

Development of a Database Management System for a Municipal Agriculture Office in the Philippines

Danielle Gem Mora Mappatao, Diana Marie De Silva, Miguel Darwin Lapitan and Gabriel John De Leon

Department of Industrial Engineering
College of Engineering and Agro-Industrial Technology
University of the Philippines Los Baños, Philippines

dmmappatao@up.edu.ph, drdesilva1@up.edu.ph, mdlapitan@up.edu.ph, gldeleon@up.edu.ph

Abstract

Efficient agricultural data management is crucial for ensuring timely government support and improving the productivity of farming communities. In the Philippines, the Municipal Agriculture Office (MAO) of Peñablanca, Cagayan, depends on the Registry System for Basic Sectors in Agriculture (RSBSA). The limitations of RSBSA, including inaccuracies in records, delays in registration, and restricted system access, hinder the office's effective service delivery. This study developed and implemented a tailored Database Management System (DBMS) using Agile methodology to evaluate existing challenges, design a user-friendly DBMS, implement the system, and assess its usability and impact. The DBMS streamlined workflows, enhanced data accuracy, and reduced task completion times, such as decreasing farmer registration from 15 minutes to 5 minutes and validating beneficiary lists from six hours to seconds. Usability testing yielded a high Single Usability Metric (SUM) score of 86.19%, reflecting strong performance and user satisfaction. Key features included automated data validation, simplified beneficiary list generation, and efficient record updates, addressing critical challenges faced by the MAO. The developed system not only optimized operations but also strengthened the MAO's capacity to manage agricultural data and support local programs effectively, positioning it for continued refinement to meet evolving organizational needs.

Keywords

Agricultural data management system, Agile software development, Farmer registry system, Single Usability Metric, and Database management system

1. Introduction

Digital technologies play a critical role in transforming agricultural and industrial practices by enhancing efficiency, reducing production costs, ensuring product quality, and supporting more rational use of labor and resources. These advancements not only strengthen the competitiveness of enterprises but also drive growth and sustainability by minimizing operational losses (Nezamova O.A. and Olentsova J.A. 2018). In the agricultural sector, the effective management and utilization of data have become particularly crucial for development and informed decision-making within both national and local governments.

In the Philippines, the Registry System for Basic Sectors in Agriculture (RSBSA), implemented by the Department of Agriculture, serves as the primary database of farmers, fisherfolk, and farm workers nationwide (DA-10, 2023). As a centralized repository of farmer information, it is designed to enhance the targeting of agricultural support programs, improve transparency in resource distribution, and monitor the outcomes of interventions. Beyond its national role, the system has significant implications at the local level, where Municipal Agriculture Offices (MAOs) rely on accurate and accessible data to ensure effective program delivery.

As the frontline extension arm of the Department of Agriculture, the MAO plays a critical role in bridging national agricultural programs and the needs of local communities. In Peñablanca, Cagayan, the office supports farmers across 24 barangays, with rice and corn production as its primary focus (RA 7160 1991). It facilitates extension programs, administers government subsidies, and coordinates with the DA to promote sustainable agricultural practices. Through these responsibilities, the MAO contributes to strengthening agricultural resilience, ensuring efficient implementation of support programs, and fostering inclusive local development.

Despite the strategic importance of the RSBSA, several systemic challenges have been identified. Studies by Reyes and Gloria (2017) and Tiri (2022) highlight issues such as inaccurate records, delays in registration, and limited system accessibility. These shortcomings constrain the operations of MAOs, including that of Peñablanca, which depend on the RSBSA for critical functions such as farmer registration, subsidy distribution, and beneficiary validation. These national-level limitations are further compounded locally, where the MAO continues to rely heavily on manual processes in managing agricultural data.

In Peñablanca, the MAO’s current process of handling farmer information and validating beneficiary lists remains predominantly manual. Registration involves enumerators conducting one-on-one interviews with farmers—each typically lasting 10–15 minutes—recording their details by hand on printed forms, and later encoding this information into Excel files. These files serve as the office’s sole data repository. Similarly, the validation of beneficiary lists, which are generated by the RSBSA, requires staff to manually cross-reference and update records. This process is time-consuming, often taking an entire working day for four employees to verify lists of 2,000 to 5,000 farmers. Common errors include missing names, duplicate entries, incorrect barangay details, and records of deceased individuals. To illustrate these inefficiencies, Table 1 summarizes the most common data errors encountered by the MAO and their implications for subsidy eligibility. These interviews and record updates are conducted multiple times per year, particularly prior to each subsidy distribution cycle, which significantly increases the workload and contributes to delays and inefficiencies.

