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Article

# ENHANCING WILDLIFE CONSERVATION AND COMMUNITY RESILIENCE THROUGH AI-BASED BIODIVERSITY MONITORING AND SPATIAL ANALYSIS IN TROPICAL FOREST ECOSYSTEMS

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**Abstract:** The increasing demand for accurate and accessible biodiversity information has underscored the need for digital technologies that can strengthen wildlife monitoring and conservation initiatives. Responding to this need, this study developed a Digital Photo-Based Faunal Information System for Samar State University (SSU) that unifies artificial intelligence (AI)-supported species recognition, mobile-based field documentation, cloud computing, and Geographic Information System (GIS) technologies into a single biodiversity management platform. Using a developmental research framework, the system was iteratively designed and refined through the Agile software development methodology, encompassing planning, prototyping, implementation, testing, and evaluation. Its capabilities include digital image acquisition of faunal species, automated recording of geospatial and descriptive information, AI-assisted taxonomic identification, and spatial visualization of wildlife observations through an interactive GIS environment. System quality was assessed using the ISO/IEC 9126 software evaluation model, with performance ratings obtained from 60 end users. The evaluation confirmed that the application satisfied the established software quality criteria, achieving mean scores of 4.44 for functionality, 4.39 for usability, 4.32 for reliability, and 4.27 for efficiency. Beyond serving as a digital repository, the platform transforms fragmented biodiversity records into an integrated and searchable ecological database that improves species documentation, facilitates spatial assessment, and supports long-term environmental monitoring. The convergence of AI, GIS, cloud infrastructure, and mobile computing demonstrates the potential of intelligent digital systems to enhance institutional biodiversity management while informing conservation planning, environmental governance, and community resilience strategies for sustainable ecosystem stewardship.

**Keywords:** Artificial intelligence; Biodiversity monitoring; Wildlife conservation; Geographic Information System (GIS); Species identification; Biodiversity informatics; Tropical forest ecosystems; Community resilience.

# 1. INTRODUCTION

The growing emphasis on biodiversity conservation has heightened the need for reliable ecological information that can inform scientific research, environmental policy, and resource management. High-quality biodiversity records serve as the foundation for evaluating ecosystem conditions, tracking shifts in species occurrence, and generating evidence necessary for conservation planning and environmental decision-making (Magurran et al., 2018; Schmeller et al., 2017). Without systematic documentation, opportunities to detect ecological changes, identify species at risk, and formulate appropriate conservation interventions become considerably limited.

Recent developments in biodiversity informatics have expanded the availability of digital tools capable of improving how ecological information is collected, organized, and utilized. Nevertheless, many academic and research institutions continue to depend on disconnected recording methods and independently maintained datasets, resulting in duplicated records, inconsistent documentation standards, and limited accessibility for researchers and conservation practitioners (Tanalgo, 2025; Berba & Matias, 2022). These limitations reduce the long-term value of biodiversity information and hinder its application in environmental monitoring and institutional conservation initiatives. Recognizing these challenges, the present study developed and evaluated a Digital Photo-Based Faunal Information System for Samar State University (SSU). Rather than functioning solely as a digital repository, the system was envisioned as an integrated platform that supports biodiversity documentation through centralized data management, facilitating more efficient storage, retrieval, and utilization of faunal records. By strengthening institutional research capacity and providing a comprehensive biodiversity database, the system contributes to conservation planning while advancing the adoption of biodiversity informatics for more sustainable and evidence-driven environmental management practices (Gadelha et al., 2020; Magcale-Macandog et al., 2021).

Advances in digital technologies have reshaped biodiversity research by providing more efficient approaches to documenting, managing, and interpreting ecological information. Artificial intelligence (AI) has expanded the capacity for rapid and accurate species identification, minimizing the reliance on manual taxonomic expertise while improving the efficiency of biodiversity assessments (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018). At the same time, mobile applications have enabled standardized field-based data collection and immediate recording of ecological metadata, whereas cloud computing has strengthened data preservation, synchronization, and accessibility across multiple users and devices (Benateau et al., 2019; Wei, 2024). Complementing these technologies, Geographic Information Systems (GIS) facilitate the spatial visualization and analysis of biodiversity records, allowing researchers to examine species distributions, identify ecological hotspots, and better understand landscape-level patterns (Agduma et al., 2023).

