AI-ASSISTED BIODIVERSITY MONITORING AND SPATIAL ASSESSMENT FOR SUSTAINABLE WILDLIFE CONSERVATION AND COMMUNITY RESILIENCE IN TROPICAL FOREST ECOSYSTEMS

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Abstract

Biodiversity documentation is essential for ecological monitoring, conservation planning, and environmental management. However, Samar State University (SSU) currently lacks a centralized and structured system for documenting faunal species, resulting in fragmented, inconsistent, and inaccessible biodiversity records. This study aimed to design and develop a Digital Photo-Based Faunal Information System that integrates mobile data collection, artificial intelligence-assisted species identification, cloud-based storage, and Geographic Information System (GIS) visualization. The study employed a developmental research design using Agile methodology, involving planning, design, development, testing, and evaluation phases. Data were collected through field observations, system implementation, and user evaluation using a structured questionnaire based on ISO/IEC 9126 software quality standards. The developed system enables users to capture faunal images, automatically record metadata, identify species using AI, and visualize geotagged observations on an interactive map. Evaluation results from 60 system users indicated high system performance, with composite mean scores of 4.44 (functionality), 4.39 (usability), 4.32 (reliability), and 4.27 (efficiency). The findings demonstrate that the system effectively improves biodiversity documentation, data accessibility, and ecological analysis. The system supports evidence-based conservation planning, environmental governance, and community resilience by providing accessible ecological information for sustainable resource management and decision-making. Integrating mobile computing, AI, GIS, and cloud technologies provide a scalable and reliable solution for institutional biodiversity management and conservation.

Keywords: biodiversity monitoring, artificial intelligence, GIS, mobile application, cloud database, faunal monitoring.

INTRODUCTION

Biodiversity documentation plays a critical role in understanding ecological systems, monitoring species distribution, and supporting conservation planning. Accurate and well-organized records provide essential data for analyzing ecosystem health, detecting environmental changes, and guiding evidence-based decision-making (Magurran et al., 2018; Schmeller et al., 2017). Reliable biodiversity data are fundamental in identifying threatened species, assessing habitat conditions, and developing effective conservation strategies.

However, despite technological advancements, many institutions still rely on fragmented and informal data recording practices, which limit data consistency, accessibility, and long-term usability (Jauregui et al., 2022; Berba & Matias, 2022). Hence, the purpose of the study was to design, develop, and evaluate a Digital Photo-Based Faunal Information System for SSU to address the absence of a centralized and organized biodiversity documentation system. This is significant as it enhances research capability, supports conservation planning, and provides a centralized biodiversity database for the university community. It may contribute to strengthening institutional biodiversity monitoring and aligns with current advancements in biodiversity informatics, promoting more sustainable and evidence-based environmental management practices (Gadelha et al., 2018; Magcale-Macandog et al., 2021).

Samar Island is recognized as one of the most biologically important regions in the Philippines, hosting a high diversity of endemic and threatened species (Amoroso et al., 2020). Despite this richness, faunal documentation remains incomplete and inconsistent across the region. At SSU, biodiversity data are scattered across personal devices and unstructured digital files, with no standardized system for data recording, validation, or management. This lack of a centralized platform limits data reliability, accessibility, and usability for research and conservation, thereby constraining the university's capacity to generate accurate ecological insights and support environmental decision-making (Jauregui et al., 2022).

Recent developments in artificial intelligence (AI), mobile computing, cloud storage, and GIS have significantly transformed biodiversity documentation. AI enables automated species identification with improved speed and accuracy, reducing dependence on expert taxonomists (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018). Mobile technologies facilitate real-time data collection and standardized metadata recording in field settings (Allan et al., 2019), while cloud-based platforms enhance data storage, synchronization, and accessibility across users and devices (Elmendorf et al., 2016). Furthermore, GIS supports spatial analysis and visualization of species distribution, enabling the identification of biodiversity hotspots and ecological patterns (Dela Cruz et al., 2023). AI-based technologies can be a mechanism for addressing existing limitations in biodiversity data management.

In response to the increasing need for effective biodiversity management in the Philippines, this study sought to develop a Digital Photo-Based Faunal Information System that integrates AI, mobile data acquisition, cloud computing, and GIS technologies to strengthen biodiversity documentation at SSU. The proposed system was designed to facilitate the capture of faunal images, automate the generation and storage of species metadata, support AI-assisted species identification, and present georeferenced observations through an interactive GIS-based visualization platform. The system was expected to improve the accuracy, consistency, accessibility, and efficiency of biodiversity information management, which could help provide reliable ecological data to support research, conservation planning, and environmental decision-making.