Table 1. Error description, beneficiary status equivalent, and error occurrences

Error	Description	Beneficiary Status	Error Occurrences
No Name	The farmer is not in the beneficiary list but is in the master list of the MAO.	Conditional	156
No Area	The farmer does not own any area as of the date of verification.	No	107
Deceased	The farmer is deceased	No	30
Wrong Name	The farmer’s name (first name, middle name, or last name) is misspelled	Yes	25
Area Conversion	The farmer converted their area to produce a different crop (e.g., from producing corn to producing rice)	No	10
Double Entry	Information about the farmer has duplicates in the beneficiary list	Conditional	7
Spouse	The wife or other family member in the household of a beneficiary	No	6
Wrong Address	The address of the farmer (barangay) is different from the masterlist	Yes	1
Area Transfer	The farmer listed in the beneficiary list transferred their area to another farmer	No	1

Overall, the large volume of data, combined with the manual and fragmented structure of verification and data entry, explains why the entire process requires a full working day to complete. The reliance on printed lists, manual referencing, and single-user input further exacerbates the inefficiency of the current system.

The necessity to maintain accurate and current records stems from the dynamic nature of the agricultural sector and the critical need for informed decision-making and efficient program implementation. Record updating precedes subsidy distribution to ensure impartiality and to maximize the number of eligible farmers benefiting from the

programs. The office conducts five distribution cycles annually: two for fertilizer, two for seeds, and one for financial aid. These cycles still do not include distributions from the local government unit of Peñablanca, other agencies, or calamity-driven allocations. Given the limited resources provided by the DA and other providers, specific criteria, such as farm area size, are considered for beneficiary selection. Additionally, the office imposes a household-based limit on each subsidy.

In the digital age, technology offers transformative solutions to address the challenges of data organization, retrieval, and analysis. A tailored Database Management System (DBMS) has emerged as a critical tool for streamlining and optimizing data management processes. Unlike the manual workflows currently in use, a DBMS can automate tasks such as data validation, record updates, and report generation, significantly reducing the time and effort required. By integrating the core functions of the RSBSA with additional features tailored to the MAO's operational needs, a custom DBMS can address the limitations of the existing system while providing a scalable foundation for future improvements.

1.1. Objectives

This study aimed to develop and implement a tailored DBMS for the MAO of Peñablanca, Cagayan, Philippines. The system was designed to manage collected data and verify beneficiary lists from the RSBSA. Specifically, this study sought to:

- Identify the challenges faced by the MAO of Peñablanca due to the limitations of the RSBSA;
- Design a reliable, streamlined, and user-friendly DBMS architecture;
- Develop a functional DBMS to meet identified needs; and
- Evaluate the potential impact of implementing the DBMS in the office.

2. Literature Review

2.1. Role of Database Management Systems in Agricultural Data Management

A Database Management System (DBMS) is a software system that enables users to define, create, and maintain databases. Beyond the software itself, a computerized DBMS also involves hardware resources and the active participation of users, all of which work together to ensure effective database management. Importantly, a DBMS carries out key functions that uphold the integrity and consistency of data, making it a vital tool in modern information systems (Mata-Toledo 2005).

Beyond simple record-keeping, DBMS allows users to tailor-make their databases, aligning with their specific needs and goals. The term "DBMS" encompasses not only the user but also the database and other application programs, establishing a seamless interface between data and software applications. This synergy underscores the indispensable role that DBMS play in contemporary data management and emphasizes its role as an integral component of information systems (Peterson 2023).

For the Municipal Agriculture Office (MAO) of Peñablanca, these capabilities are particularly critical. A DBMS provides a reliable and customizable solution for managing agricultural data, automating repetitive processes, generating accurate reports, and adapting to the evolving needs of the sector. By implementing a DBMS, the MAO can overcome inefficiencies tied to manual systems, enhance decision-making, and ultimately improve the delivery of agricultural services.

Recent usability-focused studies provide additional context for this work. De Leon et al. (2020a) examined the effects of page layout, user workload, and list structures on usability, while De Leon et al. (2020b) explored the influence of command buttons, entry fields, and graphics. Both studies demonstrated that careful integration of design factors can significantly enhance the Single Usability Metric (SUM) in digital platforms. More recently, Delos Reyes et al. (2024) developed a web-based Data Collection and Management System (DCMS) for a business process outsourcing provider, addressing similar issues of transcription errors, data cleaning time, and system reliability. The positive outcomes of these earlier studies informed the development of the tailored DBMS for the MAO, particularly in emphasizing usability-driven design choices that improve efficiency, accuracy, and user satisfaction.

2.2. The Registry System for Basic Sectors in Agriculture (RSBSA)

The RSBSA, launched in 2011, operates as an electronic compilation of basic information on farmers, farm laborers, and fishermen (Amante, 2016). The registry stores fundamental data about farmers, farm laborers, and fishermen,

such as names, birthdays, places of birth, educational level, conditional cash transfer (CCT) status, agrarian reform beneficiaries (ARB) status, kind of agricultural activity being done, characteristics of the farm parcel, ownership, crops grown, livestock and poultry tended, fishing activities done, ownership and type of fishing vessel, and aquaculture activities done. This comprehensive information serves as the basis for tailored activities and policies in agriculture and fisheries. Moreover, it is basic for distinguishing beneficiaries who will benefit from government-sponsored agricultural programs and services (Reyes & Gloria, 2017).