Despite these technological advancements, their adoption remains uneven in many academic institutions, where biodiversity information is often managed through disconnected files and independently maintained records rather than integrated digital systems. This challenge is particularly relevant to Samar State University (SSU), where the absence of a standardized platform for recording, validating, and organizing faunal observations has limited the consistency, accessibility, and long-term value of biodiversity data. Such limitations reduce the institution's ability to generate dependable ecological evidence and constrain its contributions to conservation research and environmental decision-making (Tanalgo, 2025).

The need for a more systematic biodiversity management approach is especially significant given the ecological importance of Samar Island, which supports a remarkable concentration of endemic and threatened wildlife species (Patindol, 2016). Ensuring that biodiversity information is collected, organized, and analyzed through integrated digital technologies is therefore essential not only for strengthening institutional research capabilities but also for supporting conservation initiatives across one of the Philippines' most biologically significant regions. In this context, AI-enabled biodiversity informatics offers a practical framework for overcoming existing documentation and data management challenges while improving the quality and usability of ecological information.

Addressing the growing demand for technology-driven biodiversity management, this study developed a Digital Photo-Based Faunal Information System to modernize the documentation and monitoring of wildlife resources at Samar State University (SSU). The proposed platform combines artificial intelligence (AI), mobile computing, cloud-based information management, and Geographic Information System (GIS) technologies within a unified digital environment to streamline biodiversity data collection and analysis. Through this integration, the system enables field-based image capture, automatic generation of ecological metadata, AI-supported species recognition, centralized storage of biodiversity records, and interactive spatial visualization of georeferenced observations. Collectively, these capabilities are intended to strengthen the quality, accessibility, and management of faunal information while providing dependable ecological data to support research activities, conservation initiatives, and evidence-informed environmental planning.

**Objectives**

The study aimed to design, develop, and assess a Digital Photo-Based Faunal Information System that enhances institutional biodiversity documentation through the integration of artificial intelligence, mobile technologies, cloud computing, and GIS-based spatial analysis. Specifically, the study sought to:

1. design a mobile application capable of documenting faunal observations by capturing field images and automatically generating essential metadata, including geographic coordinates, date, and time;
2. incorporate an AI-powered species recognition component to facilitate accurate and efficient identification of recorded fauna;
3. establish a centralized cloud repository for the secure storage, organization, retrieval, and management of biodiversity information;
4. implement an interactive GIS module for mapping and visualizing georeferenced wildlife records to support spatial assessment and biodiversity monitoring; and
5. determine the software quality of the developed system based on the ISO/IEC 9126 standards, specifically in terms of functionality, usability, reliability, efficiency, maintainability, and portability.

## 2. METHODOLOGY

The study adopted a developmental research design to guide the creation and assessment of a Digital Photo-Based Faunal Information System for Samar State University (SSU). An Agile software development framework was employed to support iterative system refinement, allowing successive cycles of planning, interface design, application development, testing, implementation, and user feedback. This iterative approach ensured that modifications identified during each development cycle were incorporated before subsequent phases of the project.

System development was informed through a combination of literature synthesis, field observations, and stakeholder consultation. Biodiversity data were collected by documenting faunal species within the university grounds using smartphone devices, which generated both photographic records and associated field metadata. The completed application integrated several technologies to support its core functions, including React Native with Expo for cross-platform mobile development, Firebase for authentication and cloud-based database management, the Gemini API for AI-assisted species recognition, the iNaturalist API for taxonomic verification, and the Google Maps API for geospatial visualization of biodiversity records. Operationally, the application processed user-generated photographs and metadata through an input-process-output workflow that transformed field observations into organized, searchable, and georeferenced biodiversity information.

System quality was evaluated by sixty (60) purposively selected participants composed of students, faculty members, and individuals with sufficient information technology proficiency to assess software performance. Evaluation data were collected using a structured questionnaire adapted from the ISO/IEC 9126 software quality model, examining six software characteristics: functionality, usability, reliability, efficiency, maintainability, and portability.

Descriptive statistics were employed to summarize the evaluation results. Frequencies and percentages were used to describe the distribution of participant responses, while weighted mean values were computed to determine the overall level of system performance for each software quality attribute. The weighted mean was calculated using the standard formula:

$$WM = \frac{\sum(f \times w)}{N}$$

where f represents the frequency of each response, w denotes the assigned weight corresponding to the response category, and N refers to the total number of respondents. The resulting weighted mean values were interpreted according to the evaluation scale presented in Table 1.