Objectives

This study designed and developed a Digital Photo-Based Faunal Information System that integrates artificial intelligence, mobile data collection, cloud-based storage, and GIS visualization to improve biodiversity documentation, monitoring, and conservation management at SSU.

1. To develop a mobile-based system capable of capturing faunal images and automatically recording metadata such as date, time, and geographic location.
2. To integrate AI-assisted species identification for accurate and efficient recognition of faunal species.
3. To create a centralized cloud-based database for storing, organizing, and managing biodiversity records.
4. To develop a GIS-based visualization feature that maps geotagged faunal observations for spatial analysis and biodiversity monitoring.
5. To evaluate the developed system in terms of functionality, usability, reliability, efficiency, maintainability, and portability using ISO/IEC 9126 software quality standards.

METHODOLOGY

A Developmental Research Design was adapted using Agile methodology to design and develop a Digital Photo-Based Faunal Information System for SSU. The approach allowed iterative development through planning, design, testing, implementation, and evaluation to ensure system effectiveness.

Data were collected through literature review, field observation, and user consultation. Faunal images were captured using smartphones within the university premises, while system evaluation was conducted using a structured questionnaire based on ISO/IEC 9126, measuring efficiency, functionality, usability, reliability, maintainability, and portability. A total of 60 purposively selected respondents, including students, faculty, and IT-literate individuals, participated in the evaluation.

The system was developed using React Native and Expo for mobile application development, Firebase for authentication and cloud storage, Gemini API for AI-based species identification, iNaturalist API for taxonomic data, and Google Maps API for spatial visualization. Data processing followed an input-process-output framework, where user-submitted images and metadata were analyzed, stored, and presented as structured biodiversity records.

Statistical analysis utilized frequency, percentage, and weighted mean to evaluate system performance. Ethical considerations, including informed consent, confidentiality, data privacy, and non-invasive wildlife observation, were strictly observed throughout the study.

To evaluate the performance of the developed Digital Photo-Based Faunal Information System, data gathered from sixty (60) respondents were analyzed using frequency, percentage, and weighted mean (WM). The evaluation followed the ISO/IEC software quality model, focusing on functionality, usability, reliability, efficiency, maintainability, and portability. The weighted mean was computed using the formula:

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

where f represents the frequency of responses, w is the assigned weight, and N is the total number of respondents. The rating from users was interpreted using the **Table 1** below.

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

RESULTS

Overview of the System

The Digital Photo-Based Faunal Information System was successfully designed and developed to address the absence of a centralized and structured biodiversity documentation platform at Samar State University. The system integrates a mobile-based data collection interface, a web-based administrative platform, and a cloud-based database, thereby enabling real-time storage, retrieval, and visualization of faunal records. This approach is consistent with current developments in biodiversity informatics, where digital platforms enhance data accessibility, standardization, and long-term storage (Gadelha et al., 2018; Elmendorf et al., 2016).

In the Philippine context, the need for centralized and structured biodiversity databases has been emphasized due to persistent gaps in data coverage, metadata consistency, and accessibility (Jauregui et al., 2022; Berba & Matias, 2022). The platform was expected to significantly improve data organization, reliability, and usability for research and conservation purposes.

The mobile component of the system enables field observers to capture faunal images and automatically record associated metadata such as geographic coordinates, date, and time. This method aligns with the increasing adoption of mobile technologies in ecological data collection, which improve efficiency and reduce human error in biodiversity documentation (Allan et al., 2019). Locally, similar approaches have been recognized as essential in addressing inconsistencies in biodiversity recording and improving field-based data collection practices in the Philippines (Berba & Matias, 2022).

Meanwhile, the web-based administrative platform supports data validation, user management, and monitoring, ensuring that only verified and high-quality data are stored. The use of a cloud-based database further enhances system performance through real-time synchronization, secure storage, and scalability, which are critical features of modern biodiversity information systems (Elmendorf et al., 2016).