Despite its significance, several studies have identified recurring challenges in its implementation. Data accuracy remains a major concern, as the absence of thorough validation allows ineligible or incorrect entries. The lack of a clear operational definition of “farmer” has also caused confusion and inconsistent inclusion of beneficiaries. The timeliness of registration is another issue, with delays of up to several weeks limiting the prompt delivery of government assistance (Reyes and Gloria 2017; Tiri, 2022).

System integration and accessibility are equally problematic. The RSBSA has limited linkage with other government databases, and its restricted access to designated individuals often creates bottlenecks in data management. Furthermore, challenges related to land ownership and tenancy, such as underreporting of agrarian reform beneficiaries or disputes over the registration of owners and farm laborers, further complicate the system’s reliability (Reyes and Gloria 2017, Tiri 2022).

While these limitations persist, Reyes and Gloria (2017) and Tiri (2022) acknowledge the RSBSA’s value as a tool for agricultural development. Regular updating, clearer definitions, and improved accessibility have been recommended to maximize its effectiveness. These identified challenges closely reflect the experiences of the Municipal Agriculture Office (MAO) of Peñablanca, reinforcing the need for a tailored DBMS to enhance its RSBSA-related processes.

2.3. Existing DBMSs for Agriculture in the Philippines

In the Philippines, Database Management Systems (DBMSs) have played a transformative role in advancing agriculture. One notable example is the Registry System for Basic Sectors in Agriculture (RSBSA), which connects the Department of Agriculture (DA) directly with its beneficiaries—mainly farmers and fishers. It also serves as a reference database for identifying and managing the DA’s programs and projects, ensuring faster assistance delivery and more efficient implementation (Department of Agriculture, 2021).

Another key system is PalayStat, developed in 2014 by the Socioeconomics Division of the Philippine Rice Research Institute (PhilRice). PalayStat is a web-based platform that compiles data from the Rice-Based Farm Households Survey (RBFHS), conducted every five years. By making this data accessible, the system supports policymakers, researchers, and the public in making informed decisions (Zuniga, 2022).

The Philippine Rice Information System (PRISM), launched in 2014 through a partnership between the International Rice Research Institute (IRRI) and the DA, uses satellite imagery and advanced technology to monitor rice production. PRISM provides critical insights on rice seasonality, yields, and risks, contributing to food security in the Philippines and serving as a model for other countries in Southeast Asia (PRISM, 2014).

Together, these systems demonstrate how DBMSs improve agricultural practices by ensuring accurate data, supporting better decision-making, fostering collaboration, and enhancing efficiency. They highlight the vital role of technology in driving sustainable growth in the agricultural sector.

3. Methods

3.1. Study Design

This study adopted the Agile methodology for system development due to its iterative and flexible nature. Agile is particularly suitable for creating a functional DBMS tailored to the needs of the MAO of Peñablanca. The methodology allowed continuous feedback and adjustments throughout the development process, ensuring the system aligned closely with the evolving requirements of the MAO and its users. Key phases included requirement collection and documentation, system design, development, testing, evaluation, and preparation for launch. Figure 1 illustrates the Agile model used in this study, highlighting each phase of the DBMS development process. This structured,

iterative approach facilitated effective collaboration with stakeholders and positioned the DBMS for successful adoption upon completion.

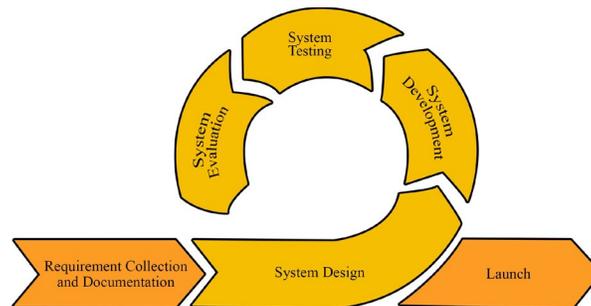


Figure 1. Agile model of the study.

3.2. System Development Process

1. **Requirement Collection and Documentation** - Information was gathered from the MAO of Peñablanca and the RSBSA through a review of the existing system and interviews with office staff. This phase identified challenges in current processes and established the requirements for building the DBMS.
2. **System Design** - A use-case diagram and an entity-relationship diagram (ERD) were created to visualize system functionality and database structure. These design tools helped identify potential flaws and enhanced understanding among stakeholders.
3. **System Development** - Design parameters were translated into functional software code. The researcher collaborated closely with programmers to ensure accurate implementation of the envisioned system.
4. **System Testing** - Usability testing was conducted with end-users to identify flaws and refine system functionality. The Single Usability Metric (SUM) was employed to standardize performance measurement, with scores below 50% indicating poor usability and scores above 50% reflecting strong performance (Pearson 2021). In this study, SUM was calculated by combining three metrics: user satisfaction, efficiency, and usability. A score above 50% indicates good usability, while a score below 50% suggests the system needs improvement.
5. **System Evaluation** - A focus group discussion (FGD) with MAO employees assessed whether the DBMS met its objectives and identified areas for improvement. Results from usability testing and the FGD informed further refinements.
6. **Launch** - The completed DBMS will be introduced to MAO staff. Although the system has not yet been deployed, its development demonstrates substantial potential to improve data management processes. Continuous refinements based on user feedback will support effective implementation and adoption.

