for technological interventions that enhance feed formulation processes. Therefore, it is crucial for chicken farmers to receive training on feed formulation and mixing to ensure that their chickens receive the necessary nutrients for optimal growth and production.

This study aims to address the identified gap in technological support for feed formulation in the Philippine poultry industry by developing the Android-based mobile application, Penny-wise Layer Feed Formulation PDA. Grounded in PHILSAN Feed Reference Standards (PSAN, 2003), the application will leverage the Rapid Application Development (RAD) model to deliver a user-friendly and efficient tool. By facilitating accurate and streamlined feed formulation processes, the Penny-wise PDA seeks to empower poultry farmers, reducing time, effort, and costs associated with feed procurement and enhancing overall operational efficiency. Specifically focused on layer poultry farming in the Philippines, this research aims to provide a practical solution that improves immediate productivity and fosters long-term sustainability and competitiveness within the local egg-farming industry.

The objectives of this study include (1) identifying the specific technological needs of poultry farmers in feed formulation, (2) developing a user-friendly mobile application that adheres to industry standards, and (3) assessing the application's effectiveness in improving feed formulation practices among layer poultry farmers.

METHODOLOGY

Research Design. The study utilized a developmental research methodology, focusing on the Rapid Application Development (RAD) Model to create the Penny-wise Layer Feed Formulation PDA. This approach, guided by Chien's (2020) adaptation of the RAD methodology, emphasized rapid prototyping and iterative development cycles. The RAD model comprises several vital steps: requirements gathering, prototyping, user feedback, iterative refinement, and final implementation. This structured process allowed for quick adjustments based on continuous user feedback, ensuring that the application effectively met user needs. The RAD model has been successfully applied in various settings, including psychiatric outpatient services (Shaker et al., 2023), telecommunications infrastructure networks (Ardhiansyah, 2019), records tracking management (2023), and agricultural irrigation systems (Nalendra, 2021). In each case, the model's iterative nature enabled efficient adaptations, highlighting its versatility and effectiveness in various development contexts.

Following the development phase, a descriptive research method was employed to evaluate the application's effectiveness using the ISO/IEC 25010:2011 software quality standards. This dual-phase approach ensured a thorough and user-centered development process while providing a structured evaluation framework for assessing the application's quality.

Research Locale. The research was conducted at Jose Rizal Memorial State University-Katipunan Campus in Katipunan, Zamboanga del Norte. This location was selected for its accessibility and the availability of target respondents who could provide relevant feedback. The university setting was deemed ideal due to its diverse educational environment, which fosters collaboration

among students, instructors, and IT professionals. It facilitated an effective development and evaluation phase for the study, leveraging the expertise of its participants.

Research Participants. Sixty respondents participated in the study, selected based on their expertise and relevance to the research. The participants included fifty Bachelor of Agricultural Technology (BAT) and Bachelor of Science in Agriculture (BSA) students, chosen for their strong foundational knowledge of agricultural practices and potential to use the application effectively. Five College of Agriculture and Forestry instructors provided professional insights into the application's functionality and educational value. Lastly, five university IT experts evaluated the application's technical aspects, ensuring it met software quality standards. This diverse group of participants provided comprehensive feedback encompassing practical, educational, and technical perspectives.

Research Instrument. The mobile application was evaluated using an instrument based on ISO/IEC 25010:2011 standards. This standard offers a detailed framework for assessing software quality, focusing on key attributes such as functionality, usability, reliability, and maintainability. Specific questionnaires and evaluation forms were designed to capture detailed feedback from the respondents on these attributes. The structured nature of these instruments ensured an objective and thorough assessment of the application, aligning with international software quality standards.

Data Gathering Procedure. The data-gathering procedure was divided into two main phases: development and evaluation. The RAD methodology facilitated rapid prototyping and iterative feedback loops during development. *It involved* gathering detailed requirements from potential users, developing initial prototypes, collecting user feedback, and refining the prototypes based on this feedback until the final version met the project specifications. Participants were selected and provided with evaluation forms based on ISO/IEC 25010:2011 standards in the evaluation phase. The data collection process involved distributing these forms to the respondents, collecting their completed evaluations, and analyzing the data to assess the application's effectiveness in terms of functionality, usability, reliability, and maintainability.

Ethical Considerations. Several ethical considerations were addressed to uphold the integrity and ethical standards of the research. Informed consent was obtained from all participants, ensuring they were fully aware of the study's purpose, role, and rights, including the right to withdraw at any time. Confidentiality was maintained by anonymizing the data to protect participants' privacy. Participation was strictly voluntary, with no pressure or coercion involved. The researchers ensured that the study posed no harm to the participants, either physically or psychologically. Throughout the study, integrity and transparency were prioritized, ensuring that findings were reported accurately and without bias. These ethical guidelines were crucial in conducting responsible research and ensuring the welfare and rights of all participants.