Furthermore, the system transforms raw field data into meaningful biodiversity information. User inputs such as images and metadata are processed through AI-assisted species identification and structured database management, producing organized outputs including species records and spatial visualizations. The integration of AI advancements in image-based species identification significantly improves accuracy and efficiency in processing large ecological datasets (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018). Local studies also support the application of AI in biodiversity systems, demonstrating its effectiveness in improving species identification accuracy and data processing within Philippine contexts (Tababa et al., 2022). This reduces reliance on manual identification and enhances the scalability of biodiversity documentation systems.

The integration of external Application Programming Interfaces (APIs) including Gemini for image recognition, iNaturalist for taxonomic data retrieval, and Google Maps for geospatial visualization—enables automated identification and spatial mapping of faunal observations. This API integration demonstrates a functional, modular, and scalable system architecture that supports interoperability. Similar approaches have been employed in global and local biodiversity platforms, where interconnected systems enhance data richness, accessibility, and usability (Sullivan et al., 2017; Magcale-Macandog et al., 2021). In the Philippines, systems such as MakiBIS highlight the importance of centralized and integrated biodiversity databases for improving ecological data management and supporting conservation initiatives (Magcale-Macandog et al., 2021).

Faunal Documentation Output

The developed Digital Photo-Based Faunal Information System successfully documented a diverse range of faunal species within selected areas of SSU, including birds, insects, reptiles, and amphibians. Each recorded observation contains comprehensive and standardized information, such as captured images, scientific and common names, taxonomic classification, date and time of observation, GPS coordinates, and habitat description. The inclusion of these key data elements ensures that each record is not only descriptive but also scientifically valid and usable for ecological analysis. Standardized biodiversity records are essential in ensuring consistency, comparability, and reliability of ecological data, particularly in institutional and localized biodiversity monitoring systems (Gadelha et al., 2018; Berba & Matias, 2022).

The integration of geotagged and time-stamped data significantly enhances the scientific value of each observation by enabling spatial and temporal analysis of species distribution. Georeferenced data allow researchers to map species occurrences, identify biodiversity hotspots, and monitor ecological changes over time, which are critical components of conservation planning and environmental management (Allan et al., 2019; Dela Cruz et al., 2023). Additionally, time-stamped records support longitudinal studies by providing chronological evidence of species presence, which is essential in detecting seasonal patterns, migration trends, and potential impacts of environmental changes.

Furthermore, the use of photo-based documentation strengthens the accuracy and traceability of biodiversity records. Captured images serve as verifiable evidence of species observations, reducing ambiguity and enabling validation by experts or through automated identification systems. In previous studies, mage-based biodiversity documentation improves reliability, minimizes identification errors, and facilitates data verification (Tripp et al., 2020; Norouzzadeh et al., 2018). In the Philippine context, where biodiversity data gaps and inconsistencies remain a challenge, incorporating photographic evidence contributes to improving the quality and credibility of ecological datasets (Jauregui et al., 2022).

Furthermore, the system supports the continuous accumulation of biodiversity data through real-time data entry and cloud-based storage. This capability allows the creation of a dynamic and growing database that serves as a baseline for future ecological studies, species monitoring, and conservation initiatives. Establishing such baseline datasets is crucial for understanding long-term ecological trends, assessing species population changes, and informing evidence-based decision-making (Magcale-Macandog et al., 2021).

Database Design and Functionality

The system utilizes a cloud-based NoSQL database, specifically Firebase Firestore, to store and manage structured biodiversity data efficiently. This database design supports a flexible schema, allowing the system to accommodate diverse and evolving biodiversity records without the rigid constraints of traditional relational databases. Such flexibility is particularly important in ecological data management, where data structures may vary depending on species type, observation context, and metadata requirements (Gadelha et al., 2018). In addition, the system enables real-time synchronization across devices, ensuring that newly uploaded records are instantly available to users and administrators. This feature enhances collaboration and data consistency, which are critical in modern biodiversity information systems (Elmendorf et al., 2016).

The database supports efficient querying and retrieval of species data, allowing users to quickly access specific records based on attributes such as species name, location, or date of observation. This improves the usability and analytical potential of the system, particularly for research and monitoring purposes. The incorporation of secure storage mechanisms, including authentication protocols, further ensures data privacy and integrity by restricting access to authorized users only. These features collectively contribute to a robust and reliable data management system that aligns with best practices in cloud-based information systems (Pressman & Maxim, 2020).