In this study, the Agile methodology was specifically adopted to align each development phase with the research objectives. The Requirement Collection and Documentation phase addressed the first objective, which involved evaluating and describing the RSBSA. The System Design phase corresponded to the second objective by establishing a reliable, streamlined, and user-friendly DBMS architecture. The System Development phase focused on the third objective: developing a functional DBMS that met the identified needs. Finally, the System Testing and System Evaluation phases aligned with the fourth objective, which was to assess the impact of DBMS implementation within the office. This structured, objective-driven approach ensured a focused and efficient development process, laying the foundation for the successful deployment of a user-friendly and adaptable DBMS.

4. System Development

4.1. System Rationale and Needs Assessment

The development of a tailored DBMS for the MAO of Peñablanca was guided by interviews with seven employees, including the MAO staff and the RSBSA enumerator, all of whom are directly involved in managing RSBSA-related data. The discussions revealed that, while the MAO utilized the RSBSA for program targeting, the existing processes could have been more convenient. Staff had to depend on printed forms and Excel spreadsheets to record, store, and validate data, manually reviewing and correcting entries. This inefficient workflow caused significant delays and consumed considerable time. Feedback from the employees highlighted the need for a system that could automate repetitive tasks, enhance data accuracy, and provide real-time access to critical information. The study aimed to

address these challenges by proposing a system that streamlines workflows, automates repetitive tasks, and enhances data accuracy and accessibility.

4.2. System Design

The system design phase utilized a use-case diagram and an Entity-Relationship Diagram (ERD) to define DBMS functionality, user interactions, and database structure for the MAO of Peñablanca. Figure 2 illustrates the key functions of the DBMS and the interactions between MAO employees and enumerators. The system enables the registration of new farmers, access to the masterlist, and the updating or correction of farmer information. It also supports the uploading and validation of beneficiary lists, the generation of targeted beneficiary lists, and the production of reports.

MAO Employees manage most tasks, while Enumerators focus on farmer registration and updating records. Although role-based access control was planned to align permissions with responsibilities, it was not implemented due to time constraints. The system automates repetitive tasks, ensures data accuracy, and supports efficient program implementation.

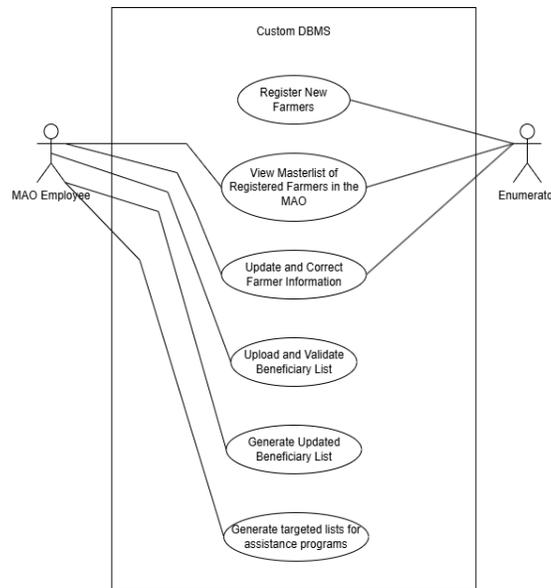


Figure 2. Use-case diagram of the custom DBMS

Figure 3 presents the database structure defining user roles and data flow across its key entities. Enumerators register farmers into the system, while MAO Employees manage the centralized Masterlist that organizes all farmer records, including details such as RSBSA number, name, barangay, and area size. The Masterlist, with attributes like masterlist_name and date_modified, serves as the foundation for generating targeted Beneficiary Lists based on criteria such as barangay or farm size. Externally uploaded Beneficiary Lists are validated against the Masterlist to ensure accuracy and consistency, and any discrepancies are documented in Reports. These reports, linked to the Beneficiary List, capture error types and counts, providing insights into validation outcomes and supporting efficient program implementation. These design elements ensure that the DBMS aligns with MAO workflows, streamlines processes, and supports accurate data management and targeted program delivery.

4.3. Design Development

The development of the DBMS was guided by the previously established use-case diagram and entity-relationship diagram. Using Visual Studio as the primary development environment and C# as the coding language, the system was built with a modular structure to address inefficiencies in manual processes and to streamline agricultural data management. Excel was integrated into the system to support data management and export processes, particularly for beneficiary and master lists.

The system's interface was designed for simplicity and clarity, featuring dropdown menus, structured data tables, and real-time validation to minimize errors. Modularity ensured each page served a specific function, allowing seamless navigation and efficient task completion. The interconnected modules enabled updates made in one section to reflect across the system in real-time, improving data accuracy and eliminating redundancy.