**Table 1**. Interpretation of the responses from 60 system users.

| Weighted Mean | Interpretation |
|---|---|
| 4.21 – 5.00 | Strongly Agree |
| 3.41 – 4.20 | Agree |
| 2.61 – 3.40 | Neutral |
| 1.81 – 2.60 | Disagree |
| 1.00 – 1.80 | Strongly Disagree |

Throughout all stages of the investigation, ethical principles governing research involving human participants and wildlife observations were strictly observed. Participation in the evaluation was voluntary and preceded by informed consent, while respondent confidentiality and data privacy were maintained during data collection and analysis. Field documentation activities were likewise conducted using non-invasive procedures to ensure that wildlife species and their natural habitats were not disturbed.

# 3. RESULTS

***Overview of the System***

The developed Digital Photo-Based Faunal Information System establishes an integrated digital environment for managing biodiversity information at Samar State University (SSU). Rather than maintaining biodiversity records across isolated files and independently managed datasets, the platform consolidates field observations, species documentation, and administrative management into a unified information system. This integrated architecture promotes more consistent documentation practices while improving the availability and long-term management of ecological records. Such an approach reflects the growing role of biodiversity informatics in supporting standardized data management, broader accessibility, and sustainable preservation of biodiversity information (Gadelha et al., 2020; Wei, 2024)

The system operates through three interconnected components that collectively support the biodiversity documentation workflow. Field observations are conducted through a mobile application that enables users to photograph faunal species while automatically generating essential metadata, including geographic coordinates, date, and time of observation. Automating these processes minimizes manual data entry, reduces recording errors, and improves the consistency of biodiversity datasets, reinforcing the value of mobile technologies for ecological monitoring (Benateau et al., 2019). Similar digital approaches have likewise been identified as important in addressing persistent documentation challenges and strengthening biodiversity data collection initiatives within the Philippine setting (Berba & Matias, 2022).

Information collected from the field is transmitted to a centralized cloud infrastructure, where biodiversity records are securely stored, synchronized, and made available for subsequent retrieval and analysis. Complementing this data repository is a web-based administrative interface that facilitates user administration, record verification, and quality control procedures. Together, these components ensure that only validated observations are incorporated into the institutional biodiversity database while maintaining the scalability and accessibility expected of contemporary environmental information systems (Wei, 2024).

The development of this platform directly responds to continuing concerns regarding fragmented biodiversity documentation, inconsistent metadata practices, and limited access to ecological information in the Philippines (Tanalgo, 2025; Berba & Matias, 2022). By providing a centralized mechanism for recording, validating, and managing faunal observations, the system strengthens the reliability of biodiversity information and expands its usefulness for ecological research, conservation planning, and institutional environmental management.

Rather than serving solely as a repository for field observations, the platform functions as an intelligent biodiversity information system that converts ecological data into actionable knowledge. Photographs and accompanying metadata collected by users undergo automated processing, where artificial intelligence assists in species recognition before validated information is organized within a structured biodiversity database. The processed records are subsequently presented through searchable species profiles and geospatial visualizations, enabling more efficient interpretation of biodiversity patterns and supporting ecological assessment. The use of AI-driven image analysis has been shown to substantially improve both the speed and accuracy of species identification, making it possible to manage large volumes of biodiversity information with greater consistency than conventional manual approaches (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018). Similar findings have been reported in Philippine biodiversity applications, where AI technologies have enhanced taxonomic identification and streamlined ecological data processing (Tababa et al., 2022).

A defining characteristic of the developed platform is its interoperable system architecture, which extends functionality through the integration of multiple external Application Programming Interfaces (APIs). Image recognition is supported through the Gemini API, taxonomic verification is facilitated by the iNaturalist API, and spatial representation of biodiversity records is delivered using the Google Maps API. Rather than operating as isolated software components, these services function collectively to automate species identification, enrich biological information, and generate interactive geographic representations of wildlife observations. This modular architecture improves system flexibility, promotes interoperability, and allows future expansion without requiring major structural modifications.

The adoption of interconnected digital services reflects the broader direction of contemporary biodiversity informatics, where integrated platforms maximize the value of ecological datasets by improving information exchange, accessibility, and analytical capability (Sullivan et al., 2017; Magcale-Macandog et al., 2021). Within the Philippine context, initiatives such as MakiBIS have similarly demonstrated that centralized and interoperable biodiversity databases strengthen ecological information management while providing a more reliable foundation for conservation planning and environmental decision-making (Magcale-Macandog et al., 2021).