RESULTS AND DISCUSSION

The Development of the Penny-wise Layer Feed Formulation PDA. After a series of iterations, the Penny-wise Layer Feed Formulation PDA was successfully developed. Figure 1 shows the application dashboard where users can select the layer chicken feed type based on age. The following numbers represent the aspects reflected in the app: (1) – These buttons redirect to the activities where users can formulate feed ingredients; (2) – The icon that gives more information about the feed; and, (3) - This is one of the options based on the chicken's age in weeks.

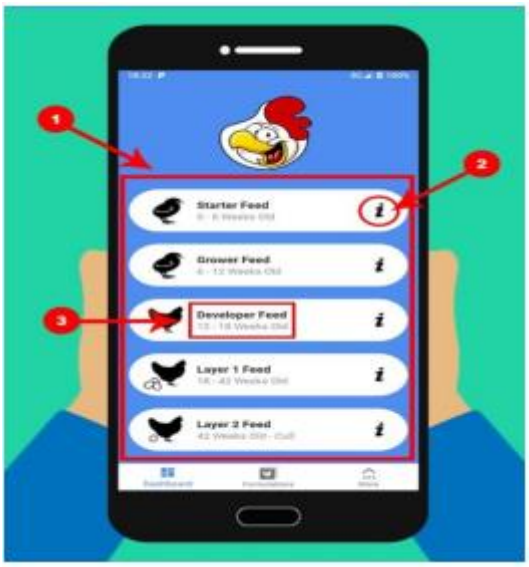

Figure 1
Application Dashboard

Figure 2 (a) shows the nutrient recommendation Menu where the user can select the layer chicken's nutrient recommendation based on age. (1) This button will be clicked so the user can select the recommendations based on the layer chicken's age. Figure 2 (b) shows the menu when clicking the "Select Nutrients Recommendation" button.

Figure 2 (a)
Nutrients Recommendation Menu

Figure 2 (b)
Nutrients Recommendation Menu

Figures 3 (a & b) show the ingredients menu, where the user can select the available ingredients in their area and create a mix of them.

Figure 3 (a)
Ingredients Menu

Figure 3 (b)
Ingredients Menu

(1) Represents the total number of ingredients needed. (2) Show or hide the Recommended Ingredients needed for the chosen age of layer chicken and the Results of the mixed ingredients. (3) Displays the recommended amount of nutrients for mixing the ingredients. (4) Displays the calculated values of nutrients after mixing up three types of ingredients. (5) Shows the list of ingredients. (6) Shows the button for adding or modifying the values of nutrients of each ingredient until the desired nutrients arrive. (7) A button to show or hide the box (7.1) that contains values of the elements, distribution, meal price (optional), and the value of each ingredient. (8) Shows the name of ingredients with a checkbox.

Figure 4 shows the Add Values Menu, where the user can add the appropriate amount of distribution and, if possible, the approximate price of the feed. (1) This is where the user enters the amount of distribution. (2) Displays the current total distribution. (3) This is where the user enters the price. It is optional. (4) Displays the total accumulation of the cost. Figure 5 shows the Save Data Menu, where the user can view and check the details of their mixed ingredients. (1) Displays the total calculated result of each element for the currently selected ingredients. (2) Displays the ingredients' respective values from distribution, price, elements, cost, and quantity needed. (3) Displays the overall quantity needed and the total accumulated cost. Once the recommended nutrients are reached, the user can save the recipe for future use.

Figure 4
Add Values Menu

Figure 5
Save Data Menu

Results of the Evaluation of the Newly Developed Penny-wise Layer Feed Formulation PDA. The evaluation results based on the respondents' responses are presented in Table 1.

Table 1

The evaluation results of the newly developed mobile application in terms of its functionality, usability, and maintainability

Software Product Quality Characteristics	BAT & BSA Students		CAF Instructors		IT Experts	
	$\bar{x}$	Description	$\bar{x}$	Description	$\bar{x}$	Description
1. Functionality	4.50	Very Much Functional	4.15	Very Much Functional	4.95	Very Much Functional
2. Usability	4.45	Very Much Usable	4.90	Very Much Usable	4.90	Very Much Usable
3. Reliability	4.50	Very Much Reliable	4.73	Very Much Reliable	5.00	Very Much Reliable
4. Maintainability	4.40	Very Much Maintainable	4.75	Very Much Maintainable	4.90	Very Much Maintainable