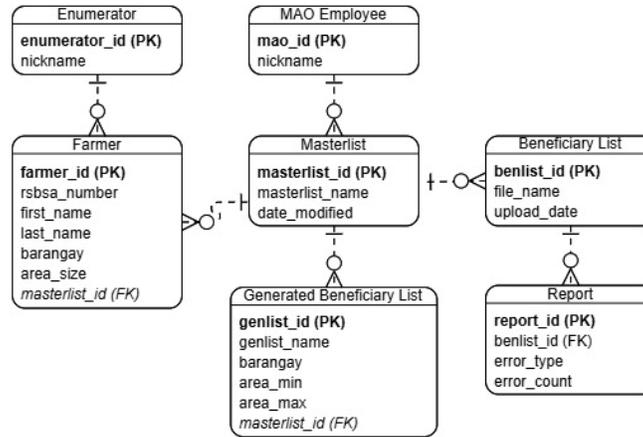


Figure 3. Entity Relationship Diagram of the DBMS

4.4. Key Functional Pages of the DBMS

The key functional pages of the Database Management System are shown in Figure 4.



Figure 4. Key functional pages of the DBMS

Homepage. Functions as the system's central interface, providing intuitive navigation to key features such as masterlist management, farmer registration, and beneficiary list review. Consistent design elements, such as a navigation bar and real-time time/date display, enhance usability and align with the MAO's operational needs.

Masterlist Overview Page. Provides a centralized view of registered farmers, with features like data filtering, editing, and exporting. Users can generate tailored lists based on specific criteria, improving efficiency in data management and decision-making.

Register Farmer Page. Digitizes the farmer registration process, replicating the RSBSA form for familiarity and ease of use. Features such as conditional fields, automated data population, and real-time updates streamline the registration workflow and ensure accuracy.

Beneficiary List Review Page. Focuses on validating and managing beneficiary lists by automating cross-referencing with master lists. Key functionalities include uploading lists, generating error reports, and exporting validated data for further use.

5. System Testing and Evaluation

5.1. Testing Process and Methodology

Usability testing was conducted to evaluate the functionality and performance of the custom DBMS. The testing involved seven participants out of the 21 employees of the MAO, composed of four Agricultural Technologists, one Agriculturist I, one Job Order staff, and one Enumerator assigned by the DA. They performed tasks aligned with the system's primary use cases: registering farmers, updating information, validating beneficiary lists, and generating reports. These participants were selected because they are the employees most directly engaged with the RSBSA and the distribution of subsidies, making them the most relevant users for system evaluation.

Dummy datasets, such as masterlists and beneficiary lists, were used during testing to simulate real-world scenarios while preserving the integrity of actual data. The dummy masterlist contained 100 farmers, compared to the actual RSBSA masterlist of around 2,000 records. This reduced size was chosen to allow tests to be repeated multiple times under controlled conditions and to facilitate easier observation of results. While the formal user tests did not use the full dataset, the system's ability to handle larger data was confirmed during development, where the actual masterlist of about 2,000 farmers was successfully loaded and can be viewed and edited with ease. Future evaluations may incorporate the complete dataset in user testing to validate scalability under real-world usage.

The usability testing employed the Single Usability Metric (SUM) to combine key usability factors: user satisfaction, efficiency, and overall usability. These metrics were assessed using tools such as Time on Task, the After-Scenario Questionnaire (ASQ), and the System Usability Scale (SUS). Additionally, qualitative feedback from participants provided valuable insights for refining the system. Participants were tasked with four core tasks: registering a farmer, updating farmer information, generating targeted lists, and validating beneficiary lists (as shown in Table 2). They captured their interactions using a screen recorder for detailed analysis. Instructions were delivered through Google Forms on a separate device, ensuring clarity and reducing errors during task execution.

Table 2. List of tasks performed for usability testing

Task	Description
1	Register a new farmer
2	Update farmer information
3	Generate a new targeted list
4	Validate beneficiary list

5.2. Usability Metrics and System Evaluation

This study employed three key usability metrics—user satisfaction, efficiency, and usability—to evaluate the performance of the DBMS. Each metric was assessed using specific tools, as outlined in Table 3, ensuring a comprehensive evaluation of the system's functionality and user experience.

Table 3. Usability metrics and their corresponding evaluation tools

Metric	Evaluation Tool
User Satisfaction	After-Scenario Questionnaire
Efficiency	Time on Task
Usability	System Usability Scale

User Satisfaction. The ASQ, developed by Lewis (1991), was used to assess the system's reliability and user satisfaction. The ASQ gathered feedback immediately after users completed a scenario, which consisted of related tasks simulating real-world conditions. This approach enabled the study to capture users' perceptions of the system's ability to support efficient task execution and meet their expectations for consistency and dependability. Key factors such as ease of task completion and overall satisfaction were evaluated to determine whether the system reliably facilitated user goals.