***Faunal Documentation Output***

The implementation of the Digital Photo-Based Faunal Information System resulted in the establishment of a comprehensive institutional repository of faunal observations at Samar State University (SSU). Through continuous field documentation, the platform generated biodiversity records representing multiple faunal groups, including avian species, insects, reptiles, and amphibians. More importantly, each observation was transformed into a standardized ecological record by consolidating taxonomic information, photographic evidence, geographic location, observation date and time, and habitat descriptions within a single digital entry. Such standardized datasets are fundamental to biodiversity informatics because they improve data consistency, facilitate information exchange, and enhance the reliability of ecological investigations conducted across different spatial and temporal scales (Gadelha et al., 2020; Berba & Matias, 2022).

Beyond documenting species occurrence, the system increased the analytical value of biodiversity information by integrating spatial and temporal attributes into every observation. The automatic recording of geographic coordinates enabled the spatial representation of species distributions, allowing biodiversity records to be examined in relation to habitat characteristics, ecological patterns, and areas of conservation importance. Likewise, incorporating chronological information through time-stamped observations provides opportunities to evaluate changes in species occurrence over extended periods, supporting investigations of seasonal dynamics, migration behavior, and ecological responses to environmental disturbances (Benateau et al., 2019; Agduma et al., 2023). Rather than functioning as isolated observations, individual records collectively become an ecological dataset capable of supporting long-term biodiversity assessment.

Another notable strength of the platform lies in its use of photographic documentation as an integral component of biodiversity recording. Digital images provide permanent visual evidence that can be independently verified by taxonomic specialists or processed through automated species recognition technologies, thereby strengthening the credibility of documented observations. Previous studies have shown that image-based biodiversity documentation reduces identification uncertainty, improves taxonomic validation, and increases the overall quality of ecological databases (Tripp et al., 2020; Norouzzadeh et al., 2018). This feature is particularly valuable in the Philippine context, where limitations in biodiversity documentation continue to affect the completeness and reliability of ecological information (Tanalgo, 2025).

Rather than producing a static collection of species records, the developed system establishes an evolving biodiversity knowledge base through real-time data acquisition and cloud-enabled information management. As additional observations are contributed, the database continuously expands, creating an increasingly robust foundation for biodiversity monitoring, ecological research, and conservation planning. The availability of an institutional baseline dataset strengthens the capacity to detect long-term ecological changes, monitor shifts in species populations, and generate scientific evidence that can inform resource management and conservation policies (Magcale-Macandog et al., 2021).

***Database Design and Functionality***

Effective biodiversity monitoring depends not only on accurate field observations but also on the ability to preserve, organize, and retrieve ecological information over time. Recognizing this requirement, the developed system employs a cloud-native data management architecture using Firebase Firestore, a NoSQL database designed to support dynamic and continuously expanding biodiversity datasets. Unlike conventional relational databases that rely on fixed table structures, the database accommodates heterogeneous ecological records with varying metadata requirements, making it well suited to biodiversity informatics where observation attributes frequently differ among species and field conditions (Gadelha et al., 2020).

A key advantage of this architecture is its capacity to maintain a synchronized repository that remains continuously accessible across multiple devices and user accounts. As biodiversity observations are submitted, records are immediately reflected within the centralized database, allowing administrators and authorized users to work with the most current information without requiring manual data consolidation. This real-time synchronization promotes consistency among users while strengthening collaborative data management, an essential characteristic of contemporary environmental information systems (Wei, 2024).

Beyond data storage, the platform was designed to support efficient information discovery and secure management of biodiversity records. Users can retrieve observations through searchable attributes such as taxonomic identity, geographic location, or observation date, enabling faster access to ecological information for research, monitoring, and conservation activities. Access to the database is likewise protected through authentication mechanisms that regulate user permissions and safeguard the integrity and confidentiality of stored information. These capabilities reflect established principles of dependable cloud-based information systems by balancing accessibility with data security (Pressman & Maxim, 2020).

Perhaps the most significant contribution of the cloud infrastructure lies in its long-term sustainability. As additional biodiversity observations are collected, the database can expand without requiring fundamental modifications to its underlying structure, ensuring that increasing data volumes remain manageable over time. This scalable architecture represents a substantial improvement over spreadsheet-based and decentralized recording practices, which frequently result in duplicated records, fragmented datasets, and difficulties in information sharing. By replacing these traditional approaches with an integrated digital repository, the system strengthens institutional biodiversity management while addressing persistent challenges related to data continuity, accessibility, and standardization that have been documented within the Philippine biodiversity landscape (Tanalgo, 2025).