The use of a cloud-based NoSQL database also ensures scalability and adaptability, enabling the system to handle increasing volumes of biodiversity data as more observations are collected over time. Unlike traditional spreadsheet-based recording methods, which are prone to data fragmentation, redundancy, and limited accessibility, the developed system significantly enhances data organization, centralization, and long-term preservation. This transition from manual or semi-structured recording to a centralized digital platform addresses common challenges in biodiversity data management, particularly in the Philippine context where data gaps and inconsistencies persist (Jauregui et al., 2022).

Furthermore, the database is designed to integrate seamlessly with external APIs, enabling automatic enrichment of species data through connections with platforms such as iNaturalist and AI-based identification tools. This capability enhances the completeness and accuracy of biodiversity records by supplementing user-generated data with verified taxonomic information. Such integration reflects the growing emphasis on interoperability in biodiversity informatics, where interconnected systems improve data sharing, accessibility, and analytical capability (Magcale-Macandog et al., 2021).

Implications for Sustainable Environmental Management and Community Resilience

System Features

The developed system incorporates several key features that collectively enhance both functionality and user experience. These include user authentication through a Firebase-based login system, mobile-enabled image upload and capture, AI-assisted species identification, search and filter functions, species information display, a GIS-based mapping interface, and an administrative data management panel. The inclusion of secure user authentication ensures that access to the system is restricted to authorized users, thereby protecting data integrity and privacy, which are critical components of modern information systems (Pressman & Maxim, 2020). The mobile integration for image capture and upload allows field observers to document fauna in real time, supporting efficient and accurate data collection in natural environments. This aligns with current practices in biodiversity monitoring, where mobile technologies facilitate rapid data acquisition and improve documentation efficiency (Allan et al., 2019; Berba & Matias, 2022).

A key component of the proposed system is its AI-assisted species identification capability, which automates the recognition of faunal species from uploaded images. This functionality minimizes dependence on expert taxonomists, which then helps in addressing a major constraint in biodiversity documentation, particularly the limited availability of specialized taxonomic expertise. Advances in machine learning and computer vision have demonstrated high levels of accuracy in automated species identification, substantially improving the efficiency, consistency, and scalability of biodiversity data processing (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018). Furthermore, the system incorporates advanced search and filtering functionalities that enable users to efficiently retrieve and analyze biodiversity records using multiple criteria, including species name, geographic location, date of observation, and taxonomic classification. These capabilities enhance data accessibility and facilitate more efficient ecological analyses, long-term biodiversity monitoring, and evidence-based conservation decision-making.

The species information display feature provides users with detailed taxonomic and ecological data, enriching the overall value of each observation. Meanwhile, the GIS-based mapping interface allows users to visualize the spatial distribution of faunal records, supporting ecological analysis and conservation planning. The importance of integrating GIS in biodiversity systems has been widely recognized, as it enables spatial analysis and improves understanding of species distribution patterns (Dela Cruz et al., 2023). The administrative data management panel further strengthens the system by allowing administrators to validate data, manage users, and oversee system operations, ensuring data quality and system reliability.

While several biodiversity monitoring platforms exist globally, the developed system represents one of the first institution-based AI-assisted biodiversity documentation systems designed specifically for localized biodiversity assessment within Samar Island ecosystems. The integration of mobile computing, cloud databases, AI-assisted species recognition, and GIS visualization into a unified platform provides a practical and scalable framework for biodiversity monitoring in resource-limited academic institutions and conservation areas.

GIS Visualization

One of the major contributions of the developed system is the integration of GIS functionality, which enables the spatial representation and analysis of biodiversity data. All faunal records collected through the system are geotagged and visualized on an interactive map using the Google Maps API, allowing users to view the precise locations of species observations. The incorporation of geospatial data enhances the scientific value of biodiversity records by linking species occurrences to precise geographic coordinates, enabling more accurate spatial analysis, ecological interpretation, and informed conservation decision-making (Allan et al., 2019). In biodiversity informatics, the integration of GIS is widely recognized as essential for transforming raw observational data into spatially meaningful information that can inform research and conservation efforts.

The GIS-based mapping interface enables users to visualize and analyze the spatial distribution of faunal species across the university campus. The system facilitates the identification of biodiversity hotspots, characterized by areas exhibiting relatively high concentrations of species records. This spatial information provides a scientific basis for ecological assessment and conservation planning by enabling researchers and institutional administrators to prioritize areas for protection, habitat management, and further biodiversity investigations.