Efficiency. Efficiency was evaluated using the Time on Task (ToT) metric, which measured the duration users spent completing each scenario. The ToT benchmarks were based on current manual workflows and internal expectations. Specifically, Scenario 1 reflected the time required to record data on a printed form, while Scenario 4 represented the typical duration MAO staff needed to validate beneficiary lists. For Scenarios 2 and 3, benchmark times were obtained from programmer tests, which provided consistent reference points for comparison. However, this approach may not fully capture actual staff performance, as programmers generally complete tasks more quickly.

Recognizing this limitation, the study regarded the resulting efficiency scores as potentially optimistic due to the use of faster benchmark times. To assess the possible effect of more realistic staff performance, a sensitivity analysis was conducted in which benchmark values for Scenarios 2 and 3 were adjusted to be two and three times longer than those used in the study. Under the programmer-based benchmarks, the quality rate for efficiency was 95.59%, corresponding to a SUM score of 86.64%. When benchmark times were doubled, the efficiency decreased to 67.53% and the SUM to 77.29%; when tripled, efficiency dropped to 50.36% and the SUM to 71.57%.

These findings indicate that the efficiency scores reported in this study may be somewhat optimistic, as they are based on faster programmer benchmarks. Nevertheless, even when more conservative staff-based assumptions were applied, the resulting SUM scores remained well above the 50% threshold defined by Pearson (2021), which signifies good usability. This demonstrates that the DBMS maintains acceptable efficiency and usability levels across a range of realistic performance conditions (Table 4).

Table 4. Sensitivity analysis of efficiency scores using adjusted benchmark durations for scenarios 1 and 2.

Benchmark Assumption	Quality Rate of Efficiency	SUM
Programmer benchmarks (used in the study)	95.5915%	86.6439%
2× longer benchmark (estimated staff time)	67.5349%	77.2916%
3× longer benchmark (estimated staff time)	50.3640%	71.5680%

Usability. The SUS, introduced by Brooke (1996), was used to evaluate the system's overall usability. This widely recognized tool assessed aspects such as ease of navigation, accessibility, and satisfaction through a brief questionnaire. The SUS generated a usability score to highlight strengths and areas needing improvement, offering a reliable measure of the system's intuitiveness and user experience (Peres et al. 2013).

5.3. Single Usability Metric Analysis

The SUM was computed by averaging the standardized z-scores of the three usability metrics: user satisfaction, efficiency (time on task), and usability (SUS score). Following Sauro and Kindlund (2005a), each metric was equally weighted to yield the overall SUM. Higher SUM values indicate better usability.

The SUM Score Standardization Process Flow Diagram, as shown in Figure 5, outlines the procedure for calculating the SUM for the DBMS. The process begins with assessing three primary metrics across four usability testing tasks.

Each metric is standardized into a z-value to account for differences in scale, and these z-values are subsequently converted into percentage equivalents for comparability.

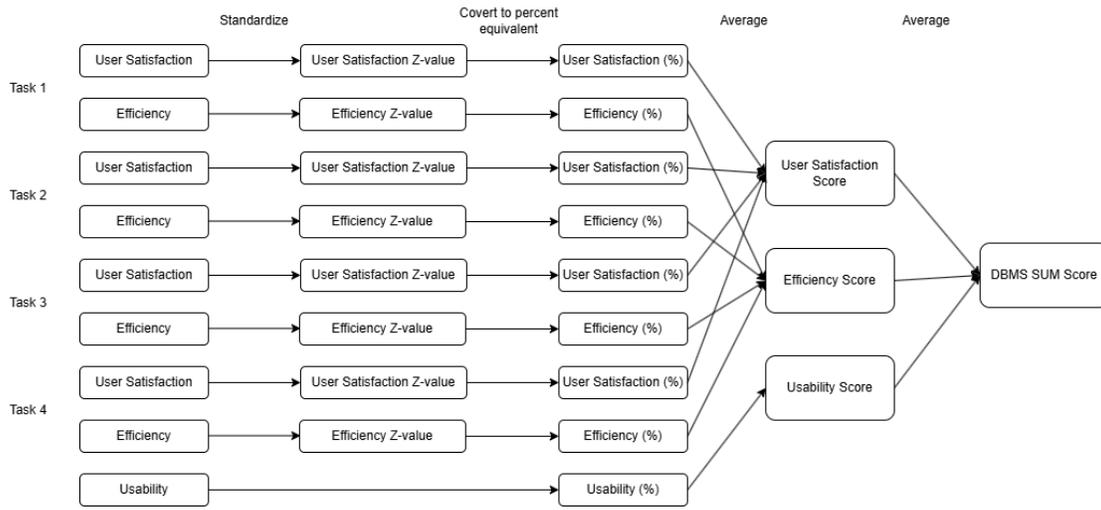


Figure 5. SUM score standardization process flow diagram.

The percentage scores for user satisfaction and efficiency are averaged across the four tasks to compute their respective scores. The usability score is directly calculated from the percentage equivalent of the SUS responses. Lastly, the scores for user satisfaction, efficiency, and usability are combined as a weighted average to produce the final DBMS SUM score. The results presented in Table 5 highlight the SUM evaluation of the DBMS across three key metrics: User Satisfaction, Efficiency, and Usability.