Interoperability has become a defining characteristic of contemporary biodiversity information systems, allowing ecological data to be enriched, validated, and exchanged across multiple digital platforms. Consistent with this approach, the developed system was designed to communicate with external services through Application Programming Interfaces (APIs), enabling the automatic retrieval of complementary taxonomic information and AI-assisted species identification. Rather than relying exclusively on manually entered observations, the platform enhances user-submitted records by incorporating verified species data from resources such as iNaturalist together with intelligent image recognition technologies. This integration improves the completeness and credibility of biodiversity records while expanding their analytical value for ecological research and conservation initiatives. The adoption of interoperable digital services reflects current developments in biodiversity informatics, where interconnected platforms facilitate more efficient information exchange, broader accessibility, and stronger data-driven environmental analyses (Magcale-Macandog et al., 2021).

**Implications for Sustainable Environmental Management and Community Resilience**

***System Features***

The Digital Photo-Based Faunal Information System integrates multiple functionalities into a unified platform that streamlines biodiversity documentation and management. Its core features include secure user authentication, mobile-based image capture and upload, AI-assisted species identification, searchable species records, GIS-enabled spatial visualization, and an administrative interface for managing biodiversity data. Together, these components provide an efficient workflow that supports field data collection, record validation, and information retrieval within a single system. To ensure secure and reliable operation, the platform employs Firebase-based authentication, restricting system access to authorized users and safeguarding data integrity (Pressman & Maxim, 2020). Its mobile functionality enables real-time recording of faunal observations, allowing users to capture images directly in the field and minimizing delays and recording errors commonly associated with manual documentation. This approach supports current biodiversity monitoring practices that promote the use of mobile technologies to improve the efficiency and quality of ecological data collection (Benateau et al., 2019; Berba & Matias, 2022).

AI-assisted species identification serves as one of the system's primary functionalities, enabling the automatic recognition of faunal species from uploaded photographs. By reducing the need for manual taxonomic identification, the feature improves the speed, consistency, and scalability of biodiversity documentation, reflecting the effectiveness of machine learning and computer vision in ecological applications (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018).

The system also includes advanced search and filtering tools that allow biodiversity records to be retrieved using attributes such as species, taxonomic group, observation date, and geographic location. These functions improve data accessibility and support more efficient ecological assessment, biodiversity monitoring, and conservation planning.

The system presents detailed taxonomic and ecological information for every recorded species, allowing users to access comprehensive reference data alongside each observation. An interactive GIS interface complements these records by displaying species distributions spatially, making ecological patterns easier to examine and supporting biodiversity assessment and conservation planning (Agduma et al., 2023). Administrative tools maintain the quality of the database through record verification, user management, and routine system monitoring. Unlike existing biodiversity platforms developed for broad-scale applications, the proposed system addresses the localized documentation needs of Samar State University and the surrounding Samar Island ecosystems. The combination of mobile data collection, cloud-based storage, AI-assisted species identification, and GIS visualization establishes an integrated framework that supports efficient biodiversity monitoring while remaining practical for academic institutions and conservation initiatives with limited resources.

***GIS Visualization***

GIS functionality expands the system beyond species documentation by enabling the visualization and spatial analysis of biodiversity records. Every faunal observation is automatically geotagged and displayed on an interactive map through the Google Maps API, allowing users to examine the geographic distribution of recorded species. The availability of spatially referenced data strengthens ecological interpretation and supports more informed conservation planning, as geospatial information provides a clearer understanding of species occurrence and habitat patterns (Benateau et al., 2019). GIS has consequently become an essential component of biodiversity informatics, converting field observations into meaningful spatial information for research and environmental management.

The interactive GIS interface provides a spatial view of faunal observations across the university campus, allowing users to examine where species have been recorded. Visualizing these records on a map makes it easier to identify areas with relatively high species occurrences, offering valuable information for ecological assessment, habitat management, and conservation planning.

The mapped observations also support the evaluation of species distribution patterns, including habitat associations and species clustering, while providing insights into environmental factors that may influence faunal diversity. These spatial analyses strengthen ecological interpretation and contribute to evidence-based conservation initiatives. Similar applications of GIS have been recognized in the Philippines for identifying ecologically important areas and supporting biodiversity management strategies (Agduma et al., 2023).