The system supports the analysis of species distribution patterns, allowing users to examine habitat associations, species clustering, and the potential influence of environmental factors on faunal diversity. Such spatially explicit information enhances ecological interpretation and contributes to evidence-based environmental decision-making. In the Philippine context, spatial analysis has been recognized as an essential approach for identifying ecologically significant areas and informing biodiversity conservation strategies (Dela Cruz et al., 2023).

Furthermore, the integration of GIS technology enables the analysis of spatiotemporal patterns in biodiversity by combining georeferenced observations with temporal data. As biodiversity records accumulate over time, the system facilitates the detection of changes in species distribution, seasonal fluctuations, habitat utilization, and emerging ecological trends within the university campus. Such capabilities support long-term biodiversity monitoring, which is fundamental for identifying ecological changes, evaluating the effects of anthropogenic disturbances and climate variability, and informing adaptive conservation and environmental management strategies (Allan et al., 2019).

The visualization of spatiotemporal biodiversity patterns enhances the interpretation and communication of ecological information, providing researchers, institutional administrators, and other stakeholders with accessible, evidence-based insights to support informed decision-making and sustainable resource management.

System Evaluation

In **Table 2**, the system obtained a composite mean of 4.44, interpreted as *Strongly Agree*, indicating that respondents perceived the system as highly functional. Users confirmed that the system accurately performs essential tasks such as image capture, species identification, and data storage. The system meets user expectations in terms of delivering required functionalities. The integration of AI and database systems contributed to efficient task execution, consistent with findings that digital biodiversity systems enhance data processing and accuracy (Gadelha et al., 2018).

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.

In **Table 3**, the usability of the system received a composite mean of 4.39, indicating that users found the system easy to learn and interact with. The high usability rating reflects the effectiveness of the system's interface design and navigation structure. A user-friendly system is essential in encouraging adoption, particularly among students and non-expert users. This aligns with studies emphasizing that usability is a critical factor in the success of information systems (Laudon & Laudon, 2021).

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.

In **Table 4**, the system achieved a composite mean of 4.32, indicating that it performs consistently with minimal errors. This result implies that the system is dependable and capable of maintaining stable performance under normal usage conditions. Reliability is crucial for ensuring data integrity in biodiversity documentation systems, particularly when used for research and conservation (Pressman & Maxim, 2020).

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.

In **Table 5**, the efficiency criterion obtained a composite mean of 4.27, indicating that the system performs tasks quickly and efficiently. The results show that the integration of cloud computing and APIs contributes to faster processing and real-time data synchronization. Efficient systems improve user satisfaction and productivity, especially in field-based data collection scenarios.

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

In **Table 6**, the system obtained a composite mean of 4.18, interpreted as *Agree*, indicating that the system is maintainable but may still require improvements. While the system is generally easy to update and manage, slightly lower ratings suggest opportunities for improvement in system flexibility and scalability. This is common in newly developed systems and can be enhanced through continuous updates and optimization.

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.

In **Table 7**, the portability of the system achieved a composite mean of 4.23, indicating strong agreement among respondents. The results indicate that the system can be easily deployed and used across compatible devices, particularly Android platforms. However, expanding compatibility to other operating systems may further enhance portability.

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.

In **Table 8**, the overall weighted mean of 4.31 indicates that respondents *strongly agree* that the system meets software quality standards. The evaluation results confirm that the Digital Photo-Based Faunal Information System is highly acceptable and effective in terms of functionality, usability, reliability, efficiency, and portability. The slightly lower rating in maintainability suggests areas for future improvement, particularly in system scalability and adaptability. The system is suitable for institutional use and aligns with existing literature emphasizing the importance of digital systems in improving biodiversity data management and accessibility (Magcale-Macandog et al., 2021; Jauregui et al., 2022).

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 study was conducted primarily within selected areas of SSU, Catbalogan City, Samar Philippines and therefore may not fully represent biodiversity patterns across broader tropical forest ecosystems. Species identification relied partly on AI-assisted tools whose accuracy may vary depending on image quality and taxonomic complexity. Future studies may incorporate expert validation, larger datasets, and wider geographic coverage to further improve system performance and ecological applicability.