User Satisfaction, evaluated through the ASQ, achieved a quality rate of 75.4115% with a corresponding z-score of 0.6875. This result reflects a high level of user confidence and satisfaction in performing tasks, indicating the system's reliability in enabling users to complete their objectives effectively. The positive feedback suggests that users found the system dependable and adequately designed to meet their expectations.

Efficiency, assessed through task completion times, recorded a quality rate of 95.5915% with a z-score of 1.7051. This metric demonstrates that the system effectively streamlined processes, with task completion times either aligning with or outperforming the predefined benchmarks. The high efficiency score underscores the system's ability to reduce unnecessary steps, automate workflows, and optimize task execution.

Usability, measured using the SUS, achieved a quality rate of 88.9286% with a z-score of 1.2227. This high score confirms that users found the system intuitive and easy to navigate, reflecting its user-friendly design. The usability results indicate that the system successfully supports user interaction and navigation without causing frustration, aligning with the objectives of a well-designed DBMS.

The final SUM score, calculated as 86.6438%, demonstrates that the system surpassed the usability benchmark of 50%, as outlined in Section 3.2. This score reflects an overall positive evaluation of the system's reliability, efficiency, and user-friendliness.

Table 5. SUM of the DBMS.

Metric	Quality Rate	Z-score
User Satisfaction	75.4115%	0.6875
Efficiency	95.5915%	1.7051
Usability	88.9286%	1.2227
SUM	1.1097	
SUM (%)	86.6438%	

5.4. User Feedback and Experience Evaluation

Feedback from the FGD and ASQ indicated that the DBMS was effective, user-friendly, and significantly improved workflow efficiency. Users praised its simplicity, intuitive design, and time-saving features, particularly for RSBSA encoding and beneficiary list validation, which were previously labor-intensive. Tasks such as data entry, uploading lists, and retrieving information were faster and better organized, allowing staff to focus more on core responsibilities. Users consistently highlighted the system as “easy to follow” and efficient. The clear design and structured workflow minimized confusion and improved task completion speed. Pre-filled fields, duplicate detection, and streamlined report generation were cited as major contributors to productivity.

Usability issues included small text in forms, cumbersome numeric inputs, and checkboxes that allowed multiple selections. Navigation between fields could be smoother. Technical issues noted by the researcher included redundancy in updating farmer records, incomplete “YES” remarks in validated beneficiary lists, and inaccurate duplicate counts during validation. Users recommended improvements such as enhanced navigation, larger fonts, consolidated numeric inputs, integration of old and new data, backup memory, and potential voice command features to further increase efficiency. Overall, the DBMS reduced task durations, minimized errors, and enhanced data accuracy. Users emphasized that the system effectively replaced manual processes, enabling faster, more reliable management of agricultural data. Despite minor issues, its practicality, ease of use, and efficiency were widely recognized, and most users would recommend it, confirming the system’s success in achieving its primary objectives.

6. Conclusion

The Database Management System (DBMS) developed for the Municipal Agriculture Office (MAO) of Peñablanca significantly improved agricultural data management by addressing the inefficiencies of the Registry System for Basic Sectors in Agriculture (RSBSA). Farmer registration was reduced from 15 minutes using paper forms to about 5 minutes, while validating beneficiary lists, which previously required 6 hours, could now be completed in seconds. These time savings, coupled with features such as automated validation and direct record updates, ensured higher accuracy, reduced manual errors, and streamlined workflows across the municipality’s 24 barangays. The system’s usability was further validated by achieving a SUM score of 86.19%, surpassing the 50% benchmark for acceptable performance.

Despite these gains, future refinements remain important. Fixing redundant file creation and inaccurate duplicate counts will enhance reliability, while usability upgrades—such as auto-focus navigation, clearer input fields, and role-based access controls—can improve efficiency and security. In the long term, adding cloud-based backups and regular updates informed by user feedback will sustain the DBMS’s impact. Overall, the system not only met its objectives of improving accuracy, efficiency, and usability but also positioned the MAO to better deliver agricultural services. With ongoing enhancements, it can serve as a scalable model for other municipalities seeking to modernize their agricultural data management systems. This study demonstrates how industrial engineering tools and digital platforms can modernize agricultural data systems in developing contexts.

References

- Amante, J. N. R., Insight from a DBM junior leader RSBSA: How we finally put our farmers and fisherfolk on the map, *DBM*, Available: <https://www.dbm.gov.ph/wp-content/uploads/Executive%20Summary/2016/06%20Amante.pdf>, 2016.
- Brooke, J., SUS: A quick and dirty usability scale, DOI: <https://doi.org/10.1201/9781498710411-35>, 1996.
- DA-10, DA opens registry system for agri finder, *Philippine Information Agency*, Available: <https://mirror.pia.gov.ph/press-releases/2023/06/06/da-opens-registry-system-for-agri-finder>, 2023.
- De Leon, G. J., Gratuito, J. P. and Polancos, R. V., The impact of command buttons, entry fields, and graphics on single usability metric (SUM), *Proceedings of the International Conference on Industrial Engineering and Operations Management*, pp. 33-44, Dubai, UAE, March 10–12, 2020b.
- De Leon, G. J., Gratuito, J. P. and Polancos, R.V., The interactional effects of page layout, user workload, and lists in improving the single usability metric, *Proceedings of the International Conference on Industrial Engineering and Operations Management*, pp. 45-56, Dubai, UAE, March 10–12, 2020a.
- Delos Reyes, S. A., De Leon, G. J., Eusebio, M. L. and Revilla, J. A., Development of a web-based data collection and management system (DCMS) for the task collection process of a business process outsourcing (BPO) provider, *Proceedings of the 3rd Australian International Conference on Industrial Engineering and Operations Management*, pp. 288-299, Sydney, Australia, September 24–26, 2024.