The results demonstrate that the Penny-wise Layer Feed Formulation PDA is highly effective across all assessed dimensions: functionality, usability, reliability, and maintainability. The application received high ratings, with an average weighted mean of 4.5 from students, 4.15 from CAF instructors, and 4.95 from IT experts for functionality. Usability scores were similarly high, with 4.45 from students and 4.9 from CAF instructors and IT experts. Reliability ratings reached 4.5 from students, 4.73 from CAF instructors, and a perfect five from IT experts, while maintainability was rated at 4.4, 4.75, and 4.9, respectively. These results indicate that the application effectively meets the needs of its diverse user base, providing a reliable, user-friendly tool that performs consistently and is easy to maintain. These findings are significant for the poultry farming industry. High functionality and reliability suggest that farmers can depend on the application to optimize feed formulations accurately, leading to enhanced productivity and reduced costs. The user-friendly design ensures the application is accessible to users with varying technical expertise, promoting widespread adoption. The application's maintainability indicates that it can evolve with future needs and technological advancements, ensuring its long-term viability. These positive evaluations suggest that the Penny-wise Layer Feed Formulation PDA can substantially benefit poultry farmers by simplifying feed formulation processes and improving the nutritional management of layer chickens.

Feed formulation applications have also shown significant potential in optimizing livestock nutrition and reducing farmers' costs. These tools utilize various programming methods to create balanced, least-cost rations tailored to specific animal requirements (Gupta, 2022; Oladokun & Johnson, 2012). Implementing such technologies can lead to improved sustainability in livestock production by enhancing precision in nutritional management (Liebe & White, 2019). A study on the BLRI FeedMaster app demonstrated its effectiveness in increasing milk yield, reducing feed quantity and costs, and minimizing the need for professional consultations (Kabir et al., 2022). This app proved particularly beneficial for farmers with limited economic and educational resources. Adopting feed formulation applications can result in substantial cost savings, with one study reporting a 9% reduction in feed formulation costs compared to traditional methods (Oladokun & Johnson, 2012). These findings suggest that farmers can rely on such applications to optimize feed formulations, potentially leading to enhanced productivity and reduced expenses.

Conclusions and Directions for Future Use. The study successfully developed and evaluated the Penny-wise Layer Feed Formulation PDA using the Rapid Application Development (RAD) model and ISO/IEC 25010:2011 software quality standards. The evaluation results indicated that the application is very much functional, usable, reliable, and maintainable. These findings demonstrate that the application effectively meets user needs, performs consistently, and can be easily maintained and updated. The positive reception of the application signifies a meaningful advancement in poultry farming practices, as it equips farmers with a reliable tool to enhance feed formulation accuracy, thereby optimizing nutritional management and contributing to the overall productivity of layer chickens. Moreover, this study highlights the potential for integrating modern software solutions into agricultural practices. By adopting this application, poultry farmers can

reduce feed formulation costs and improve their flocks' nutritional management, leading to better growth rates and egg production. However, the study has its limitations. The research was conducted within a specific educational setting, which may limit the generalizability of the findings to broader agricultural contexts. Future investigations could explore the application of similar technological advancements in other areas of agriculture, such as crop management or livestock health monitoring.

Additionally, further research can focus on expanding the application's features, incorporating machine learning algorithms for more precise feed recommendations, and assessing its long-term impact on productivity and cost-efficiency in various farming contexts. This study not only fulfills the need for a user-centered feed formulation tool but also contributes to the body of knowledge in agricultural technology by demonstrating the effective application of the RAD model in developing agricultural software. The positive reception by agricultural and IT experts suggests that interdisciplinary collaborations can further refine and enhance such tools, leading to broader improvements in agricultural efficiency and sustainability.

Contributions of Authors. The collaborative effort among the authors in developing the Penny-wise Layer Feed Formulation PDA has been instrumental in advancing agricultural technology. Author 1, the programmer, utilized Java and SQLite to implement critical functionalities, ensuring the application's technical reliability. Author 2, serving as the UI/UX designer, writer, and data gatherer, crafted intuitive interfaces, documented the development process, and gathered crucial user feedback. Author 3 played an important role as the software analyst, editor, and primary data analyst, bringing critical expertise to evaluating the application's performance and ensuring the integrity of the research findings. Author 4's supervision and editing ensured scholarly rigor and coherence in documenting the study's findings. Their collaborative efforts have enhanced technological solutions in agriculture and paved the way for future innovations in farming practices, emphasizing the importance of interdisciplinary teamwork in driving efficiency and sustainability in agriculture.

Funding. This work received no specific grant from any funding agency.

Conflict of Interests. The authors declare that there is no conflict of interest.

Acknowledgment. We gratefully acknowledge the invaluable contributions of individuals from Jose Rizal Memorial State University (JRMSU)-Katipunan Campus, who have played important roles in the success of this research. Special thanks to the College of Agriculture and Forestry instructors and students, whose participation and insights were integral to shaping the development and evaluation of the Penny-wise Layer Feed Formulation PDA. We extend our appreciation to the IT experts for their technical guidance and support. In particular, we express our deepest gratitude to Prof. Valerio Tugahan for his steadfast guidance and mentorship throughout the study. Their collective contributions have significantly advanced agricultural technology, highlighting the importance of collaborative efforts in research and innovation.