DISCUSSION

The Digital Photo-Based Faunal Information System was successfully developed as an integrated platform combining mobile data collection, a web-based administrative interface, and a cloud-based database, enabling real-time storage, retrieval, and visualization of biodiversity data . This centralized approach improves data organization, accessibility, and reliability, addressing gaps in fragmented biodiversity records (Gadelha et al., 2018; Jauregui et al., 2022).

The system enables users to capture faunal images with automatic metadata recording, while AI-assisted identification enhances accuracy and efficiency in species recognition (Wäldchen & Mäder, 2018; Norouzzadeh et al., 2018). The integration of APIs such as Gemini, iNaturalist, and Google Maps supports automated identification and GIS-based visualization, allowing spatial analysis of species distribution and identification of biodiversity hotspots (Allan et al., 2019; Dela Cruz et al., 2023).

The system successfully documented diverse faunal species with standardized records, including geotagged and time-stamped data, enabling spatial and temporal ecological analysis. Photo-based documentation further strengthens data reliability by providing verifiable evidence of species observations (Tripp et al., 2020).

The cloud-based NoSQL database ensures real-time synchronization, secure storage, scalability, and efficient data retrieval, aligning with modern biodiversity information systems (Elmendorf et al., 2016). Key features such as user authentication, AI identification, search functions, and GIS mapping enhance usability and support research and conservation activities.

Evaluation results showed high system performance, with an overall mean of 4.31 ("Strongly Agree"), indicating strong functionality, usability, reliability, efficiency, and portability, with maintainability rated slightly lower but still acceptable. These findings confirm that the system is effective, user-friendly, and suitable for institutional biodiversity documentation, supporting previous studies on digital biodiversity systems (Magcale-Macandog et al., 2021).

The results indicate that the developed system effectively addresses the lack of structured biodiversity documentation at SSU. The integration of AI improved species identification efficiency, while cloud-based storage enhanced data accessibility and reliability.

The GIS component enabled spatial analysis of biodiversity data, allowing users to identify species distribution patterns and ecological hotspots. This supports conservation planning and environmental management efforts.

The high evaluation scores reflect strong user acceptance, indicating that the system is functional, user-friendly, and reliable. These findings align with previous studies emphasizing the importance of digital systems in improving biodiversity data management.

Overall, the integration of AI, mobile technology, cloud computing, and GIS provides a robust and scalable solution for biodiversity documentation, strengthening research capability, ecological monitoring, and conservation planning.

However, limitations include dependence on internet connectivity and AI accuracy, which may be affected by image quality and database coverage.

CONCLUSION

The study successfully developed a Digital Photo-Based Faunal Information System that integrates mobile computing, AI, cloud storage, and GIS technologies. The system improves biodiversity documentation by providing a centralized, efficient, and reliable platform for recording and analyzing faunal data.

The study demonstrates that integrating AI, mobile technologies, cloud computing, and Geographic Information Systems can significantly enhance biodiversity documentation and monitoring. Beyond improving institutional biodiversity management, the system contributes to sustainable conservation planning, environmental stewardship, and community resilience by providing reliable ecological information for evidence-based decision-making. The developed platform offers a scalable model that can be adapted by educational institutions, local government units, and conservation organizations to support sustainable biodiversity management and environmental sustainability initiatives.

Future enhancements may include citizen science participation, machine-learning model retraining using local species datasets, integration with national biodiversity databases, and predictive analytics for biodiversity conservation planning.

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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

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was reviewed and approved by the Institutional Human Research Ethics Committee (SSU-IHREC), Samar State University, under Protocol Code 2026-0022-I. Ethical approval was granted on 23 February 2026, prior to the commencement of data collection.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The datasets are not publicly available because they contain sensitive biodiversity location data and human participant evaluation data that are subject to ethical and institutional restrictions to protect ecological resources and participant confidentiality.

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Conflict of Interest

The authors declare that there are no known financial, personal, professional, or institutional conflicts of interest that could have influenced the design, conduct, analysis, interpretation, or publication of this research. The authors affirm that the study was conducted independently and that all findings are presented objectively and without bias.

Declaration of Generative AI and AI-Assisted Technologies in the Manuscript Preparation Process

During the preparation of this work, the author(s) used ChatGPT (OpenAI) and Gemini AI in order to assist in language refinement, content organization, academic writing enhancement, and preliminary species identification support. After using these tools/services, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the published article.