- Department of Agriculture, Guidelines for the validation activity of the updating of the registry system for basic sectors in agriculture (RSBSA), *Department of Agriculture*, Available: https://www.da.gov.ph/wp-content/uploads/2021/09/mo55_s2021.pdf, 2021.
- Lewis, J. R., Psychometric evaluation of an after-scenario questionnaire for computer usability studies, *ACM SIGCHI Bulletin*, 23(1), 78–81, DOI: <https://doi.org/10.1145/122672.122692>, 1991.
- Mata-Toledo, R., Database Management Systems, *James Madison University, Harrisonburg, VA.*, DOI: <https://doi.org/10.1002/0471743984.vse2361>, October 14, 2005.
- Nezamova O. A. and Olentsova J.A., The main trends of digitalization in agriculture, *IOP Conf. Ser.: Earth Environ. Sci.* 981 032018, DOI: 10.1088/1755-1315/981/3/032018, 2022
- Pearson, C. J., The single usability metric (SUM) — A completion rate conundrum, *UX Collective*, Available: <https://uxdesign.cc/the-single-usability-metric-a-completion-rate-conundrum-c6fd0e5a54ca>, 2021.
- Peres, S. C., Pham, T. and Phillips, R., Validation of the system usability scale (SUS), *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 57(1), 192–196, DOI: <https://doi.org/10.1177/1541931213571043>, 2013.
- Peterson, R., What is DBMS (database management system)? Application, types & example, *Guru99*, Available: <https://www.guru99.com/what-is-dbms.html>, 2023.
- Republic Act No. 7160, *Official Gazette*, Available: <https://www.officialgazette.gov.ph/1991/10/10/republic-act-no-7160/>, 1991.
- Reyes, C. M. and Gloria, R. A. B., Evaluation of the registry system for basic sectors in agriculture, *PIDS*, Available: https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps1703_rev.pdf, 2017.
- Satellite rice monitoring: The Philippine rice information system (PRiSM), *CGIAR*, Available: <https://www.cgiar.org/innovations/satellite-rice-monitoring-the-philippine-rice-information-system-prism/>, 2014.
- Sauro, J., and Kindlund, E., A method to standardize usability metrics into a single score, *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 401–409, DOI: <https://doi.org/10.1145/1054972.1055028>, 2005.
- Tiri, M. G., Registry system for basic sectors in agriculture (RSBSA) in the municipality of Concepcion: An evaluation, *IJCRT.org*, Available: <https://ijcrt.org/papers/IJCRT2208435.pdf>, 2022.
- Zuniga, M. J., Rice data in a click, *Philippine Rice Research Institute*, Available: <https://www.philrice.gov.ph/rice-data-in-a-click/>, 2022.

Biographies

Danielle Gem Mora Mappatao is a recent graduate with a Bachelor of Science in Industrial Engineering from the University of the Philippines Los Baños. Her research interests include process optimization and data-driven decision-making. She is passionate in applying IE principles to improve efficiency and productivity in various sectors.

Diana Marie De Silva earned joint doctorate degrees of Ph. D. in Business Economics from KU Leuven and Ph. D. in Management Engineering and Real Estate Economics from the University of Padua. She has a degree of Master of Science in Finance and a Bachelor of Science in Industrial Engineering from the University of the Philippines where she is an Associate Professor at the Department of Industrial Engineering. Her main research areas are on interorganizational networks (i.e. alliances, collaborations, supply chains), systems design, and project management.

Miguel Darwin DC. Lapitan is an Instructor at the Department of Industrial Engineering, University of the Philippines Los Baños. He earned his BS in Industrial Engineering degree from the same university, magna cum laude, and received recognition for his participation in numerous local and international academic competitions. His research interests include mathematical modeling, systems simulation, and multi-objective and stochastic optimization.

Gabriel John De Leon is an Assistant Professor at the Department of Industrial Engineering, University of the Philippines Los Baños (UPLB). He earned a BS Industrial Engineering degree from the same university as the most outstanding student leader recognized with academic excellence, leadership, and service awards. He completed his master's degree at De La Salle University. His research interests include systems simulation, mathematical modeling, and platform usability. He currently leads a project on systems simulation to enhance operational efficiency and contributes to the development of various digital platforms that improve institutional processes.