The integration of temporal information with georeferenced observations allows the system to monitor biodiversity changes across both space and time. As new records are added, users can observe shifts in species distribution, seasonal variations, habitat use, and other emerging ecological patterns within the university campus. These capabilities strengthen long-term biodiversity monitoring and provide valuable evidence for assessing ecological change, human impacts, and climate-related influences on wildlife populations (Benateau et al., 2019).

Presenting biodiversity information through spatiotemporal visualization also improves the interpretation of ecological data. Researchers, institutional administrators, and other stakeholders can readily identify meaningful trends, supporting informed conservation decisions and more sustainable environmental resource management.

***System Evaluation***

The functionality of the developed system received a highly favorable evaluation, obtaining a composite mean of 4.44, which corresponds to a Strongly Agree rating **(Table 2).** This result indicates that respondents experienced the application as dependable in carrying out its intended operations, suggesting that the integration of AI-assisted identification and digital data management effectively supports biodiversity documentation. The positive assessment reinforces previous findings that intelligent biodiversity systems improve the accuracy and efficiency of ecological information processing (Gadelha et al., 2020).

**Table 2.** *Respondents' Evaluation of the System Functionality of the Digital Photo-Based Faunal Information System*

| Indicator | Weighted Mean | Interpretation |
|---|---|---|
| Accuracy of system outputs | 4.45 | Strongly Agree |
| Completeness of features | 4.38 | Strongly Agree |
| System performs required tasks | 4.50 | Strongly Agree |
| Composite Mean | 4.44 | Strongly Agree |

*Note.* The table presents the respondents' assessment of the system's functionality in terms of accuracy, completeness of features, and task performance using a 5-point Likert scale. Higher weighted mean values indicate higher perceived functionality.

**Table 3** indicates that the system obtained a Strongly Agree rating for usability, with a composite mean of 4.39. This finding suggests that users can readily adopt the application with minimal training, making it suitable for routine biodiversity documentation among students, researchers, and field personnel. A system that is easy to operate encourages consistent data collection and sustained user participation, both of which are essential for maintaining reliable biodiversity records. This observation supports the assertion of Laudon and Laudon (2021) that usability is a fundamental factor influencing the successful implementation of information systems.

**Table 3.** *Respondents' Evaluation of the System Usability of the Digital Photo-Based Faunal Information System*

| Indicator | Weighted Mean | Interpretation |
|---|---|---|
| Ease of use | 4.42 | Strongly Agree |
| User interface design | 4.36 | Strongly Agree |
| Learnability | 4.40 | Strongly Agree |
| Composite Mean | 4.39 | Strongly Agree |

*Note.* The table shows the respondents' evaluation of system usability, including ease of use, user interface design, and learnability, based on ISO/IEC 9126 software quality standards.

**Table 4** shows that the developed system received a Strongly Agree rating for reliability, with a composite mean of 4.32. The result reflects users' confidence in the system's ability to support uninterrupted biodiversity documentation without compromising the quality of recorded information. Stable system performance is particularly important in ecological monitoring, where dependable data serve as the foundation for research and conservation initiatives. This finding is consistent with Pressman and Maxim (2020), who emphasized reliability as a key attribute of high-quality software systems.

**Table 4.** *Respondents' Evaluation of the System Reliability of the Digital Photo-Based Faunal Information System*

| Indicator | Weighted Mean | Interpretation |
|---|---|---|
| System stability | 4.33 | Strongly Agree |

| | | |
|---|---|---|
| Error handling | 4.28 | Strongly Agree |
| Consistency of performance | 4.35 | Strongly Agree |
| Composite Mean | 4.32 | Strongly Agree |

*Note.* The table presents the respondents' assessment of system reliability in terms of stability, error handling, and consistency of performance. Weighted means were interpreted using the adopted Likert scale interpretation.

**Table 5** presents a composite mean of 4.27, corresponding to a Strongly Agree rating for efficiency. The findings indicate that the system is capable of supporting timely biodiversity documentation, allowing users to complete field-based tasks without unnecessary delays. Efficient processing and rapid access to information are particularly valuable in ecological data collection, where timely recording and retrieval of observations contribute to more effective monitoring and improved user productivity.