REFERENCES

Ardhiansyah, M. (2019). Penerapan model Rapid Application Development pada aplikasi Helpdesk Trouble Ticket PT. Satkomindo Mediyasa. *Jurnal Teknologi Sistem Informasi dan Aplikasi.*

Bailey, C. A. (2020). Precision poultry nutrition and feed formulation. *Journal of Applied Poultry Research, 29*(3), 700–710. https://doi.org/10.1016/j.japr.2020.06.002

Bouvarel, I., Nys, Y., & Lescoat, P. (2011). Hen nutrition for sustained egg quality. In *Improving the safety and quality of eggs and egg products* (pp. 261–299). Woodhead Publishing.

Chien, C. (2020, February 4). What is Rapid Application Development (RAD)? Retrieved October 10, 2021, from https://codebots.com/app-development/what-is-rapid-application-development-rad

Ehtesham, A., & Chowdhury, S. D. (2002). Responses of laying chickens to diets formulated by following different feeding standards. *Pakistan Journal of Nutrition, 1*, 127–131.

Gupta, R. (2022). An Insight on Feed Formulation for Livestock. *Corpus Journal of Dairy and Veterinary Science (CJDVS)*.

Helgi Library. (2021). Egg consumption per capita in the Philippines. Retrieved October 7, 2021, from https://www.helgilibrary.com/indicators/egg-consumption-per-capita/philippines/

Henuk, Y. L. (2003). Nutrient adjustments of the diets fed to cage and barn laying hens to decrease waste. *World's Poultry Science Journal, 59*(2), 245–254. https://doi.org/10.1079/WPS20040014

Kabir, M.A., Sultana, N., Al Noman, A., Jahangir Hossain, S.M., Miraz, M.F., & Deb, G.K. (2022). FeedMaster: A least-cost feed formulation App for minimizing the cost and maximizing milk yield. *Journal of Advanced Veterinary and Animal Research, 9*, 374 - 382.

Kariuki, I., Hong, S., Kang, S., Ngae, G. N., Kim, K., Nyaga, S., Mwangi, N., Kanyotu, A., & Nyaga, M. (2021). Increase in egg production in households using low-cost rations as feeds for indigenous chickens in Kenya. *Journal of the Korean Society of International Agriculture, 33*(4), 411–420. https://doi.org/10.7740/jksi.2021.33.4.411

Kasule, L., Katongole, C. B., Nambi-Kasozi, J., Lumu, R., Bareeba, F. B., Presto, M. H., Ivarsson, E., & Lindberg, J. E. (2014). Low nutritive quality of own-mixed chicken rations in Kampala City, Uganda. *Agronomy for Sustainable Development, 34*(3), 921–926. https://doi.org/10.1007/s13593-014-0205-6

Khan, M., Chowdhury, B., Bhuiyan, M., Uddin, M. J., Dawlatana, M., & Rahim, M. (2008). Nutrient content of poultry feed used in different poultry farms of Bangladesh. *Bangladesh Journal of Scientific and Industrial Research, 43*(1), 1–12.

Liebe, D.M., & White, R.R. (2019). Analytics in sustainable precision animal nutrition. *Animal Frontiers: The Review Magazine of Animal Agriculture, 9*, 16 - 24.

McCrea, B. (2018). Growing your own layer feed. *Chicken Whisperer.* Retrieved from https://www.chickenwhisperermagazine.com

Molnár, S., & Szőllősi, L. (2020). Sustainability and quality aspects of different table egg production systems: A literature review. *Sustainability, 12*(19), 7884. https://doi.org/10.3390/su12197884

Nalendra, A. K. (2021). Rapid Application Development (RAD) model method for creating an agricultural irrigation system based on the Internet of Things. *IOP Conference Series: Materials Science and Engineering, 1098,* 012043. https://doi.org/10.1088/1757-899X/1098/1/012043

Oladokun, V.O., & Johnson, A. (2012). Feed formulation problem in Nigerian poultry farms: a mathematical programming approach. *American Journal of Scientific and Industrial Research, 3*, 14-20.

Philippine National Standard Authority (P.S.A.N.). (2003). Philippine National Standard (PNS) on animal feed ingredients (4th ed., Vol. 53). Retrieved from https://members.wto.org/crnattachments/2015/SPS/PHL/14_2165_00_e.pdf

Shaker, A. A., Austin, S. F., Jørgensen, M. S., Sørensen, J. A., Bechmann, H., Kinnerup, H. E., Petersen, C. J., Olsen, R. K., & Simonsen, E.

(2023). Facilitating in-house mobile app development within psychiatric outpatient services for patients diagnosed with borderline personality disorder: Rapid Application Development approach. *JMIR Human Factors, 10*(1), e30628. https://doi.org/10.2196/30628