**Table 5.** *Respondents' Evaluation of the System Efficiency of the Digital Photo-Based Faunal Information System*

| Indicator | Weighted Mean | Interpretation |
|---|---|---|
| Response time | 4.30 | Strongly Agree |
| Processing speed | 4.27 | Strongly Agree |
| Resource utilization | 4.25 | Strongly Agree |
| Composite Mean | 4.27 | Strongly Agree |

*Note.* The table summarizes respondents' evaluation of the system efficiency, including response time, processing speed, and resource utilization. Higher scores indicate better system efficiency

**Table 6** shows that the system received a composite mean of 4.18, interpreted as Agree, for maintainability. Although the evaluation reflects a satisfactory level of maintainability, the relatively lower rating suggests that further refinements may improve the system's adaptability to future modifications and enhancements. Continuous maintenance and periodic updates remain essential to ensure that the application can accommodate evolving user requirements and technological developments over time.

**Table 6.** *Respondents' Evaluation of the System Maintainability of the Digital Photo-Based Faunal Information System*

| Indicator | Weighted Mean | Interpretation |
|---|---|---|
| Ease of updates | 4.20 | Agree |
| System adaptability | 4.18 | Agree |
| Code manageability | 4.15 | Agree |
| Composite Mean | 4.18 | Agree |

*Note.* The table presents respondents' assessment of the system maintainability in terms of ease of updates, adaptability, and code manageability. Results were interpreted based on the adopted weighted mean scale.

**Table 7** indicates that the system obtained a composite mean of 4.23, corresponding to a Strongly Agree rating for portability. The findings suggest that the application can be deployed and operated effectively on supported devices, allowing users to access its functionalities across different environments. Although the current implementation demonstrates satisfactory portability, extending support to additional operating systems could further improve the system's accessibility and broader adoption.

**Table 7.** *Respondents' Evaluation of the System Portability of the Digital Photo-Based Faunal Information System*

| Indicator | Weighted Mean | Interpretation |
|---|---|---|
| Compatibility across devices | 4.22 | Strongly Agree |
| Ease of deployment | 4.25 | Strongly Agree |
| System adaptability to environments | 4.21 | Strongly Agree |
| Composite Mean | 4.23 | Strongly Agree |

*Note.* The table shows the respondents' evaluation of the system portability, including compatibility across devices, ease of deployment, and adaptability to different environments.

**Table 8** presents an overall weighted mean of 4.31, interpreted as Strongly Agree, demonstrating that the developed system satisfies the established software quality standards. The consistently high ratings across the evaluated criteria indicate that the application is suitable for institutional biodiversity documentation and supports reliable ecological data management. While maintainability received the lowest assessment among the quality attributes, the result highlights opportunities for future system enhancement rather than a limitation in overall performance. These findings reinforce the value of digital biodiversity platforms in improving the organization, accessibility, and management of ecological information (Magcale-Macandog et al., 2021; Tanalgo, 2025).

**Table 8.** *Overall Evaluation of the Digital Photo-Based Faunal Information System Based on ISO/IEC 9126 Standards*

| Criteria | Composite Mean | Interpretation |
|---|---|---|
| Functionality | 4.44 | Strongly Agree |
| Usability | 4.39 | Strongly Agree |
| Reliability | 4.32 | Strongly Agree |
| Efficiency | 4.27 | Strongly Agree |
| Maintainability | 4.18 | Agree |
| Portability | 4.23 | Strongly Agree |
| Overall Mean | 4.31 | Strongly Agree |

*Note.* The table presents the overall evaluation results of the developed system across six software quality criteria: functionality, usability, reliability, efficiency, maintainability, and portability. The overall weighted mean reflects respondents' general acceptance of the system.

**Limitations of the Study**

The scope of the study was limited to selected areas within Samar State University (SSU), Catbalogan City, Samar, which may restrict the broader application of its biodiversity findings to other tropical forest ecosystems. Although the system incorporates AI-assisted species identification, its performance remains dependent on factors such as image quality and the complexity of the observed taxa. Future research may strengthen the system through expert taxonomic validation, expanded biodiversity datasets, and implementation across more diverse ecological settings to improve its accuracy, scalability, and wider conservation relevance.

## 4. DISCUSSION

The developed Digital Photo-Based Faunal Information System establishes a centralized digital platform for biodiversity documentation at Samar State University, integrating mobile technology, cloud computing, and a web-based management interface into a unified system. This architecture addresses the limitations of fragmented biodiversity records by improving data organization, accessibility, and long-term management, consistent with current developments in biodiversity informatics (Gadelha et al., 2020; Tanalgo, 2025).

The platform streamlines biodiversity documentation through automated metadata generation, AI-assisted species identification, and GIS-based visualization of georeferenced observations. Support from external services, including Gemini, iNaturalist, and Google Maps, strengthens species identification and spatial analysis, allowing users to examine distribution patterns and identify areas of ecological importance (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018; Benateau et al., 2019; Agduma et al., 2023).

Standardized biodiversity records containing photographic evidence, geographic coordinates, and temporal information improve the reliability and scientific value of ecological data. Combined with a cloud-based NoSQL database, the system provides secure storage, real-time synchronization, efficient information retrieval, and scalable data management, making it a practical tool for biodiversity research, environmental monitoring, and conservation planning (Tripp et al., 2020; Wei, 2024).

The overall evaluation yielded a weighted mean of 4.31, interpreted as Strongly Agree, demonstrating that the developed system satisfies the established software quality criteria. High ratings across functionality, usability, reliability, efficiency, and portability indicate that the platform is well suited for institutional biodiversity documentation, while the slightly lower assessment for maintainability highlights opportunities for future refinement. These findings are consistent with previous studies recognizing the effectiveness of digital technologies in strengthening biodiversity information management (Magcale-Macandog et al., 2021).

The implementation of the system provides a practical solution to the fragmented management of biodiversity records at Samar State University. AI-assisted species identification improves the efficiency of documenting faunal observations, cloud-based infrastructure ensures centralized and reliable data management, and GIS capabilities facilitate the analysis of species distributions and ecologically significant areas. Collectively, these technologies enhance ecological monitoring, strengthen conservation planning, and expand institutional research capacity.

Despite these positive outcomes, the system remains subject to certain limitations. Its performance depends on stable internet connectivity, while the accuracy of AI-assisted identification may vary according to image quality and the availability of reference data. Addressing these constraints through continuous system enhancement and database expansion may further improve the platform's effectiveness and long-term applicability.

# 5. CONCLUSION

The development of the Digital Photo-Based Faunal Information System demonstrates the potential of integrating mobile applications, artificial intelligence, cloud computing, and GIS into a single platform for biodiversity documentation. The resulting system provides a structured and dependable approach to managing faunal records, improving the collection, organization, and analysis of ecological information.

The findings highlight the value of intelligent digital technologies in strengthening institutional biodiversity monitoring while supporting conservation planning and evidence-based environmental management. Owing to its scalable architecture, the platform can be adopted or adapted by educational institutions, local government units, and conservation organizations seeking to modernize biodiversity information systems and promote sustainable resource management.

Further development may focus on expanding public participation through citizen science initiatives, improving AI performance using locally derived species datasets, connecting the platform with national biodiversity information systems, and incorporating predictive analytics to support future conservation strategies.

**Supplementary Materials**

The following supporting information can be downloaded

at: https://drive.google.com/drive/folders/1-lakbdweA494pPr7xFQGBJ_n0LtKwVnS

- **Figure S1:** System Architecture of the Digital Photo-Based Faunal Information System.
- **Figure S2:** Mobile Application Workflow for Faunal Data Collection.
- **Figure S3:** Web-Based Administrative Dashboard Interface.
- **Figure S4:** GIS-Based Visualization of Geotagged Faunal Observations.
- **Table S1:** Complete List of Documented Faunal Species and Associated Metadata.
- **Table S2:** Respondents' Individual Ratings for the ISO/IEC 9126 Software Quality Evaluation.
- **Table S3:** Functional Requirements and System Specifications.
- **Table S4:** Software and Application Programming Interfaces (APIs) Used in System Development.
- **Dataset S1:** Biodiversity Observation Dataset Used for System Testing (anonymized).
- **Dataset S2:** Raw Evaluation Data from the ISO/IEC 9126 User Assessment.

- **File S1:** User Manual for the Digital Photo-Based Faunal Information System.

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**Institutional Review Board Statement**

The study complied with the principles of the Declaration of Helsinki and received ethical approval from the Samar State University Institutional Human Research Ethics Committee (SSU-IHREC) under Protocol Code 2026-0022-I on 23 February 2026, before data collection commenced.

**Data Availability Statement**

The datasets generated during this study are available from the corresponding author upon reasonable request. Public access is restricted to protect sensitive biodiversity location data and participant confidentiality.

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**Conflict of Interest**

The authors declare no financial, personal, professional, or institutional conflicts of interest related to this study.

**Declaration of Generative AI and AI-Assisted Technologies**

The authors used ChatGPT (OpenAI) and Gemini AI to assist with language editing, manuscript organization, and preliminary species identification. All AI-generated outputs were carefully reviewed and revised, and the authors assume full responsibility for the final content of the manuscript.

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